Using Remote Sensing Techniques to Assess Land Use/Land Cover Change in Laylan Sub-District, Kirkuk Province, Iraq

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Abstract

In this study, Landsat (Thematic Mapper) TM and enhancement Thematic Mapper plus) ETM+ images obtained in 1990, 2000, and 2006 were used to Assess land use/land cover (LULC) changes in Laylan sub-district, Kirkuk province, Iraq, using Supervised Maximum Likelihood classification (MLC)) methods. Aerial photographs, digital LULC maps, and topographic maps were utilized to assess classification accuracy. The aim of this study is to identify the changes that have occurred in land use in the city through different periods of time. Objective of the study is also to identify the factors affecting the distribution uses of land in the city. Five different land cover/use categories have been used, named Vegetation, sand, soil, salt soil, urban areas. The classifications showed that decrease of the grasslands areas, agricultural lands and vegetation in general and the increase of urban areas mixed soil. The results are being used to project future analyze landscape diversity and fragmentation, and examine different scenarios for more ecological management. The classifications have provided an economical and accurate way to quantify, map and analyze changes over time in land cover.

Keywords: Remote sensing, Landsat TM/ETM+ images, land use/land cover (LULC), Maximum Likelihood Classifier (MLC), classification.

استخدام تقنيات التحسس النائي لتخمين التغيرات في استعمال الأرض وغطائها لمنطقة ليلان في محافظة كركوك ,العراق

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الخلاصة:

في هذه الدراسة ، تم أستخدم الصور الفضائية الملتقطة بواسطة القمر الصناعي Landsat من نوعية (TM) Thematic Mapper والنوعية (Enhancement Thematic Mapper plus) (ETM+) للأعوام 1990 ، 2000، و 2006 لمراقبة التغيير الحاصل في استعمالات ألأراض وغطائها (LULC) لمنطقة ليلان ،في محافظة كركوك من العراق ، وذلك من خلال استخدام طريقة التصنيف الموجه(Supervised Classification) وتحديدا طريقة الاحتمال الأعظم حيث تم تقييم دقة التصنيف من خلال استخدم الصور الجوية والخرائط الرقمية لاستعمالات الأرض وغطائها ، وكذلك الخرائط الطبوغرافية. الهدف من هذه الدراسة هو التعرف على التغيرات التي حدثت في استخدام الأراضي في المدينة من خلال فترات زمنية مختلفة . وكذلك لتحديد العوامل التي تؤثر على استخدامات توزيع الأراضي في تلك المنطقة. وقد

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استخدمت خمس فئات من لأغطية الأرضية الشائعة تمثلت بالغطاء النباتي والرمل و التربة، والتربة المالحة ، والمناطق الحضرية . أظهرت التصنيفات التي انخفاضا من المناطق المراعي والأراضي الزراعية والغطاء النباتي بشكل عام وزيادة المناطق الحضرية والتربة المختلطة. أظهرت نتائج التصنيف إمكانية استخدام النتائج في دراسة وإعداد مشاريع مستقبلية وكذلك اعداد دراسات في ادارة البيئة .

Introduction

Land-cover refers to the physical characteristics of earth's surface, captured in the distribution of vegetation, water, soil and and/or artificial structures. Land-use refers to the way in which land has been used by humans and their habitat, usually with accent on the functional role of land for economic activities. Land cover/land use is a composite term, which includes both categories of land cover and land use. Land cover/land use change information has an important role to play at local and regional as well as at macro level planning and management. Most of the time the planning and management tasks of the environment are troubled due to insufficient information on rates of land cover/land use changes. The land cover changes occur naturally in a progressive and gradual way, however sometimes it may be rapid and sudden due to anthropogenic activities [1].

Land-use and land-cover change (LUCC) can be major threat to biodiversity as a result of the destruction of the natural vegetation and the fragmentation or isolation of nature areas [2]. Land-use and land-cover changes are one of the main human induced activities altering the hydrological system [3]. Remote sensing techniques offer benefits in the field of land use/ land cover mapping and its change analysis. One of the major advantages of remote sensing systems is their capability for repetitive coverage, which is necessary for change detection studies at global and regional scales. Detection of changes in land use/ land cover involves use of at least two period data sets. The changes in land use/ land cover due to natural and human activities can be observed using current and archived remotely sensed data [4].

Optical remote sensing (RS) plays a vital role about defining land use and land cover (LULC) changes and monitoring interactions between nature and human activities. Additionally, RS provides time, energy and cost saving. Today, optical RS data such as satellite sensor images and aerial photos are used widely to detect LULC dynamics. LULC mapping outcomes are used for global, regional, local mapping, change detection, landscape planning and driving landscape metrics. Remote sensing image classification can be viewed as a joint venture of both image processing and classification techniques [5]. Multispectral image classification is one of the important techniques in the quantitative interpretation of remotely sensed images.

Multispectral images usually involve a pixel (picture element) having its characteristics recorded over a number of spectral channels [6] [7]. Image classification is an important part of the remote sensing data mining.

The present study was to analyze the nature of change in temporal and spatial patterns of different land use and cover(LULC), the land in Laylan sub-district, Kirkuk province, Iraq, during the period 1990-2006 using satellite images, which are good tools to clear the land use because it allows the interpreter take a comprehensive look .Those uses on the ground and the spatial relationships between them as well as geographic information systems, in order to produce maps chronicling the continuing evolution of the land cover during periods of variable time. In this study we used supervised classification method.

The study Problem

The last century witnessed a significant change in the patterns of land use and land cover at the local level, as a result for many of the variables natural and human and political rights. This has seen the study area, like the rest of the areas in the Kirkuk province many development projects and soil conservation projects. Significant changes in land cover shed were this study. To answer the following questions:

1.What types of land cover and land use Prevailing in the district of Laylan sub-district?

2. What kinds of changes in the distribution of land use and land cover during the period 1990, 2000, 2006 and what is the ratio of the change?

3. What are the main reasons that led to the difference in the areas of land cover and land use during the study period?

The Study Area

The study area is about total area of 214.750 km^2, located in Laylan sub-district which belongs to Kirkuk province in the south-east of the city. It is bounded between the latitudes 35°23'18.13", 35°16'52.61"N and longitudes 44°23'18.90, 44°35'15.97"E, where is bounded Taza sub-district from west, Qarahanjir sub-district from north east and Daquq district from south west, these places belongs Kirkuk province, also is bounded the Tuz district in Slah-aldin province and Chamchamal district in Sulimaniah province from east figure 1. From the field observations and the satellite images the area includes a diversity of land cover/land uses classes it appeared that there are several types of sand dunes accumulations, in the southern west and northern east study area and also there are soil and salt soil distributed in different regions. and in the middle of study area there are land uses rural , including agricultural fields, grasslands and wetlands, are dispersed across the surrounding landscape and it interspersed suburban land uses .

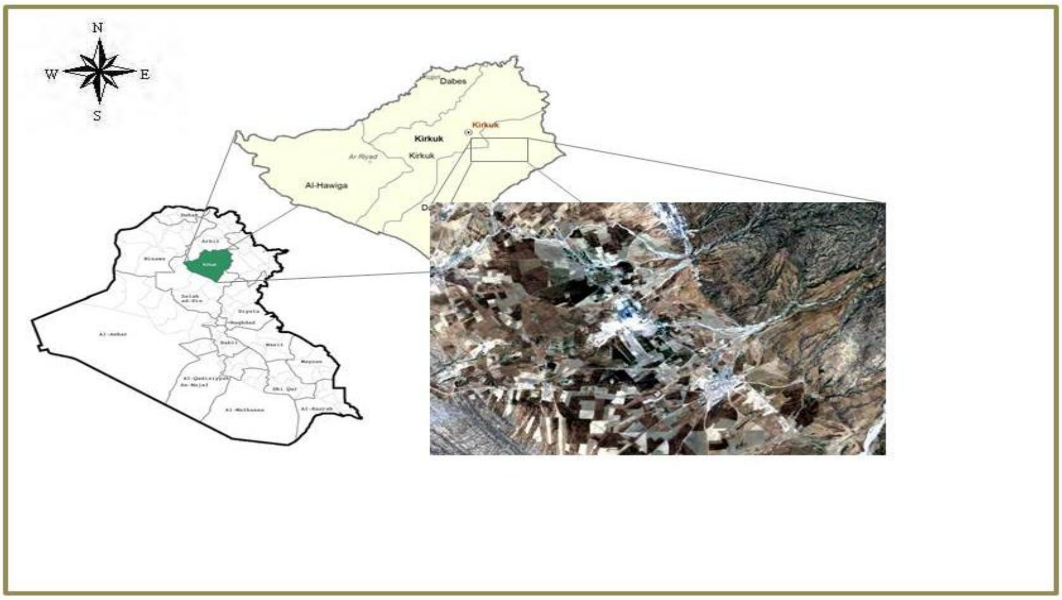

Figure 1-Orientation map of the study area.

Methodology

The research involved two main steps. In the first step, classification of satellite data for Land use/ Land cover has been done. The second step concentrated on the change detection analysis in the Land use/ Land cover. Analysis of satellite data includes registration, classification and change detection using post classification comparison Satellite data. Supervised classification is used for Land use/ Land cover mapping and change detection analysis of, TM, and ETM+ for the years1990, 2000 and 2006 respectively. According to that five classes of the vegetation, sand, soil, salt soil and urban.

The main goal of this study is to reveal environmental changes using multi- temporal satellite data, in order to extract changes. The digital image-processing software ENVI 4.7 was used for the processing, analysis and integration of spatial data to reach the objectives of the study. ENVI was used to generate the false color composite, by combing near infrared, red and green which are bands 4,3,2 together for both images. This was done for vegetation recognition, because chlorophyll in plants reflects very well to near infrared than the visible. Multi-temporal Landsat TM/ETM+ data acquired on early and mid to late spring dates in1990, 2000 and 2006 have been used to classify level I and II land cover. Ground control points obtained using a Global Positioning System (GPS) from locations in relation to the classes of the study area was plotted on Landsat ETM+ image, which was used to verify the training sites (defined classes) as regards the spectral signature. Supervised classification for the various classes was performed using and finally maximum likelihood classification was used for the classification of the images. The development of the databases of the multitemporal land cover/use maps was one of the objectives of this study and the success (or not) will work as a pilot application for other areas. The combination of these maps with other thematic maps as soil, road network, and vegetation density maps will give answers to the changes of the land cover / land use categories and in some cases the reasons of the changes.

Results and discussion

Comparison of digital interpretation with reference information indicated that digital interpretation closely resembled field observations. A more rigorous quantitative measure of accuracy performed using the test areas, however, indicated that some categories were classified and mapped more reliable than others. The overall classification accuracy in the two test sites was as 90%, 92.28 % and 94.7 % respectively. The unsupervised image classification method carried out prior to field visit, in order to determine strata for ground truth. Fieldwork carried out to collect data for training and validating land-use/cover interpretation from satellite image of 2006, and for qualitative description of the characteristics of each land-use/cover class. The land-use / land cover maps of 1990, 2000 and 2006 were produced by using supervised image classification technique based on the Maximum Likelihood Classifier (MLC) and 432 training samples. Figure 1, figure 2 and figure 3 present the classification of the study area of the years1990, 2000 and 2006.

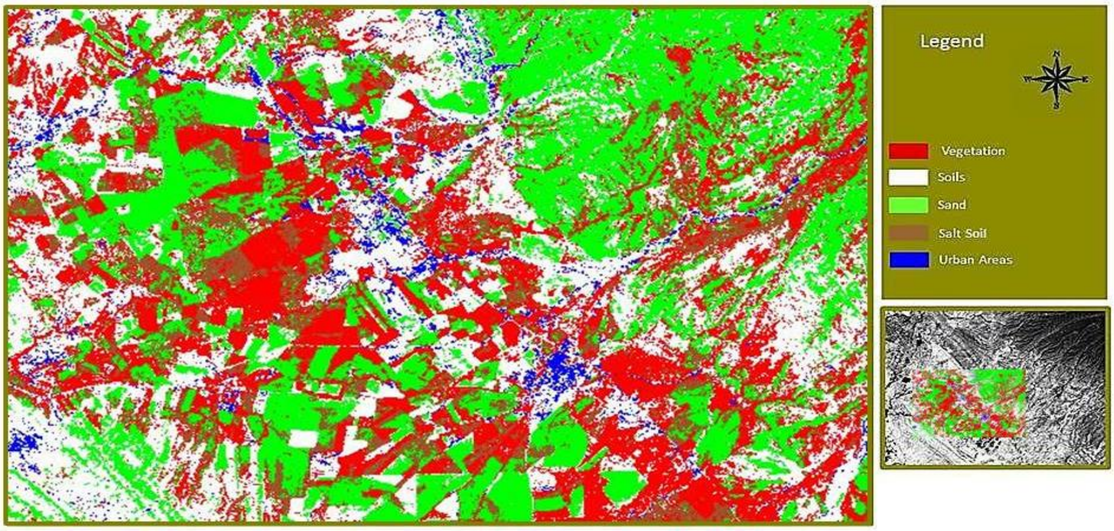

Figure 2 - The classified image of the year 1990

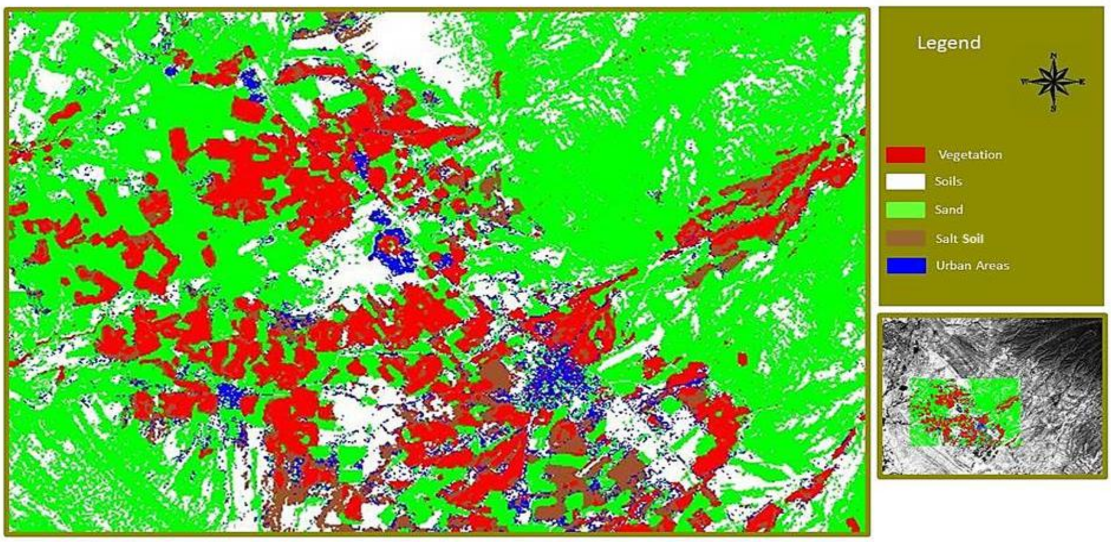

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Figure 3 - The classified image of the year 2000.

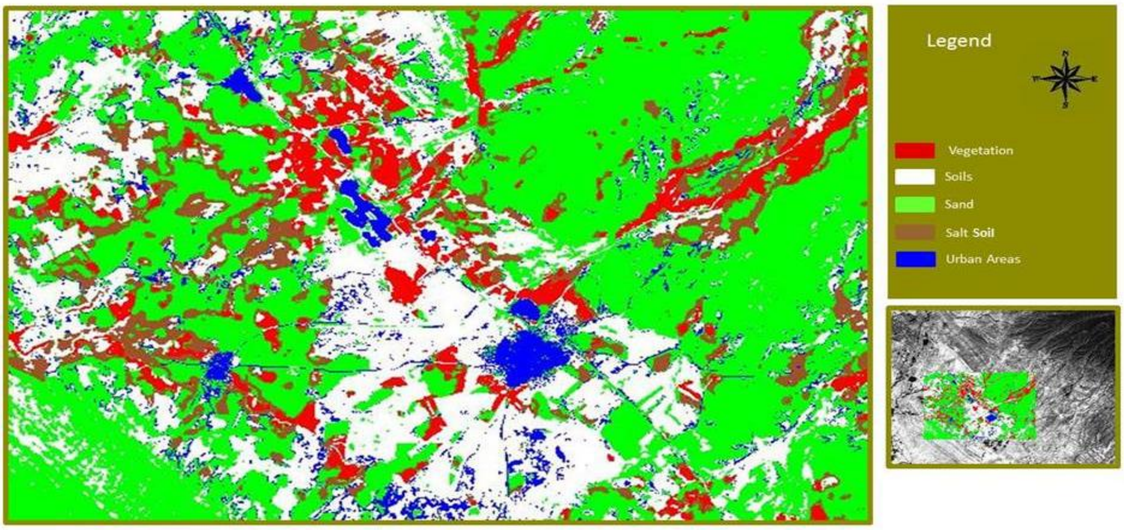

Figure 4 - The classified image of the year 2006.

Table-1 presents the area occupied by the five categories during 1990, 2000 and 2006. A multi-date post-classification comparison change detection algorithm was used to determine changes in land cover in three intervals, 1990, 2000 and 2006 table-2.

Table 1- The areas of the land cover categories for the years 1990, 2000 and 2006.

Land cover / Land use	1990 km^2	% of the total area	2000 km^2	% of the total area	2006 km^2	% of the total area
Vegetation	52.265	24.338%	33.211	15.47%	16.404	7.639%
Sand	63.106	29.386%	111.979	52.14%	102.641	47.796%
Soil	65.299	30.407%	43.929	20.46%	60.759	28.293%
Salt soil	27.807	12.949%	16.385	7.63%	22.40	10.431%
Urban Areas	6.2707	2.920%	9.244	4.31%	12.543	5.841%
Total	**214.750**	**100%**	**214.750**	**100%**	**214.750**	**100%**

Table 2- Land cover / land use changes between 1990-2000, 2000-2006 and 1990-2006.

Land cover / Land use	**1990 km^2**	**2000 km^2**	**changes**	**2000 km^2**	**2006 km^2**	**changes**	**1990 km^2**	**2006 km^2**	**changes**
Vegetation	52.265	33.211	-19.054	33.211	16.404	-16.806	52.265	16.404	-35.861
Sand	63.106	111.979	48.872	111.979	102.641	-9.337	63.106	102.641	39.535
Soil	65.299	43.929	-21.369	43.929	60.759	16.829	65.299	60.759	-4.539
Salt soil	27.807	16.385	-11.422	16.385	22.400	6.015	27.807	22.400	-5.407
Urban	6.2707	9.2449	2.974	9.244	12.543	3.298	6.2707	12.543	6.272

Figure-5 represents graphically the above changes. To evaluate the change maps for the 1990, 2000 to 2006 interval, we randomly sampled the areas that classified as change and no-change and determined whether they were correctly classified. The maps showed that between 1990 and 2006 the amount of urban areas increased as 2.921% of the total area, the sand areas also increased as 18.410% while the vegetation, soil and salt soil areas decrease 16.699%, 2.114% and 2.518% respectively (Table 2). Landscape diversity has remained relatively stable, but fragmentation, especially of Urban and the sand areas, has increased significantly during this period. The land cover/ land use classification maps will be inputs to models to simulate or predict future growth patterns. For the time being the Land Transformation Model (LTM) has been implemented which uses population growth, transportation factors, proximity or density of important landscape features as inputs to predict land use changes. Information derived from historical land use change is one of the most important factors used to forecast future trends and patterns. The model is also be used to help understand which factors are most important to land cover/land use change.

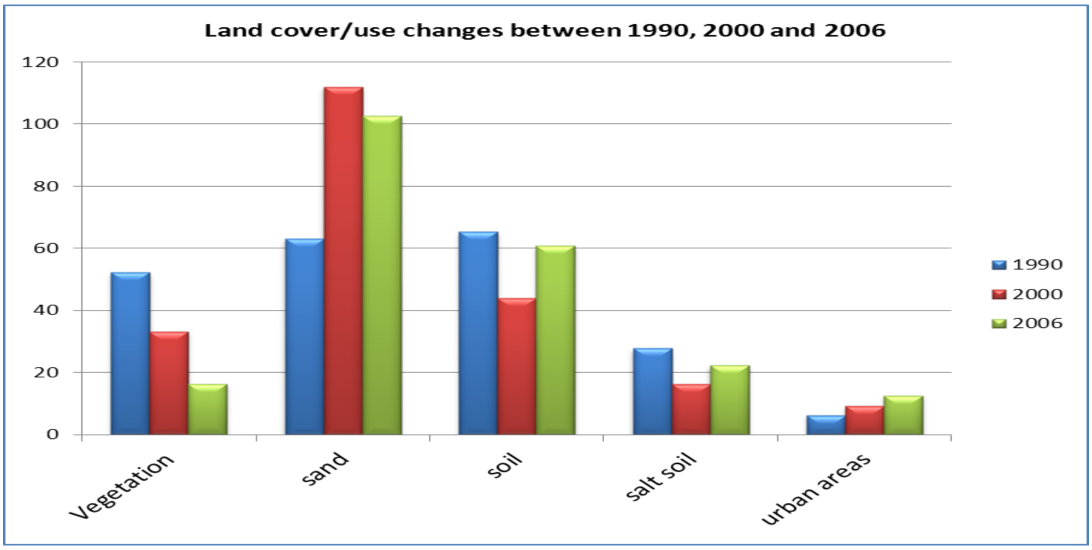

Figure 5-Changes in the five categories during1990, 2000 and 2006

Conclusions

The study has indicated the potential use of remote sensing data in studying land cover/ land use change. Information from satellite remote sensing can play a useful role in understanding the nature of changes in land cover/use, where they are occurring, and projecting possible or likely future changes. Our continuing work includes adding additional years, both before and after the dates reported here, of Landsat data and classifications to the temporal series. In addition, we have developed the methodology to accurately classify percent impervious surface area which represents an alternative way of looking at urban growth. In this study Landsat images were used satisfactorily for the identification of the five categories. It's observed that the some categories in the area under study changed during 1990- 2006 remarkably. Decrease in vegetation areas, has been as a result of anthropogenic activities in the study area. The growth of the size of urban, often at rates exceeding the population growth rate, and the accompanying loss of agricultural lands and wetlands , escalating infrastructure costs, increases in traffic congestion, and degraded environments, is of growing concern to citizens and public agencies responsible for planning and managing growth and development. In conclusion for detecting changes in areas based on a subject e.g. population increase, vegetation etc. over a period of years both spatial and in quantitative way, remote sensing data will be useful Such information is essential to planning for development and preserving our natural resources and environment, and is needed by urban planners and citizens. Satellite remote sensing approaches provide a cost-effective alternative when more information is needed, but budgets are declining.

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