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MONITORING OF LAND USE AND LAND COVER CHANGE IN DUHOK DAM WATERSHED USING GIS AND REMOTE SENSING

MASTER THESIS

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Dedication

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CONTENTS

ACKNOWLEDGEMENT ii
CONTENTS iii
LIST OF FIGURES vi
LIST OF TABLES vii
LIST OF SYMBOLS viii
ÖZET ix
ABSTRACT........ x

1. INTRODUCTION 1
1.1. Problem Statement 2
1.2. Justification for the Study 3
1.3. The Aim of the Study and Objectives 3

2. LITERATURE REVIEW 4
2.1. Remote Sensing (RS) 4
2.1.1. Satellite Images 4
2.1.2. Images Processing 6
2.1.3. Images Encasement 6
2.1.4. Normalized Difference Vegetation Index (NDVI) 7
2.2. Geographic Information System (GIS) 7
2.3. Vegetation and Agricultural Farming Systems 8
2.4. The Role of Agriculture in The Economy 9
2.5. Population Trends and Patterns 9
2.6. Land Suitability Assessment 10
2.7. Land Use/Cover Change 10
2.8. Land Use/Cover Change Simulation 11
2.9. Factors Influencing Land Use/Cover Change 11
2.10. Growth of Urban Area 11

2.11. Predicting Future Land Use Patterns 12

3. MATERIAL AND METHOD 14
3.1. Description of the Studied Area 14
3.2. Location and Area 16
3.3. Research Methods 17
3.4. Data Sets 17
3.5. Remotely Sensed Datasets 18
3.5.1. Landsat Images 18
3.6. Land Use / Land Cover Effects of Changes 20
3.7. Land Use Change Trend 21
3.8. The Land Cover and Soil Condition 21
3.9. Causes of Land Cover Change 21
3.10. Agricultural Lands Loss of Agriculture Land 22
3.11. Impact of Urbanization on Vegetation Cover 24
3.12. Soil Properties and their Reflectance 24

4. RESULTS AND DISCUSSION 25
4.1. The Normalized Difference Vegetation Index (NDVI) 28
4.2. Image Processing 28
4.2.1. Layer Staking 29
4.2.2. Classification of the 2001 Landsat TM Image 29
4.2.3. Classification of the 2015 Landsat ETM+ Image 30
4.3. Accuracy Assessment 31
4.4. Accuracy Assessment of Classification 32
4.5. Subset 32
4.6. Classification 33
4.7. Change Detection 33
4.8. Causes of Land Cover Change 36

5. CONCLUSION 38

RECOMMENDATIONS 40
REFERENCES 41

CURRICULUM VITAE 47

LIST OF FIGURES

Figure 2.1. Four decades of earth imaging 5

Figure 3.1. Location of the studied area 16

Figure 3.2. The study area in 2001- 2015 19

Figure 4.1. Supervised classification of the study area for the period (2001-2015) 27

Figure 4.2. Subset of the images for the study area 32

Figure 4.3. Rainfall in Duhok dam weather station data 35

Figure 4.4. Change detection map of the study area 36

LIST OF TABLES

Table 2.1. Timeline and history of the landsat missions 6
Table 3.1. Total annual rainfall (2001 and 2015) for the studied area 15
Table 3.2. The air temperature of the study area for July in 2001 and 2015 years 15
Table 3.3. Data landsat images 17
Table 3.4. Characteristics of landsat images used in this study from USGS Earth explorer website... 20
Table 4.1. The different land use and land cover LULC classes of the study area 25
Table 4.2. The LULC change detection results of the 2001 and 2015 years (in hectares).. 26
Table 4.3. Area covered by each land cover class in 2001 land cover map (in hectares and percentage) 30
Table 4.4. Table 9. The LULC change detection results of the 2015 year (in hectares).. 30
Table 4.5. Error matrix summary for the classified landsat images. 31
Table 4.6. The different land use and land cover classes of the study area 33
Table 4.7. Comparison of areas and rates of changes in the LULC classes between the 2001 and 2015 years (in hectares)................................... 34
Table 4.8. Rainfall in Duhok dam weather station data.. 35

LIST OF SYMBOLS

RS	: Remote sensing
GIS	: Geographical information systems
LULC	: Land use land cover
USGS	: United states geological survey
NASA	: National aeronautics and space administration
NDVI	: Normalized difference vegetation Index
NIR	: Near infra-red
MAS	: Multi-agent systems
km	: Kilometer
GPS	: Global positioning system
mm	: Millimeter
TM	: Thematic mapper
ESRI	: Environmental systems research institute
RSI	: Research systems inc.
LUCC	: Land use land cover change
MPN	: Most probable number
ha	: Hectares
TM+	: Thematic mapper plus
FAO	: Food and agriculture organization

DUHOK BARAJ HAVZASINDA CBS TEMELLİ UZAKTAN ALGILAMA KULLANILARAK ARAZİ KULLANIMI VE ARAZİ DEĞİŞİKLİĞİNİN TESPİTİ

ÖZET

Uzaktan algılama, dünya yüzeyinin sistematik ve geniş ölçekli gözlemleri için kullanılan bir teknolojidir ve büyük çaplı araştırma ve uygulama birimi için temeldir. Araştırılan bölge genelinde arazi kullanım yoğunluğu haritalama ve uzaktan algılama verilerine dayalı kara yönetimi değişikliklerinin izlenmesi henüz kapsamlı olarak incelenmemiştir. Bu tezin temel amacı, Duhok barajı havzasında uzaktan algılamaya dayalı geniş ölçekli arazi kullanım değişikliklerinin haritalanmasını ve anlaşılmasını sağlamak için arazi kullanım yoğunluğundan farklı arazi yönetim rejimlerinin izlenmesi için bir çerçeve geliştirmek ve uygulamaktır. Arazi kullanımındaki değişiklikleri ve toprak yüzeyinin arazi örtüsünü saptamak, kalkınmayı planlayan çalışma alanı hakkında sürekli ve kesin bilgi elde etmek için son derece önemlidir.

GIS ve RS teknolojileri, arazi kullanımı ve arazi örtüsü değişiklikleri gibi çalışma konularını çözmek için büyük olanaklara sahiptir. Bu tezde iki uydu görüntü verisi; 2001 yılı thematic mapper görüntü verileri, 2015 yılından itibaren gelişmiş tematik eşleştirici görüntü verileri kullanılmıştır. Çalışma alanının görüntüleri; Kayaçlar, Çayır-Mer'a ve Su kütlesi olmak üzere dört farklı sınıfa ayrılmıştır. Bu çalışmada, sınıflandırılmış haritalar sağlamak için denetlenen sınıflandırma büyük sınıflandırma yaklaşımı olup, dört arazi kullanımı ve arazi örtüsü (LULC) kategorisi tanımlanmış ve haritalanmıştır. Bu çalışmadaki temel yaklaşım, 2001 ve 2015 yılları arasında Duhok barajı havzasının arazi kullanımı ve arazi örtüsü haritalarını üretmek ve özellikle tarım arazisi ve kentsel veya yerleşim alanlarında meydana gelebilecek olası değişiklikleri izlemek ve bu havza kentleşme sürecini tespit etmektir.

Bitki örtülü ve bitki örtüsüz arazinin değişimini tespit etmek için NDVI endeksi kullanılmıştır. Erdas'taki değişim algılama işlevi kentsel büyümeyi ve kentsel alanları çevreleyen değişikliklerin yoğunluğunu saptamak için Imagine kullanılmıştır. Oluşturulan arazi haritaları, diğer arazi örtücü sınıflarıyla ilişkili olarak mavi kayaçların kazancını ve kayıplarını tespit etmek, inşa edilen alanların mekânsal eğilimini değerlendirmek, arazi örtüsü sınıfları arasındaki arazi kullanım geçişlerini incelemek, arazi kullanımını ve arazi örtüsü değişikliklerini nicel hale getirmek için yürütülmüştür. Genel olarak bu çalışmanın sonuçları son 15 yılda, 2001 yılında %1,02'den 2015'te %1,66'ya kadar artan su hacmi olduğunu göstermiştir. Bu sonuç, çalışmamızın temelini oluşturmaktadır. Genel doğruluğun toplamı sınıflandırma doğruluğunun toplamı olup, bu değerin de 2001'de %95,33 ve 2015'te %96,00 olması bu sonucun doğruluğunun kabul edilebilir olduğu anlamına gelir.

Anahtar Kelimeler: CBS, uzaaktan algılama, arazi kullanımı ve arazi örtüsü, (LULC), arazi kullanımı ve arazi örtüsü değişimi (LUCC), değişimin İncelenmesi, Duhok Baraj havzası.

MONITORING OF LAND USE AND LAND COVER CHANGE IN DUHOK DAM WATERSHED USING GIS AND REMOTE SENSING

ABSTRACT

Remote sensing is a key technology for systematic and broad-scale observations of the earth's surface and supply the basis for a large body of research and applications. Though, region wide land use intensity mapping as well as monitoring of changes of land management based on remote sensing data has not yet been studied thoroughly. The main goal of this thesis was to develop and apply a framework for monitoring land management regimes that differ in land use intensity so as to advance the mapping and understanding of broad-scale land use changes based on remote sensing. To detecting the changes of land use and land cover of the earth's surface is extremely important to achieve continual and precise information about study area for any kinds of planning of the development.

GIS and RS technologies have their great capabilities to solve the study issues like land use and land cover changes. Two satellite image data, thematic mapper image data from year 2001, enhanced thematic mapper image data from 2015were used in this thesis. The images of the study area were categorized into four different classes namely rocks, grass land and water body. In this study, supervised classification was the major classification approach to provide classified maps, and four LULC categories were identified and mapped. The aim of this study is to produce maps of land use and land cover of Duhok dam watershed during 2001 and 2015 to monitor the possible changes that may occur particularly in agricultural land and urban or built-up land, and detect the process of urbanization in this watershed.

NDVI index was used to detect the changes of vegetated land and non-vegetated land. Change detection function in erdas Imagine was used to detect the urban growth and the intensity of changes surrounding the urban areas. The generated land cover maps have been run for quantifying land use and land cover changes, to examine land use transitions between land cover classes to identify gain and losses of blue rocks in relation to other land cover classes and to asses spatial trend of built up areas. Generally, the results of this study have shown that there was an increased of water body in the last 15 years from 1.02% in 2001 to 1.66% in 2015. This final result provides the level genuine of our work. Overall accuracy is a total of classification accuracy, it shows result having with value 95.33% in 2001, and 96.00% in 2015 means these result are good.

Keywords: GIS, remote sensing, monitoring LULC, land use and land cover change, change detection, Duhok dam watershed.

1. INTRODUCTION

The damage of agricultural land to other land uses occasioned by urban growth is an issue of growing concern universal, mainly in the developing countries. Humans using the land and its resources for centuries in the pursuit of a better life. The way in which the land used by humans and exploited its resources over time is a serious problem (Cieslewicz 2002). As it has changed land cover and impacted the function of the ecosystem. Application GIS and RS in land and natural resources management is broadly used worldwide. LULC changes is one of the chief force of global environmental changes and for maintainable development. Currently technologies such as GIS and RS provide a cost effective and accurate another to know the dynamics of landscape. Digital image base detection of LULC based on multi - spectral remotely sensed data and multi-temporal have depicted a great potential to understanding the dynamics of the view to detect, recognize and monitor maps differences in the pattern of land use and land cover over time. LULC changes detection is essential landscape dynamic for a specific Period of time to have a sustainable management. The LULC changes have significant application in environmental management and for planning of peri-urban area (Vizzari 2011; Deng et al. 2009).

It is easy to understand some of the reasons for the phenomenon of urbanization. And provide opportunities for cities more than rural areas, including the improvement of potential employment opportunities, education, and access to health care, and provide an opportunity to increase family wealth (Moore 2003). This is partly due to the increase in urbanization, travel and trade, there has been a global increase in broad access to goods and services, as well as increases in the level of education (McMichael 2000). It can analyze the negative effects of rapid urbanization on water basins using multiple satellite imagery angles with the detection of change techniques. The pollution of water has a negative effect on plants, human health, and aquatic life. Monitoring of environmental changes exposed pollutants and their causes and finding needed It should be precautions a must. Remote sensing is an important alternative for such monitoring of changes in urban, water and air (Foody 2002; Lunetta et al. 2002). RS and GIS apply different sorts of processes (e.g rescaling, classification and interpolation).

On spatial data to produce maps or to extract spatial information from the data groups; there is always. Some of the uncertainty in these processes (Krivoruchko et al. 2005). Uncertainty considers aspects like error and incompleteness of the input data as well as the output data. With the invention of RS and GIS techniques LULC mapping is a useful and a detailed way to improve the selection of areas designed to agriculture, urban and industrial purpose (Rawat and Kumar 2015). The application of RS can help to study the changes in land cover in short time low cost and with good accuracy in association with GIS that provides suitable platform for data analysis, retrieval and update. Population growth and urban stretch pointed regional economic growth. Though, human caused deforestation and alterations of natural landscape to construct buildings, sewage, water supplies and transportation works put undesirable impacts on land and soil, biodiversity, vegetation, air and water qualities, and contributes to an environmental degradation both inside a watershed and in its surrounding (Benitez et al. 2012; Seilheimer et al. 2007). In order to cope these negative impact of urban sprawl and for planning a village future expansion, government official, urban planner and policy maker need careful attention of the current pattern of LULC and their spatiotemporal changes.

1.1. Problem Statement

The expansion of villages into the surrounding areas which are under agricultural lands as well as various natural land covers such as forests, wetlands and grasslands is one way in which the growth of villages had been disadvantageous. The variations that come along with this growth may has big effects on the ecosystem services, hydrological systems, biodiversity, and local climate which in role may impact human health. From the current trend of urbanization, it is clearly observable that the available agricultural land had been affected by developments like constructing commercial and residential buildings infrastructure like roads, play grounds and leisure parks.

1.2. Justification for the Study

The Duhok city, Iraq is characterized by semi-arid clime. No or rare research has been done on the monitoring of LULC change in the selected area and this research will open up the area for further researches.

My goal for this research was to better understand effects of conflict on agricultural LULC in Duhok dam watershed, which has a long history of both conflict and agriculture. Actually, in recent periods, the dynamics of LULC and particularly settlement expansion in the area requires a sophisticated system and more powerful such as GIS and RS data which supply a general global gross coverage of large areas than area photography.

1.3. The Aim of the Study and Objectives

The study focuses on the analysis of urban growth trend, examines the LULC change and predicts the urban growth patterns by using the markov Chain models at Duhok dam watershed over the time period of 14 years and prediction of 2020 has been adopted. This study analyzes the land use and land cover changes and urban sprawl in the city of Peshawar using RS landsat data for the years 2001, and 2015. The objective is to classify LULC classes in two years changes detection that occurred in each LULC classes.

- To find out factors that lead to urbanization in watershed.
- Detection of the impact of land use, whether natural and anthropogenic.
- Understanding the effect of increasing urbanization in study area in an adaptable.
- Calculate and monitoring the urban sprawl change detections and response to the population growth in the watershed over the last fourteen 14 years.
- Explore methodology to decrease the human population bias associated with a passive surveillance database.

2. LITERATURE REVIEW

2.1. Remote Sensing (RS)

Is it collects information about an area process, object or phenomenon without being in physical contact with it. Given this somewhat general definition the term has become closely linked to more specifically with the gauging of interactions between earth surface materials and electromagnetic energy. RS denotes to activities that collect information from a distance. Remote sensing these devices employ as the lasers, camera, radio frequency receiver, and radar systems, gravimeters magnetometers and seismographs (Jensen 2005). The science RS is of the acquisition, processing and interpretation of the images recorded. The interaction between electromagnetic energy and matter.

2.1.1. Satellite Images

Several type of imagery are existing for the purpose of RS of land use land cover (LULC) though, when conducting studies to monitor time series of LULC, landsat imagery is preferable as the time decision is near to the near and mid infrared bands allows close examination of vegetation and other landscape features (Zeledon and Kelly 2009). It obtained the images used for this study from the USGS earth explorer database

It has got landsat satellite images of the earth without stopping coastal shallows, land surface, and coral reefs (Since 1972). The national aeronautics and space administration (NASA) and U.S geological survey (USGS) was established. The landsat program, to routinely collect land imagery from space. NASA develops the RS tools and spacecraft, then launches and validates the performance of the satellites and instruments. And it holds the US geological Survey (USGS) satellite ownership and operation in addition to the management of all terrestrial receivers, data archiving, distribution and product generation. A result of this program is a long-term record of human and, natural changes resulting from the global landscape (figure 2.1).

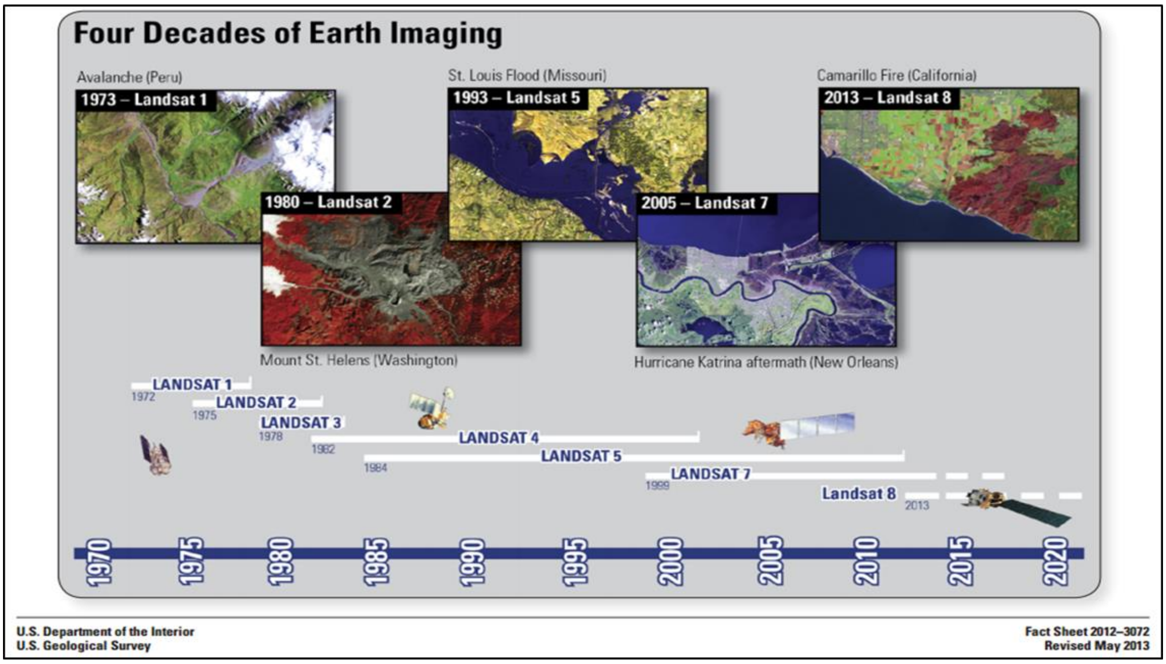

Figure 2.1. Four decades of earth imaging

On 23 July 1972, the first civilian satellite dedicated to obtain repetitive remote sensing data of earth with spatial resolution of less than 100 m was launched. Two series of landsat's have been launched, landsat (1,3) and landsat (4,5) (Table 2.1). Also in 1993 landsat 6 was launched and landsat7 launched on 1999 (Table 1) illustrates the sensors used on landsat missions (Weidick 1988).

Table 2.1. Timeline and history of the landsat missions

Satellite	Launch	Decommissioned	Sensors
Landsat 1	July 23, 1972	January 6, 1978	MSS/RBV
Landsat 2	January 22, 1975	July 27, 1983	MSS/RBV
Landsat 3	March 5, 1978	September 7, 1983	MSS/RBV
Landsat 4	July 16, 1982	June 15, 2001	MSS/TM
Landsat 5	March 1, 1984	2013	MSS/TM
Landsat 6	October 5, 1993	Did not achieve orbit	ETM+
Landsat 7	April 15, 1999	Operational	ETM+
Landsat 8	February 11, 2013	Operational	OLI/TIRS

2.1.2. Images Processing

Preprocess of images prior to classification it and change detection is very basis. Preprocessing usually comprises a sequence of sequent process, involving atmospheric correction or normalization, geometric correction, image registration, and masking. The preprocessing steps of a RS image usually are performed before the post processing enhancement, extraction and analysis of information from the image. Normally, it will be supplier the data who will preprocess the image data before delivery of the data to the client or user. Preprocess of image data predominantly it will contain radiological engineering and corrections (Since 1972).

2.1.3. Images Encasement

The main purpose of improving the image is to visual improvement interpretation of the image by increasing the clear uniqueness between the features in the scene (Lillesand et al. 2008). This ensures that features appears clear and increases the ability to differentiate several features. Different approaches are used in image enhancement including principal components analysis, kauth-thomas transformations and vegetation indices (Jensen 2005; Lillesand 2008). Image satellite enhancement is the processing of improving the visible impersonation of an satellite image it is not necessary that the enhanced image looks like a conventional image but the alterations that have been caused should be understood by processing to permit correct visual interpretation (Campbell 1996). Enhancement It is also used as a step in the pre-processing applications that require human view of the satellite image before further processing.

2.1.4. Normalized Difference Vegetation Index (NDVI)

The NDVI provides a measure of vegetation on the surface of the earth widespread areas. The NDVI is a calculation used to recognize vegetation and its health through the levels of chlorophyll detected in the leaves. NDVI is calculated from the visible and near-infrared light reflected by vegetation. vegetation health cover absorbs most of the visible light contained and reflects a large share (about 25%) of the near infra-red (NIR) light, but a low portion in the red band (RED). Unhealthy vegetation reflects more visible light and less NIR light, to apply the NDVI the following formula is used:

$$NDVI = (NIR - RED) / (NIR + RED)$$

NDVI is uses large-scale for transformation in order to enhance vegetation information. It is used to measure plant cover vegetation information (Jensen 1996; Tucker 1979; Leica 2008). They are used to measure vegetation characteristics and their inclusion in many forest assessment studies (Wulder 1998). It can be used for accurate description of land cover and vegetation classification. In some cases, multi resolution imagery and integrated analysis method were included along with NDVI for land cover classification (Nogiet al. 1993).

2.2. Geographic Information System (GIS)

GIS is a systematic collection of computers, devices and geographic data, software and staff efficiently design, storing, updating, processing, analyzing and presenting all forms of information referred to geographically (Baral 2004). The technologies been combined of GIS and RS to discover and control urban transcendence in a way which is faster and easier than traditional methods of surveying the urban environment (Da Costa and Cintra

1999). In this study in 2001 – 2015 years period, land-use changes in Duhok dam watershed were examined. Changes in shoreline and residential areas were exposed.

You can obtain spatial data or geographic data from a variety of sources such as images, GPS and current maps. Once the information is collected, the GIS stored as a set of layers in the GIS database (Evans et al. 1976). Furthermore, GIS can also be defined as a based computer system for capturing, analyzing, storing, manipulating and visualizing specially referenced data and integrating it with other computer based information (Huisman and Rolf 2011). Spatial or geographic data can be gained from a range of sources such as the imagery, existing maps and GPS. Once the information is collected, a GIS stores it as a gathering of layers in the geographical information system IS database (Evans et al. 1976). According to the Aronoff, is a based computer system that supply the following four capability to grip geo-referenced data:

- Data capture and preparation.
- Data management (storage and maintenance).
- Data manipulation and analysis.
- Data presentation.

2.3. Vegetation and Agricultural Farming Systems

In order to care the farmers and to stimulate the plant and animal production, the Kurdish ministry will insure the utilize of new methods and technology the improvement of farm apparatus, the introduction of transport subsidy, recent machinery and training in contemporary agricultural methods and techniques as well as health and safety issues. The vegetation consists mostly of open grassland and thorny woody species. Crops and livestock are of similar importance and the pressure on arable land is high.

Agriculture of north of Iraq as public and governor it can be now and for the future as one of the prime economical column of north of Iraq region, because of increasing the number of its citizen. The purpose of choosing this investigation is increasing the number of citizens of the region and Iraq. Agriculture and livestock keeping are the most common land use activities. In Duhok dam watershed, small-scale agriculture is widely practiced with most production being for subsistence use, whereas small-scale horticulture is practiced in some parts (Mbugua 2002). Increasing human population has led to loss of vegetation through cultivation, overgrazing, fuel wood, firing and charcoal production (Mbugua 2002; Sindiga 1984).

Fallows act as grazing zones for animals. Livestock breeding at times could be categorized as farmer-livestock breeding, or transhumant. Crop cultivation is usually done with simple equipment. The agricultural land falls into two discrete categories: rainy season fields and dry season fields also some commercial farming. The vegetation consists mostly of open grass land and thorny woody species. The vegetation is concentrated in strips separated by patches of bare soil. Grasses are dominant of plant life with some scrubby bushes with corresponding vegetation varying from steppes to tall grasses and scattered trees (Oyoade 1977). Crops and livestock are of similar importance and the pressure on arable land is high. Residents tend to live in permanent villages, although part of their flock may continue to migrate seasonally with the boys herd and through arrangements entrusted.

2.4. The Role of Agriculture in the Economy

It has a dual agricultural economy comprising of a commercial sector and a predominant survival sector consisting of cattle ranching, crop farming and mixed farming. These all take part in a dominant role in supporting livelihoods and economic growth to the whole region as they provide food, income, power, stability and resilience to rural livelihoods. The agricultural sector plays a key role through its impact on overall economic growth, income generation, household, food security. The main cash crops include wheat, barley, cotton and tobacco.

2.5. Population Trends and Patterns

Climate change can affect land degradation risk in agricultural areas, soil erosion, and contamination corresponding to tropical regions (Shahbazi 2010). Ability to adapt agricultural practices to a climate changing.

2.6. Land Suitability Assessment

The attempt to evaluate land suitability covers the whole basin. This assessment of suitability for livestock production is aimed at demonstrating whether livestock based agriculture is a suitable land use option or not. In ideal nature protection schemes this information could have been used to gauge the suitability of land for herbivore wild animals (De Leeuw and De Heer 2002). Availability of food and water is one of the most essential determining factors for land use decision for livestock development. Once the spatial distribution of the land use, the daily average intake pattern across the study area and the maximum possible feed availabilities throughout each month are known the monthly feed status of the given area is easy to determine. Grazing and forest lands are two major land uses in the study area. The rest is occupied by cropland (2%) and impermeable areas (8%). The agriculture is non-intensive and tillage is conventional. The forest zone comprises forestlands in various degree of degradation ranging from completely treeless spots nearby villages existing roads and areas subjected to land sliding or intensive erosion to nearly dense forests at the remote sites or some steep slopes (Guest 1966).

2.7. Land Use/Cover Change

One of the main reason of land use change which ultimately causes environmental problems it is urbanization. It includes definitions and land use planning in the context and discussions of land change, urbanization of the united states of America. This part of the thesis initiates a discussion on why land change due to urbanization is one of the major causes of environmental problems (Ellis and Pontius 2006). The cover vegetation is thicker on the north facing slopes compared with the south. On the south facing slopes, the vegetation is spare and has been overexploited for long time and at this time consists of shrubs and bushes of little economic value.

2.8. Land Use/Cover Change Simulation

Can occur LULC change through the direct and indirect consequences of human being behavior to secure essential resources. This may first have occurred by way of burning of areas to develop the availability of wild game and it accelerated with the birth of agriculture, resulting in widespread clearing such as deforestation and earth's terrestrial surface management that takes place today (Valbuena et al. 2008; Rindfuss et al. 2004). Land use land cover change (LUCC) is known as a sovistgate process which is cause by the mutual interactions between environmental and social factors at temporal scales and different spatial (Ellis and Pontius 2006).

2.9. Factors Influencing Land Use/Cover Change

To the economy, the agricultural sector plays an essential role through its effect on gross economic growth, households income generation and food security. Are influenced by a variety of factors operating on more than one spatial and temporal level and acting not in isolation but in intricate webs of place and time-specific relationships. Several theories, originating in the natural and social sciences and, more recently, in a multi-disciplinary research, has advanced to describe and explain LULC change.

Factors affecting land use physical factors economic factors human factors:

- Climate- rainfall, wind and sunlight.
- Capital- this is the money needed to buy machinery, animals, land seeds, tools, fertilizers etc.
- Soils- the mineral texture, mineral content, and depth of soil affect the land use.
- Relief- affect the possibility of the using of agricultural machinery and the rate of erosion soil.

2.10. Growth of Urban Area

In 1800, more than 97 percent of the world's population in rural areas. After a hundred years later, 5.5 percent is still only of the world's population lives in cities, although already in 2000 was slightly more than half the world's population live in more cities (Xu

2007). We move to the capitals in search of economic advantages, cultural richness, educational opportunities and diversity of experiences that large cities provide. As a result of this population shift, many capitals have grown rapidly and spread into the surrounding countryside (Huapeng et al. 2010). With the fast growth of urban areas engaged in the process of further urbanization, urban LULC are always in dramatic flux, further changing terrestrial biological, physical and meteorological processes, leading to severe ecological and ecological problems. Monitoring of urban settlements using multi-temporal RS datasets has received increasingly larger attention in recent years. Land cover change mostly used in different areas can be used to describe changes in urban settlements and vegetation patterns as an important indicator of urban ecological environments and as well, plays a significant role in the assessment of human settlements (Clarke et al. 1998).

2.11. Predicting Future Land Use Patterns

An essential part of their profession, the land use planners envision and adopt alternative patterns of land use and patterns of activity in the future in order to change the status quo. Typical land use planning process and requires that the planners landscape investigation and classification of the investigation and in the current conditions for the development of possible future development patterns and propose vegetation based on the information available (Brail and Klosterman 2001). Planners usually approach this task in two ways, a predominant or traditional approach and an analytical approach. The traditional approach is envisaged to reach a result of future land use, and then should put the current priorities of policies to achieve that result.

Analytical approach simulates alternate current strategies and compares their consequences. A recent pervasive approach to consider and simulate human decisions in LUCC is the use of multi-agent systems (MAS) (Parker et al. 2003; Matthews2006; Robinson et al. 2007; Valbuena et al. 2008). MAS are defined as modeling tools that allow entities to make decisions according to the predefined agents, and the environment also has a spatial explicit pattern. In fact, agents in the system might embody groups of people or individuals, etc (Valbuena et al. 2008; Sawyer2003; Bonabeau 2002; Crawford et al. 2005). Agents can be designed with different characteristics which will be explained later in this chapter.

3. MATERIAL AND METHOD

3.1. Description of the Studied Area (Topography, Climate, Rainfall, Temperature)

The area is the watershed of Duhok dam belongs to the Zargross mountain region. It is located at the headwater of the mainstream passing through the city of Duhok, Iraq. It is bounded by parallels N36^o 87.110′ and N37^o 01.015′ and meridians E42^o 84.055′ and E43^o 06.010′ and covering an area of 134.37 km^2. It is bordered on the north by Kamaka mountain, from the south by the white mountain, or Duhok city, from the east and northeast by Zawita and from the west by Baikhair mountain. It is an artificial lake and its water mainly comes from rain, snowmelt and the main tributaries of Sunder and Garmava which on their joining make up Duhok river.

- **Topography**

The located of watershed is mountainous area! mostly the slopes are very deep and naked due to soil erosion. The rocky slopes are steep to very steep.

- **Climate**

This study will be conducted in the Duhok dam watershed. The area is a hilly region and characterized by semi-arid and semi-humid climate. The climate of North of Iraq is characterized by extreme conditions, the large temperature difference between day and night and between winter and summer are noticed (Sharif 2001). As a mountain area the weather of the area study is of mediterranean type. The annual evaporation exceeds the annual rainfall. As a whole, its features climate by wide diurnal and annual ranges of temperature. Annual average temperature is 19.4°C with an average summer high of 32.8°C in July and an average winter low of 5°C in January. The ratio of actual sunshine duration to maximum possible sunshine duration ranges from about 0.35 in January to about 1.0 in July (Aziz 2002).

- **Rainfall**

Rainfall of the area study is characterized by low, erratic rainfall and a dry period of 6 – 7 months. Mean annual rainfall is about 570 mm, of which more than 90% occurs between the month December and April. High concentrations in spring months are caused by thunder storms with relatively high rainfall intensities.

It has been obtained by the total annual rainfall of the study area from the meteorological station for the 2001 and 2015 years (Table 3.1).

Table 3.1. Total annual rainfall (2001, and 2015) for the studied area

Region	**Rainfall (mm), Years**	
	2001	2015
Duhok dam watershed	650	612

- **Temperature**

The minimum and maximum and average air temperature and relative humidity of the areas study provided by the ministry of agriculture region (Table 3.2).

Table 3.2. The air temperature of the area study for July in 2001 and 2015 years

Region	**Temperature (^oC), Years**			
Duhok Dam watershed	2001		2015	
	Max.	Min.	Max.	Min.
	35	5.6	37.5	7.5

3.2. Location and Area

The study area belongs to the Zargross mountain region. It is bounded by parallels N36° 87.110′ and N37° 01.015′ and meridians E42° 84.055′ and E43° 06.010′ and covering an area of 134.37 km^2. It is bordered from the north by Kamaka mountain, from the south by the white mountain, or Duhok city, from the east and northeast by Zawita and from the west by Baikhair mountain (Figure 3.1).

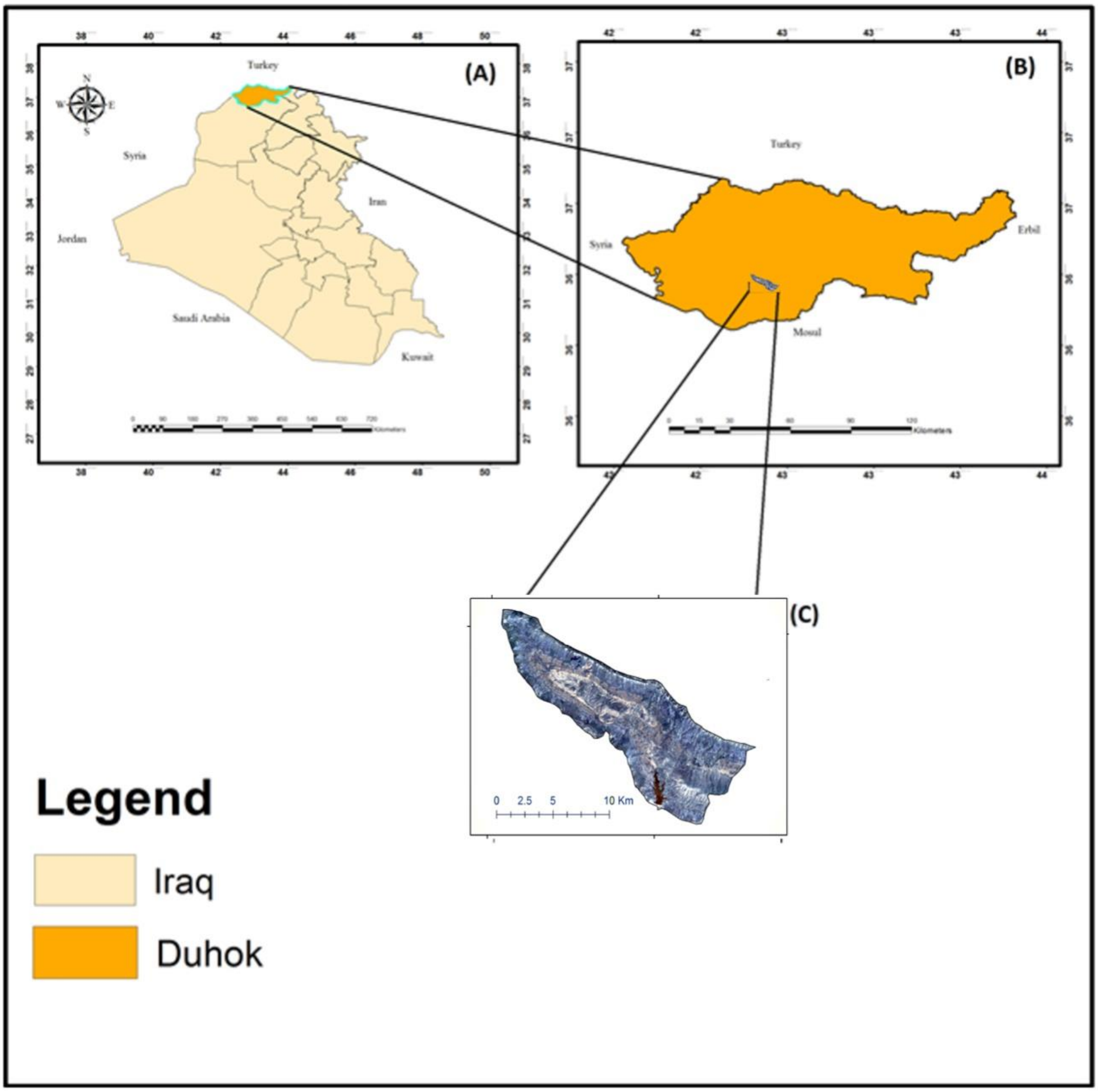

Figure 3.1. Location of the studied area

3.3. Research Methods

There are much of models or methods relating to land use land cover change modelling. Despite their differences they basically rely on a limited number of methods and assumptions. The following programs will be used during this research are:

ENVI (V. 5.3, ITT visual information solutions group (ITT VIS), formerly known as research systems Inc. (RSI), Boulder, CO, USA) for image processing.

ArcGIS (V. 10.4.1, environmental systems research institute (ESRI), Redlands, CA, USA) for producing map.

3.4. Data Sets

Landsat images used in this research included the May 28, 2001 thematic mapper (TM), and enhanced 12 June 2015 thematic plus.

Table 3.3. Data landsat images

Image	Path/row	Acquisition date
Landsat TM	170/034	2001/05/28
Landsat ETM+	170/034	2015/06/12

3.5. Remotely Sensed Datasets

3.5.1. Landsat Images

Two landsat images were used in this study a scene, (path170/34) attained on 28 May 2000 by TM sensor on board landsat 7 was used as the first data image. The second with the same path/row acquired on 12 June 2015 by ETM+ sensor on board landsat8 was used were downloaded from the USGS earth explorer (Table 3.4). The TM and ETM+ sensors images have resolution spatial of 30 m for bands (1-5 and 7). This band used to increase

the ground resolution of the six multispectral bands through image fusion. All the TM and ETM+ bands were quantized as eight bit data (Fazel 2000). Figure 3 explain a color composite (RGB 741) of the area study in 2001, 2015 years.

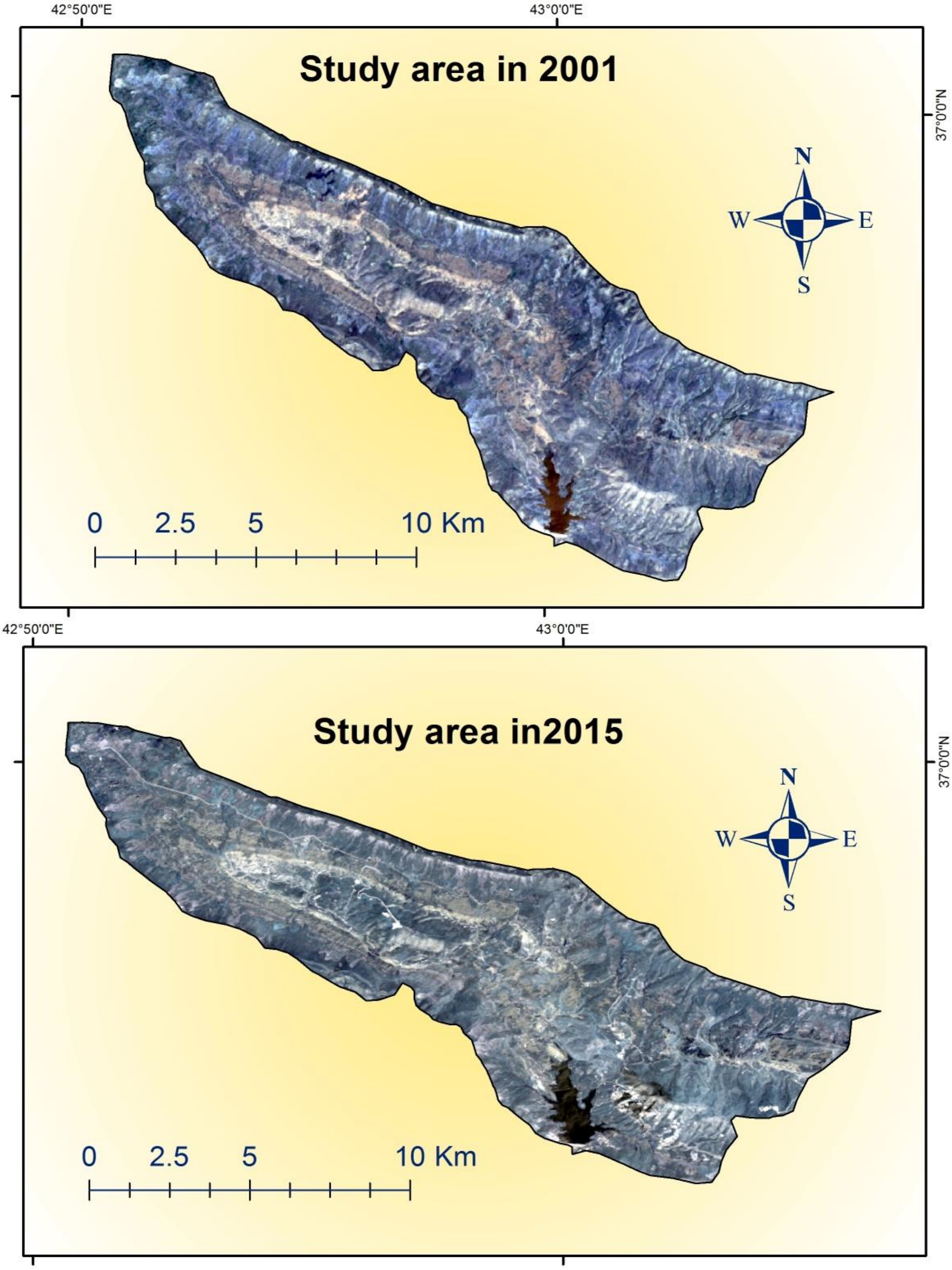

Figure 3.2. The study area in 2001, 2015 years

Table 3.4. Characteristics of landsat images used in this study (from USGS earth explorer website)

Satellite	Landsat7	Landsat8
Landsat Product Identifier	LE07_L1TP_170034_20010528_20170205_01_T1	LC08_L1TP_170034_20150612_20170408_01_T1
Acquisition Date	2001/05/28	2015/06/12
Start Time	2001:148:07:34:21.3798443	2015:163:07:43:47.2084980
Stop Time	2001:148:07:34:48.4037193	2015:163:07:44:18.9784940
Center Latitude	37°28'33.60"N	37°28'27.44"N
Center Longitude	43°08'02.40"E	43°13'08.54"E
UTM zone	38s	38s
WRS Path	170	170
WRS Row	034	034
Ellipsoid	WGS84	WGS84

3.6. Land Use / Land Cover Effects of Changes

The current land cover change pattern in the study area could be attributed to a complex interaction of environmental, socio-economic and demographic factors. Some of the factors that may have influenced on rapid change in land cover in the district are as follows.

1. Rapid population growth.
2. Land tenure system.
3. Poverty and high dependency ratio.
4. Infrastructures.
5. Natural factors.

3.7. Land Use Change Trend

The transformation can occur from the use of one land to another, and the change in the economy and the spatial distribution of the population, for example, conversion of agricultural lands to residential, industrial, commercial or recreational use. Land owners are playing a key role in any place will happen in the land, and therefore their decisions determine the method and amount of changes (Ettema et al. 2007). Thus, different types of land owners (e.g. farmers, developers, private individuals, government) make a decision in a different way according to their type and their parameters. The owners have to supply the financial investment of land change, thus, their awareness of the economic situation can control the speed of the changes. At each time step, the land owner can decide the following decisions:

1. Leave the land at current situation.
2. Develop the land by change the land usage and exploit it.
3. Develop the land by change the land usage and sell it.
4. Sell the land to another owner.

3.8. The Land Cover and Soil Condition

The main soil types in the study area is the clay soil and clay loam soils. Most of the uplands are subjected to sheet erosion. Plentiful deep gullies can also be observed. With no exception all the study soils where non saline with soil reaction above 7.

3.9. Causes of Land Cover Change

Increased stress on the land due to population growth affects the hydrology of the area. The assess the effects of changes in land use on land cover change water resources, runoff generation and floods is often necessary in hydrological modelling and it has gained great importance in the past decades. He described the calder hydrological impacts of land use. Land use change can have local, regional and global hydrologic consequences. At the global level, the biggest change in terms of land area as well as in terms of hydrological impacts is from afforestation and deforestation. Afforestation can affect the annual flow, seasonal flow and flood. It also improves water quality and reduces soil erosion. The agricultural intensification leads to a change of transpiration rates and affect runoff. The wetland drainage land, urbanization and other changes in land use with significant hydrologic consequences. The increasing urbanization of land uses uncontrolled, reduces infiltration and cause more runoff and peak discharge.

LUCC can happen through the direct and indirect consequences of human activities to secure vital resources. This may first have occurred by means of burning of areas to develop the available of wild game and it accelerate with the birth of agriculture, which led to large-scale purge such as deforestation and management of the land surface of the earth that take place today (Ellis and Pontius Jr. 2006). Land use cover change is known as a complex process resulting from the mutual interactions between environmental and social on different spatial and temporal scales factors (Valbuena et al. 2008; Rindfuss et al. 2004). In their stress study the importance of detention retention structures to reduce the increased flow rates, stream bank erosion and to improve the water quality caused by urbanization (Fongres and Fulcher 2002). A study conducted by noorazuan (website) concludes that the natural diversity of the langat river, malaysia basin, changed significantly after the 1980s and as a result, the changes also changed the flow of the stream in response to langat's. If the continued watershed urbanization is projected to the future, the current hydrologic characteristics of the coastal streams will likely continue to change, and the aquatic and riparian-associated wildlife species that are favoured under these modified conditions will continue to increase at the expense of those species better suited to historic conditions.

3.10. Agricultural Lands and Loss of Agriculture Lands

Agriculture is dangerously being endangered by rapid urbanization due to the problem of scarcity of land for agricultural purposes that will arise. Since the land is needed now uses as well as agriculture and forestry in urban cente, its value has shifted from looking at his fertility and other favourable biophysical characteristics to that of its functions. This has resulted in the acquisition of some agricultural land most suitable for residential development, especially those located near the center.

The loss of agricultural land into urbanization has become possible because of the high rate of natural population increase and migration of people to a number of towns.

Urbanization brings main changes in demand for agricultural products both from increases in urban populations and from changes in their demands. This has led to significant changes in how to meet the demands and in farmers, businesses and corporations, local and national economies. It can also bring major challenges for urban and rural food security (McGranahan et al. 2009).

In the consequence of urbanization and development of cities that resulted loss of agricultural land, continuously, urbanization affects food production by removing agricultural land from cultivation, as cities expand. Agriculture is neglected as an area becomes increasingly urbanized. Urbanization leads to the inaccessibility of land, and fragmentation of land, change in land supply, and the rapid increase in land values. Thus, it resulted in the allocation of agricultural land for residential development to a decrease in the volume (size) and quality of land (Dinye et al. 2013). Agriculture is defined as regular use and observer organizations living environment and to improve the human condition. Agriculture is the main activity that relies heavily on land resources. Hence, it is necessary to explore the possibilities of land resources (Kenk and Cotic 1983). Agricultural land is the basis of agricultural products and food production. Agricultural land is required mostly the production food for animal and human consumption, agricultural activities also include the cultivation of fibre plants, fuel and other products derived from organically. Physical, chemical, biological and mechanical inputs necessary for the growth of crops and are provided in the end of the soil, humidity, temperature, plants, animals and biological factors. Inputs of the agricultural system produce are controlled through appropriate agricultural practices. The use of the most capable and supports land provides these inputs, land and the most capable and productive agricultural land (Agyemang et al. 2011). However not all, agricultural lands are capable or suitable for producing all agricultural products, regardless of the level of management applied.

The main factors in the specific terrain, climate and irrigation. The weather determines the thermal energy and moisture inputs required for agricultural production. And restrict topographical constraints often the ability to use the equipment for agriculture. Natural resources in any region have economic significance. Agriculture is the main main activity of which depends largely on land resources. Hence, it is necessary to explore the possibilities of land resources (Andres and Nowatzki 2004).

3.11. Impact of Urbanization on Vegetation Cover

The vegetation coverage within the urban areas plays a main role in providing an environment for recreation for the inhabitants as well as energy conversion and material exchange of the earth, and vegetation cover is a visual sign of ecosystem health. Although the dynamic development of vegetation is affected by natural factors and human factors, both, the impact of human factors on the change of vegetation is more important than natural factors in recurrent human activities areas (Huang et al. 2013). Available studies have focused on the population and vegetation cover mainly on the devastating effects of human activities on vegetation. The overly green plants were recorded and used by humans to support their productive activities and living. Urbanization causes severe and permanent alteration of the natural vegetation. Industrial growths in urban areas have directly consumed a huge amount of vegetation. The development of agriculture has destroyed a large part of the original vegetation. These vegetation areas are high threatened by the transformed urban land use due to increasing pressure on land in most of the cities. In summary, it is a negative relation between the area of vegetation cover distribution and the level of urbanization and human activities (Manawadu and Wijesekera 2009).

3.12. Soil Properties and Their Reflectance

Soil study can provide information on the reflection of the soil and vice versa notes from the soil reflection can provide information on some of the characteristics of the soil and, in general, the quality of the soil condition. The main soil components are solid inorganic material consisting mainly of crystalline minerals and non-crystalline materials, organic materials, air and water, or a solution containing a variety of soluble compounds (Irons et al. 1989). There is a high correlation between the soil and the reflection of several soil properties such as organic matter content, metallurgy, moisture content, particle size distribution, the content of iron oxide color and salt content of soluble (Bowers and Hanks 1965). A supervised classification has been done in Duhok Iraq for the period 2001-2015.

4. RESULTS AND DISCUSSION

In order to monitoring of LULC change and detect any change among the different land cover classes between 2001 and 2015, maximum likelihood of supervised classification was utilized based on landsat 7 ETM and 8 OLI, the results of the classification of the images indicate that all of the classes vary between 2001 and 2015. This can be visually seen in (Figure 4.1), which shows the main land cover types. In this Figure, yellow color shows blue rock white colour shows white rocks, blue color shows water, orange colour shows grasslands.

Table 4.1. The different land use and land cover (LULC) classes of the study area

LULC class	Description	Colors
Rocks	Rocks that have in the watershed	Yellow
Grassland	Plant, trees, soil, residential, roads.	Orange
Water	The water of Duhok dam.	Blue

There is a significant change in the quantity of water body between 2001-2015 and indicate that there is a growing trend toward water in year 2015 at the expense of agricultural land, vegetation land and barren land. The quantity of water was 137.97 ha, with ratio 1.02% in 2001 increased to 224.66.42 ha, with ratio 1.66% in 2015, these because years around 2001 precipitations was low 480.4 mm because of low rainfall precipitate and water body decreased. The specific reasons of increasing water body in 2015 are the years after 2001 the rainfall rate was high 616.8 mm. increasing the rate of water constantly because of feeding from other water resources and melting snow from the mountains around Duhok dam along the years after 2001. It is shown in (Table 4.2).

Table 4.2. The (LULC) change detection results of the 2001 and 2015 year (in hectares)

Classes	**2001**		**2015**		**Difference (%)**	**Description**
	Area (ha)	**Area (%)**	**Area (ha)**	**Area (%)**		
Rocks	2554.675	18.93	2023.205	14.99	4.99	Decrease
Grassland	10805.7	80.05	11250.5	83.35	3.3	Increase
Water	137.97	1.02	224.662	1.66	0.64	Increase
Sum	13498.345	100	13498.367	100		

Noticeable changes occurred in grass land in the area, with this land cover type mild increasing that was 10805.7 ha, with ratio 80.05% in 2001 increased to 11250.5 ha, in ratio 83.35% in 2015, and rocks dominated 2554.675 ha. with ratio 18.93% in 2001 decrease to 2023.205 ha, in ratio 14.99% in 2015.

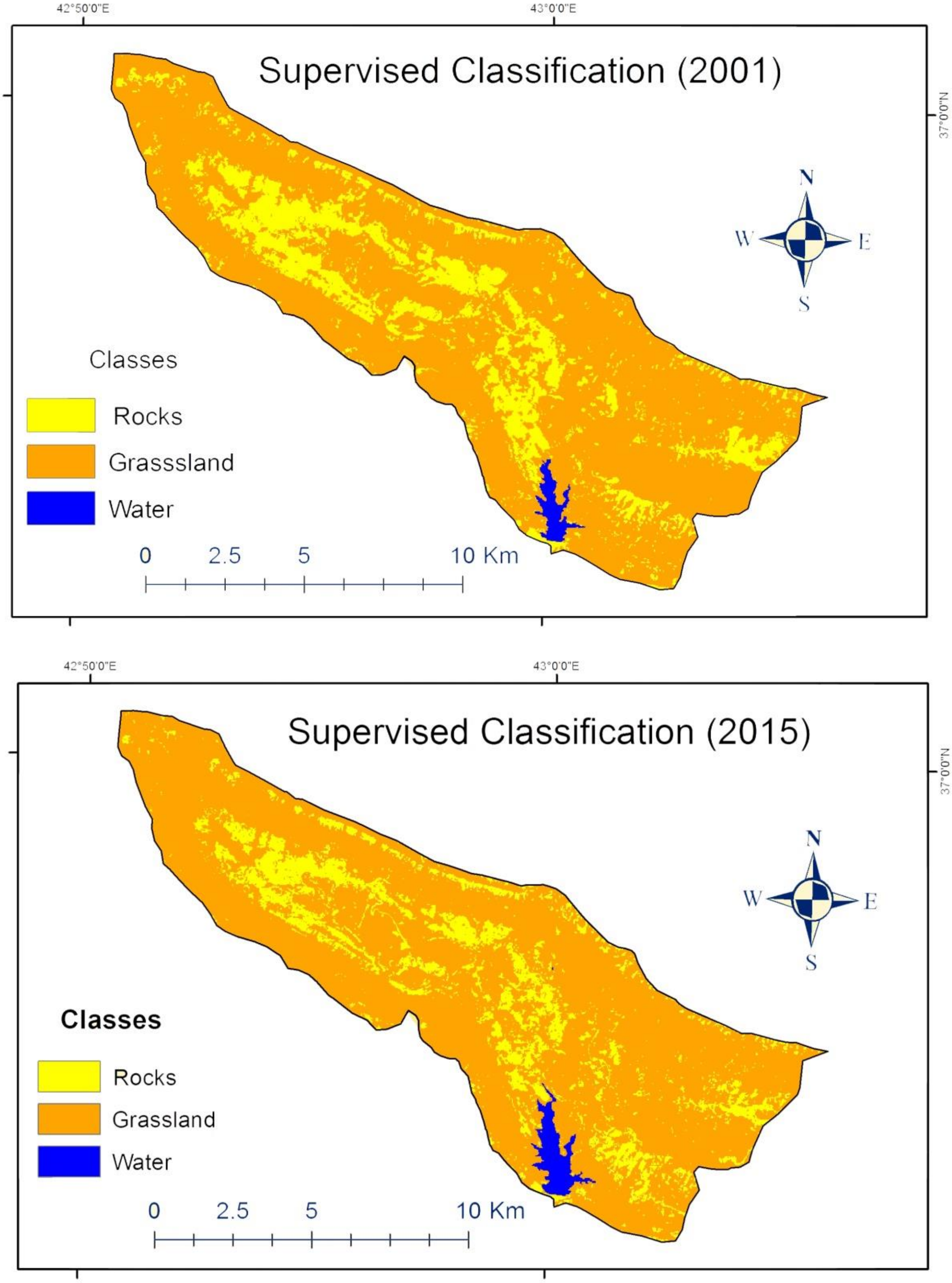

Figure 4.1. Supervised classification of the study area for the period (2001-2015)

4.1. The Normalized Difference Vegetation Index (NDVI)

The NDVI derivative from 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 ETM+ and TM dataset images. The NDVI is the most commonly used vegetation index due to it has an appropriate measurement scale ranging from -1 to 1 with zero as an approximate value of no vegetation. Negative values represent non-vegetated surfaces, whereas values close to 1 it has very dense vegetation. The NDVI has the capability to decrease extrinsic noise factors such as sun-angle variations and topographic effects (Rouse et al. 1974). Found that NDVI is sensitive to the rainfall and there is a positive relation between them. The NDVI algorithm was used for monitor changes in vegetation in this study.

NDVI = (TM4 – TM3) / (TM4+TM3), (Near infrared wavelength – red wavelength)/ (Near infrared wavelength + red wavelength)

NDVI was used in this study to analyze the amount of change in vegetation versus non-vegetated (non-green) with the three temporal data. It is also based on the spectral principle difference, On the basis of strong absorption in the red plants and strong reflection in the proximal part of the infrared of the spectrum.

4.2. Image Processing

Pre-processing of satellite images prior to image classification and change detection is necessary. Pre-treatment usually consists of a series of successive processes, including atmospheric correction or normalization, recording images, geometric correction, and concealment. It is the volatility of the atmosphere, which can enter. The difference between the values of reflection or digital numbers (DN's) in the satellite images acquired at different times. Although the effects of the atmosphere on the remote sensing data are not considered errors, while they are part of the signal that the sensor receives, consideration of these effects is important. It must be comfortable that the next target image pre-processing, should all the images appear as if they were obtained from the same sensor.

Processing is performed for the image remotely sensed in general steps before improving information processing and extracted and analyzed from the picture. Usually, the data will be the resource that will pre-processing image data before the data is delivered to the client or user. Pre-processing often of image data will consist of geometric correction and radiometric correction. But this paper only focuses on geometric correction. Geometric corrections are made to correct the deviation between the elements of the image of the site in the image data and coordinate the actual location on the ground coordinates. It includes several types of corrections system engineering, precision, and terrain corrections (Deby 2001).

4.2.1. Layer Staking

Layer stacking is a process for merging multiple images into a single image. So to do this must have the same range of images (the number of rows and number of columns), which means you will need to redraw the other bands that have different spatial resolution to the target accuracy. In other words, you must have all the images bands the same spatial precision to be able to perform the stacking layer. However, combination of images bands increase the size of the image final stacked and thus will increase the processing time later when doing your analysis. If you know you will not use all the images bands in your analysis, it would be better not to stack all the images in a single image, choose only specific images of interest. It depends on the purpose or objectives of the study.

ENVI ⟶ Basic tools ⟶ Layer Stacking

4.2.2. Classification of the 2001 Landsat TM+ Image

Initial unsupervised classification of the 2001 landsat TM image yielded results with most of the classes mixed. The upper zone of the district covering watershed was classified as grass land. The classification resulted in a 2001 land cover map with four classes settlement was the grass land covering 80.05% followed by rocks at 18.93% and water area is 1.02% (Table 4.3).

Table 4.3. Area covered by each land cover class in 2001 land cover map, in hectares and percentage

Classes	**2001**	**Area (%)**
	Area (ha)	
Rocks	2554.675	18.93
Grassland	10805.7	80.05
Water	137.97	1.02
Sum	13498.345	100

4.2.3. Classification of the 2015 Landsat ETM+ Image

The classification resulted in a 2015 land cover map with four classes settlement was the grass land covering 83.35%, followed by rocks at 14.99% and covered water area is 1.66% (Table 4.4).

Table 4.4. The LUCC detection results of the 2015 year (in hectares)

Classes	**2015**	
	Area (ha)	Area (%)
Rocks	2023.205	14.99
Grassland	11250.5	83.35
Water	224.662	1.66
Sum	13498.367	100

4.3. Accuracy Assessment

After the classification process we made a evaluate for the accuracy assessment by using method of confusion matrix by ENVI software in RS, the result of the overall accuracy and kappa coefficient for the 2001 and 2015 years (Table 4.5).

Table 4.5. Error matrix summary for the classified landsat images.

Landsat images	Overall classification accuracy	Overall kappa statistics
L7_image 2001	95.33%	0.8306%
L8_image 2015	96.00%	0.8204%

For proving the accuracy assessment of the work that is done in this study and knowing the genuine of the work. We have to do classification again for the study area; this can be done by receiving different set and point, for proving the genuine of the accuracy assessment, by doing so a new accuracy will be received. This new accuracy assessment with the accuracy that is done before the classification is it will be integrated by using ENVI 5.3 software and post classification with matrix confusion and using ground truth image complete. Basically, by using these methods the complete result of the work is it will be received. This final result provides the level genuine of our work. Overall accuracy is a total of classification accuracy, it shows a good result having with value 95.33% in 2001, and 96.00% in 2015 means these result are good (Table 4.5). Kappa coefficient is a discrete multi-technology variables for use in accuracy assessment, if kappa coefficient > 80% represent strong agreement and significant accuracy. In this study value of kappa coefficient is 0.8306% in 2001 and 0.8204% in 2015 represent a good accuracy (Table 4.5).

4.4. Accuracy Assessment of Classification

Points used in accuracy assessment were depends on the GPS points and interpretation of 2001 and 2105 aerial photograph. A confusion matrix was generated for both 2001 and 2015 land cover maps with both users and producers accuracies. Kappa statistics were also calculated for the two land cover maps. The 2001 land cover map had a comprehensive accuracy of 95.33% and kappa statistics of 0.8306% and 96% and kappa statistics of 0.8204% (Table 4.5).

4.5. Subset

In this study, the subset process in ERDAS imagines software was used to select the area study from the landsat7 images (Figure 4.2).

Envi ⟶ Basic tools ⟶ Subset Data Via ROIs

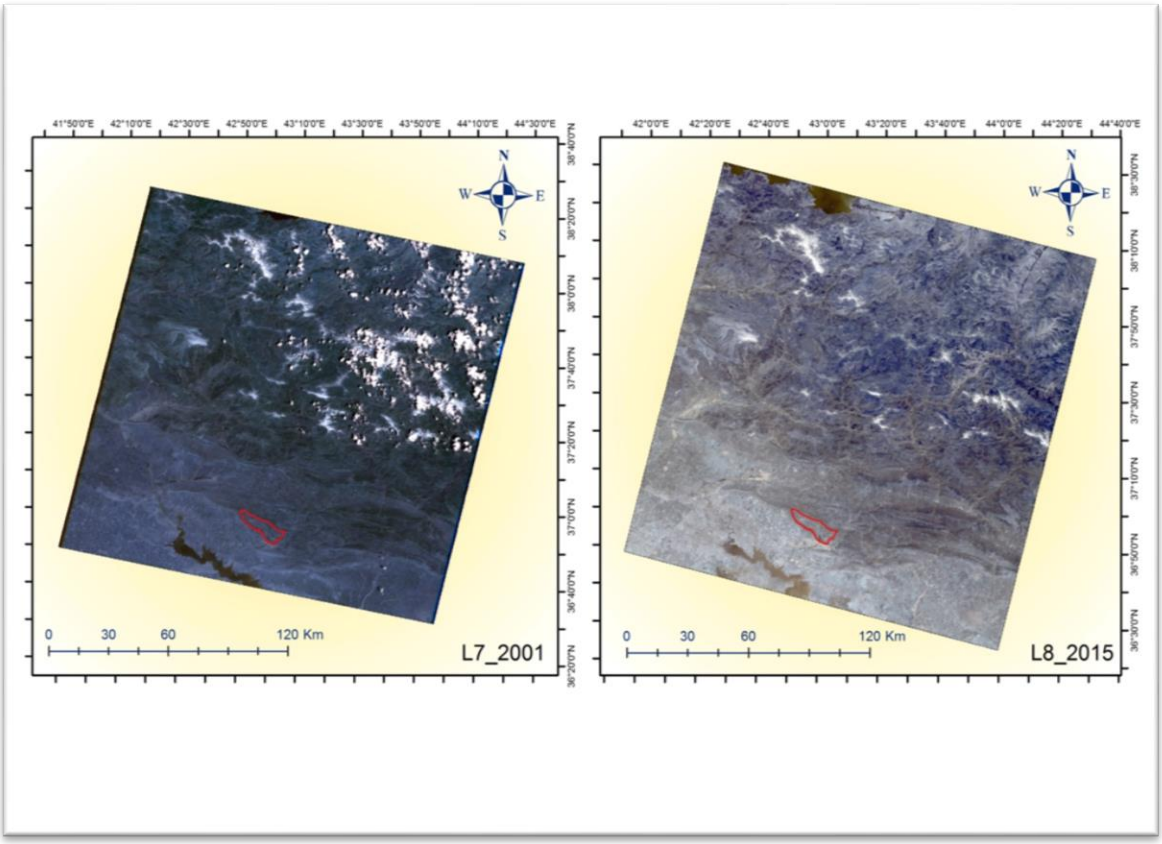

Figure 4.2. Subset of the images for the study area

4.6. Classification

The classification of the two images was geared towards separating fife classes as indicated in the classification scheme below. The classes were based on field work experience and a modification of classification scheme (Xu 2007). And a hierarchical class system was adopted.

Table 4.6 The different land use and land cover LULC classes of the study area

LULC class	Description	Colors
Rocks	Rocks that have in the watershed	Yellow
Grassland	Plant, trees, soil, residential, roads.	Orange
Water	The water of Duhok dam.	Blue

The three criteria for including an area within an urban boundary are:

1- Rocks.
2- Grassland.
3- Water.

4.7. Change Detection

Change detection is a process by which the method of changes that occur in land cover, over a certain number of years, can be observed (Huisman and Rolf 2011). Class-level metrics like transition matrix were taken into account in order to carry out change detection. These standards are included with patches of different categories. The number of patches of a certain class represents the extent of the class and they furthermore show the fragmentation of that has occurred in that class. The change detection analysis has been carried out for the 2001 and 2015 years in Duhok dam watershed, the spatial distribution of these changes is illustrated. The change detection results there is a significant change in the quantity of water body between 2001 and 2015 and indicate that there is a growing trend toward water in year 2015 at the expense of agricultural land, and rocks. As seen in (Table 4.7), 72.65 ha of grass land was converted to water, and 14.33 ha of rocks, was converted to water between 2001 and 2015. The distribution of these changes is illustrated in (Figure 4.4). The quantity of water was 137.97, with ratio 1.02% in 2001 increased to 224.662 ha, with ratio 1.66% in 2015 look figure, these changes in water body because years around 2001 precipitations was low 440 mm because drought happened and water body increased. The specific reasons of increasing water body in 2015 are the years after 2001 the average of rainfall was high 587.8 mm (Figure 4.3 and Table 4.8). Increasing the average of water constantly because of feeding from other water resources and melting snow from the mountains around Duhok dam along the years after 2001. In this research water body and the changing, it is focused on more than the other class (Figure 4.4 and Table 4.7).

Table 4.7. Comparison of areas and rates of changes in the LULC classes between the 2001 and 2015 year (in hectares)

LU/LC 2001(ha) / **LU/LC 2015 (ha)**	Rocks	Grassland	Water	Total class
Rocks	1625.29	915.14	14.33	2554.76
Grassland	397.912	10335.15	72.65	10805.72
Water	0	0.20	137.68	137.88
Total class	2023.2	1948.49	224.66	
Class change	492.907	915.342	86.89	
Def. change	1831.47	-444.778	-86.69	

Table 4.8. Rainfall in Duhok dam weather station data

Years	Annual rainfall depth(mm)
2000/2001	587
2001/2002	650
2002/2003	650
2003/2004	632
2004/2005	719
2005/2006	619
2006/2007	510
2007/2008	528
2008/2009	584
2009/2010	567
2010/2011	624
2011/2012	511
2012/2013	623
2013/2014	238

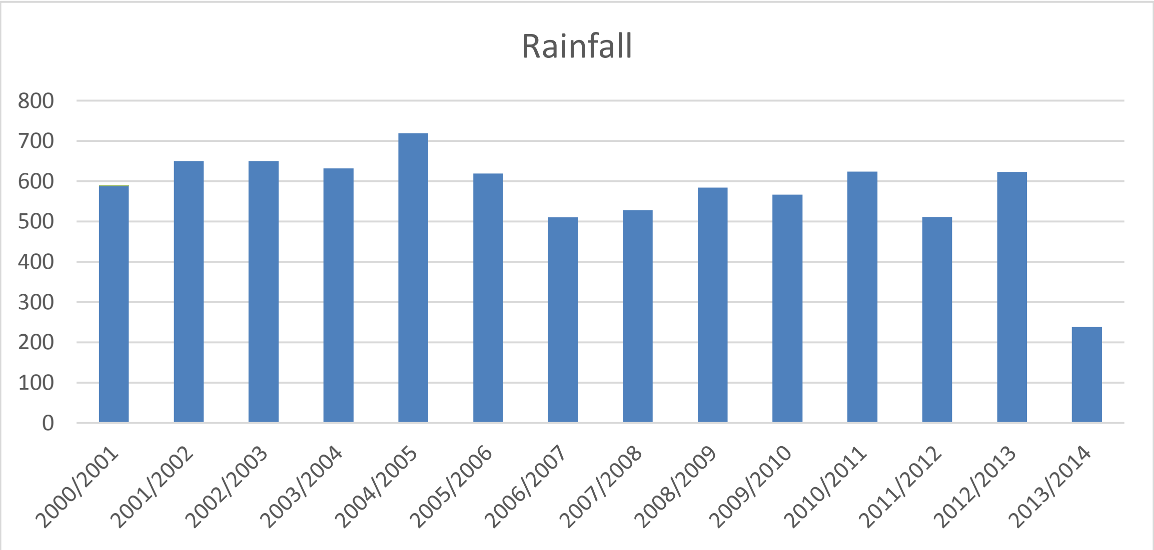

Figure 4.3. Rainfall in Duhok dam weather station data

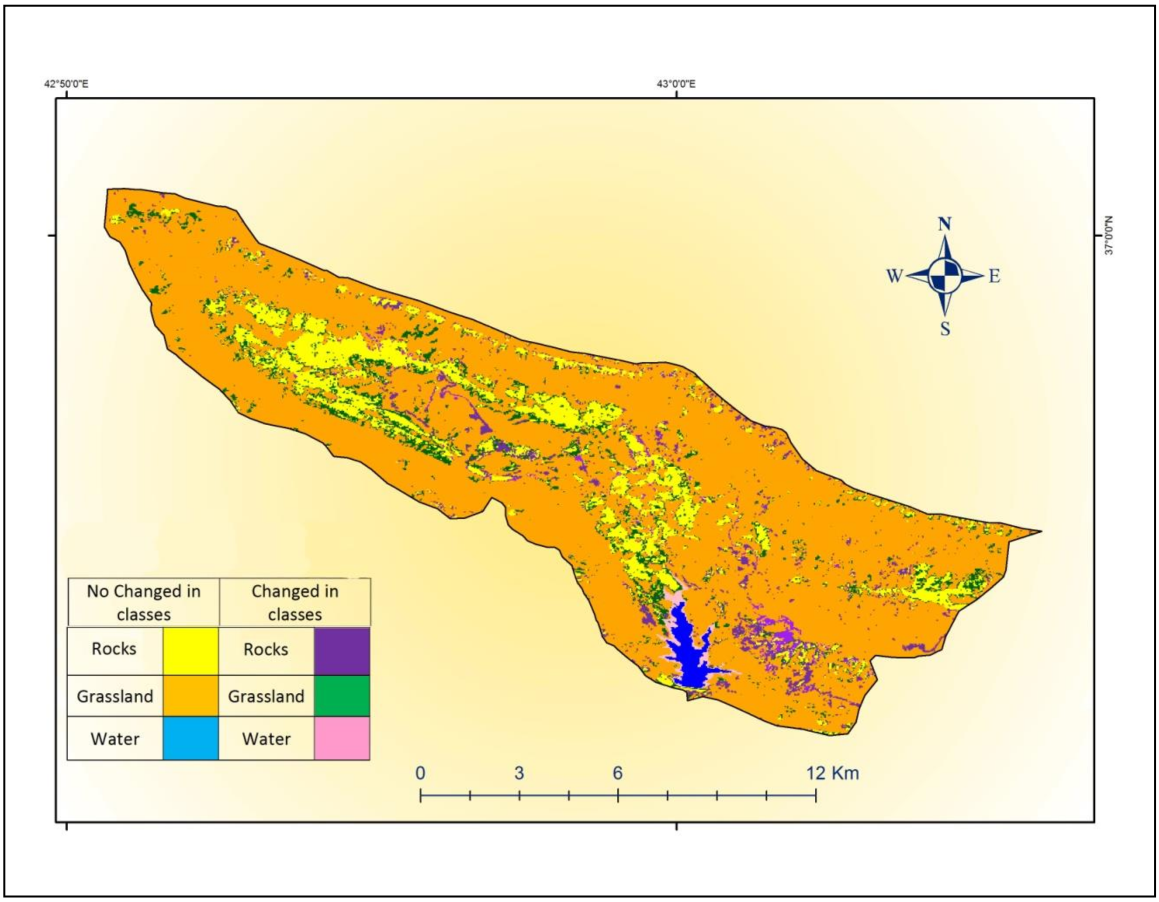

Figure 4.4. Change detection map of the study area

4.8. Causes of Land Cover Change

The current land cover change pattern in Duhok dam watershed could be attributed to a complex interaction of environmental, socio-economical and demographic factors. Some of the factors that may have influenced on rapid change in land cover in the district are as follows.

1. Rapid population growth: Agriculture is the main economic activity with over 80% of the population depended on farming. Rapid population growth has therefore translated to increased clearance of vegetation for agriculture and overgrazing.

2. Land tenure system: Ever-changing cultivation and pastoralist were the main economic activities as there was plenty of the land. Communal grazing land was also readily available and therefore less overgrazing. Subdivision and privatization of land meant no communal grazing land and this led to overgrazing. Land adjudication also meant the end

to shifting cultivation, causing increased over cultivation and degradation of the fragile environment.

3. Poverty and high dependency ratio: High poverty levels can be attributed to over reliance on agriculture, persistent drought, poor soils and irregular rainfall. High dependency levels are as result of large household size with Most of the population consisting of the young and nonworking. Charcoal making has been a very common way of survival during the harsh conditions among the poor. Poverty has led to subdivisions of the already small pieces of land for reselling.

4. Infrastructures: Population pattern is greatly influenced by physical amenities like road network. Population density is high in urban areas and along the main roads in the district.

5. Natural factors: Based on the observable land cover change pattern in this research, an analysis of rainfall data from the watershed dating back to the 1989s revealed a descending direction in the annual averages over time. On the other hand, water bodies in the watershed have influenced settlement pattern, with people preferring to settle close to water bodies like dams and permanent rivers.

5. CONCLUSION

This study has been conducted by integrating GIS and RS and spatial modelling tools. In order to detect and analyze changes in land cover classes, these techniques were implemented. In the first section, satellite data for the study periods of 2001and 2015 and RS techniques were applied to generate land cover maps through a maximum likelihood supervised image classification algorithm. Like other areas, urban monitoring and management is also one of application areas of the information sciences and technologies, GIS and RS. These technologies can be used from acquire information of extensive areas with RS data to analyzing spatially as per the requirement with GIS. These technologies can provide computer aided tools for mapping, monitoring, and analyzing urban dynamics to incorporate the acquired information for management purposes.

Two landsat images corresponding to 2001 and 2015 were produced. The overall accuracy of the two maps was above 95.8% and the overall kappa statistics was above 0.825. Different land cover classes had differing producer's and user's accuracy levels indicating different levels of omission and commission errors. Through the detection of LUCC and urbanization, the results and discussions were achieved. This thesis integrates the GIS and RS to monitor the changes of land use and covers in Duhok dam watershed from 2001 to 2015. From the results and discussions above, the trends and changes of LULC in Duhok city, Iraq, can be been clearly from the thematic maps and statistical tables. The future work and suggestions to enhance the accuracy of the results from the authors of this thesis are also drawn (Lambin et al. 2001).

The results show that using GIS knowledge and RS technology to monitor the LUCC is effective and feasible. Even though there are problems with the accuracy of the data and operations it is a scientific way to detect the LUCC.

Generally speaking, the preconcert aim which is using LUCC to monitor urban growth based on GIS and RS of this thesis has been achieved. Updating the information of LUCC using GIS and RS is helpful for development of human society. Furthermore, the limitations also have been mentioned above. To overcome such situations, GIS and RS technologies could also be one of the essential solutions to be realizing the true phenomena in the watershed and take properly immediate necessary actions. After the advent of the GIS tool in the world it has been possible to simulate the land classes for years to come in the future which could be good news for urban management in watershed (Lambin and Mostard 2005). Stated that monitoring of land cover change should be extended to areas where rapid changes are happening but are not hotspots of academic activity to better inform the world and possibly attract the attention of the academic community. Furthermore, the overall picture of causes of LUCC can best be understood using place based research and comparative analyses of case studies of land use dynamics.

RECOMENDATION

The issue of LUCC is one of the most important research fields in science of geography. The urbanization is a result from interactions between natural environment and human activities. This study provides a combining method to monitor the LUCC and urbanization in Duhok dam watershed. Although this study has discussed the LUCC especially the urbanization and achieved some results, the limitations like time and data resources made this study of human activities could not be more specific. As mentioned above, the accuracy of results from urban change detection and CA Markov depended on the accuracy of classification.

In the future studies, more time and efforts should be spent on the accuracy improvement as the accuracy of classification is extremely important to the results of LUCC. This study was only depended on the satellite images to identify the different ground features. All the results were generated from the remote sensing data. Further research should try to integrate both field based and digital based land cover change methods to ensure high accuracy.

Finally, it’s important to focus on the use of remote sensing and GIS techniques on how to monitor the land use and land cover change.

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