Integration Remote Sensing and GIS Techniques to Evaluate Land Use-Land Cover of Baghdad Region and Nearby Areas

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Abstract

The study area of Baghdad region and nearby areas lies within the central part of the Mesopotamia plain. It covers about 5700 Km^2. The remote sensing techniques are used in order to produce possible Land Use – Land Cover (LULC) map for Baghdad region and nearby areas depending on Landsat TM satellite image 2007. The classification procedure which was developed by USGS used and followed with field checking in 2010. Land Use-land cover digital map is created depending on maximum likelihood classifications (ML) of TM image using ERDAS 9.2.The LULC raster image is converted to vector structure, using Arc GIS 9.3 Program in order to create a digital LULC map. This study showed it is possible to produce a digital map of LULC and it can be constantly updated .The image was classified into five main classes, these are: Urban and Built-up land class, vegetated land class, Water class, Barren land class and Agricultural none vegetated land class. The accuracy assessment for classification was 93.70% and Kappa coefficient was 0.8833.

Keywords: Remote sensing, GIS**,** Land use-Land cover (LULC), Supervised classification, Maximum likelihood.

مكاملة تقنيات التحسس النائي ونظم المعلومات الجغرافية لتقييم استخدامات الارض– غطاءات الارض لمنطقة بغداد والمناطق المجاورة

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الخلاصة

تقع منطقة بغداد والمناطق المجاورة في الجزء المركزي من حوض مابين النهرين. وهي تغطي مساحة تقدر بحوالي 5700 كم². استخدمت تقنيات التحسس النائي لاعداد خريطة استخدام الارض– غطاء الارض لمنطقة بغداد والمناطق المجاورة اعتمادا على مرئيات لاندسات TM الملتقطة في سنة 2007 والتصنيف المتبع من قبل المسح الجيولوجي الامريكي مع التدقيق الحقلي الذي اجري سنة 2010 .

استخدمت طريقة الاحتمالية العظمى لتصنيف المرئية الفضائية لاعداد مرئية استخدام الارض– غطاء الارض باستخدام برنامج (ERDAS 9.2)، حولت البيانات الرقمية الشبكية الى الهيكلية الاتجاهية باستخدام برنامج ArcGIS 9.3 لخلق خريطة رقمية لاستخدامات الارض – غطاءات الارض. بينت هذه الدراسة امكانية انتاج خريطة رقمية يمكن تحديثها باستمرار، وقد صنفت البيانات الفضائية الى خمسة اصناف رئيسية هي: (مباني ومناطق سكنية، اراضي زراعية، مياه، اراضي جرداء واراضي زراعية غير مزروعة). بلغت دقة التصنيف فيها 93.70% وقيمة معامل كابا 0.8833.

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1. Introduction

The combination of remote sensing and geographical information systems (GIS) is a topic of general interest in the field of remote sensing and GIS. It is mainly contributes to two kinds of applications. One is GIS database updating by remote sensing images, the other is remote sensing analysis by the support of GIS data. These two aspects complement each other to make the GIS databases updated continually. Combination remote sensing images and other data in Geographic Information Systems may provide a way to produce more accurate land-use and land-cover maps.

Integration remote sensing and geographical information systems are powerful tools to derive accurate and timely information on the spatial distribution of land use-land cover changes over large areas [1,2]. GIS provides a flexible environment for collecting, storing, displaying and analyzing digital data necessary for change detection [3].Remote sensing imagery is the most important data resources of GIS. Satellite imagery is used for recognition of synoptic data of earth's surface [4], Thematic Mapper (TM) data have been broadly employed in studies towards the determination of land use-land cover, the rich archive and spectral resolution of satellite images are the most important reasons for their use.

2. Objective

The main aim of this study is to achieve a digital Land use – Land cover map, for Baghdad Region and nearby areas.

Table 1- Climatic data of Baghdad Meteorological Station of 2007

Criteria	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min. Temp. C°	3.0	7.2	10.4	15.3	23.7	25.6	27.5	23.0	26.0	18.3	9.0	4.5
Max. Temp. C°	14.0	19.1	24.8	28.4	39.1	42.8	44.7	44.8	42.0	40.0	25.0	18.5
Relative humidity %	67	61	43	41	31	23	22	24	26	33	45	52
Wind speed M/S	2.3	2.4	2.5	3.2	3.2	3.6	4.0	3.3	3.4	2.7	2.3	2.2
Ave. Rainfall (mm)	32.2	18.8	14.9	24.0	7.3	0.0	0.0	0.0	0.0	0.001	0.0	2.0

3. Location

The study area lies in Mesopotamia plain in the central part of Iraq. It covers about 5700 Km^2, figure 1. It is limited by the following coordinates:

Longitude 43°58'30" 44°45'00"
Latitude 32°59'52" 33°39'36"

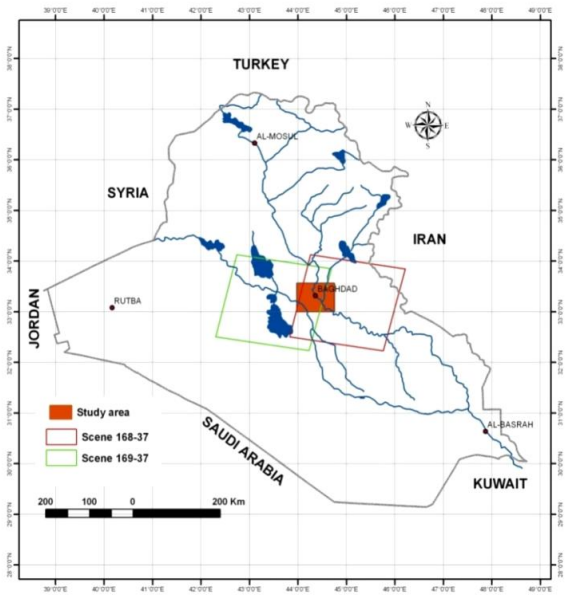

Figure 1- Location map of the study area

4. Climate

The study area has an arid climate, figure 2- and characterized by hot summer and cold winter with seasonal rainfall, the major portion of rainfall is received during months of December to May. The data of different climatic elements is tabulated in table 1. These data are obtained from Iraqi MeteorologicalOrganization.[5]

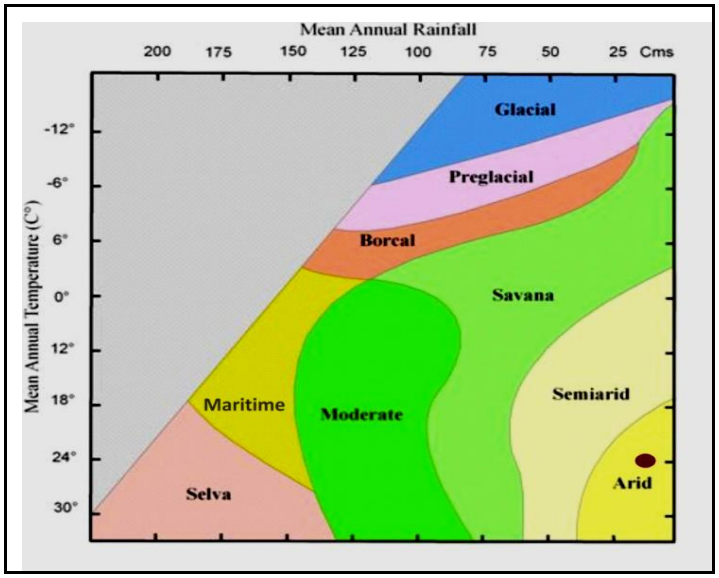

Figure 2- Climatic boundaries of the morphogenetic regions.

5. Research Methodology

5.1. Data Collection and Analysis

ERDAS Imagine V. 9.2 and Arc GIS V.9.3 softwares have been used to perform the data and analysis. The study area covered by two Landsat TM scenes with seven Spectral bands acquisition in 2007 table 2. The study depended on the use of computer-assisted interpretation of Landsat imageries data with six Spectral bands (1,2,3,4,5,7) and ancillary data from Iraq Geological Survey (GEOSURV) besides field data. Field survey was performed throughout the study area using Global Positioning System (GPS). This survey was performed in order to obtain accurate location point data for each LULC class included in the classification scheme as well . as for the creation of training sites and for signature generation in addition to take photos for each location. In order to obtain the required information from satellite image data, processing and interpretation were made systematically.

Table 2- Landsat image characteristics [7]

Instrument	Landsat 5	
Sensor	TM	
Acquisition date	11/8/2007	3/9/2007
Path / Row	168/37	169/37
Spectral bands (μm)	7 bands (10)- 0.45-0.52 (blue) (20)- 0.52-0.60 (green) (30)- 0.63-0.69 (red) (40)- 0.76-0.90 (near-infrared) (50)- 1.55-1.75 (mid-infrared) (60)-10.4-12.5 (thermal bands) (70)- 2.08-2.35 (mid-infrared)	
Ground resolution	30m*30m for multispectral bands, 120*120m for thermal bands	
Dynamic range (bit)	8 bit	

5.2. Pre-processing

Two scenes of TM images are subset it by using Area of Interest (AOI) file.The images carried out with WGS84 datum and UTM N38 projection using nearest neighbor resampling. The nearest neighborhoods resampling procedure was preferred to others resampling such as bilinear or cubic and bicubic convolution, because it is superior in retaining the spectral information of the image [7].

6. Geological Setting

The geology of the study area is special attention is paid for its relation with Land LULC. The reviewed data based on Deikran and Yacoub [8]. The study area lies within the central part of the Mesopotamia Foredeep [9].It represents continuously subsiding asymmetrical synclinal basin and mostly covered by Quaternary sediments represented by shallow depression sediments, marsh sediments, anthropogene sediments, terrace sediments of Euphrates River, gypcrete, flood plain sediments. The exposed Pre-quaternary rocks are only represented by Injana Formation.

7. Field Observations

Field Observations carried out in 2010 and spent approximately two weeks touring including taking field notes, taking photos and collecting GPS coordinates representing final output categories. The field data was useful for image analysts to have a better understanding of the relationships between the satellite images and actual ground conditions. The GPS positions were also used to train supervised classification algorithms, make additional measurements of positional accuracy, and measure the accuracy of the final product.

8. Image Classification and Creating Land Use – Land Cover Map

There is different image classification procedures used for different purposes by various researchers [10-13]. These techniques are distinguished in two main ways as supervised and unsupervised classifications. Additionally, supervised classification has different subclassification methods which are named as parellelpiped , maximum likelihood, minimum distances. These methods are named as hard classifier. In this study, supervised classification has been used to classify the image of the study area for land use – land cover classification, figure 3. The parellelpiped, maximum likelihood classifiers are used for this purposes. The parellelpiped classifier is a very simple supervised classifier that is, in principle, trained by inspecting histograms of the individual spectral components of the available training data [14].

Maps of land use - land cover are fundamental tools for natural resource management and planning. The land use - land cover map is created depending on digital interpretation of Landsat TM data. Anderson *et al.* [15] classification (United States Geological Survey-USGS classification) has been used to classify the Land classes. The Figure.4 shows the derived land use - land cover digital map of the study area, it is classified into five main classes based on the level one of USGS classification. The thematic classification map was converted to vector classification using Arc GIS software and these classes are: urban and built-up Land, vegetated Land, water, barren Land and agricultural none vegetated. The description of each class as following:

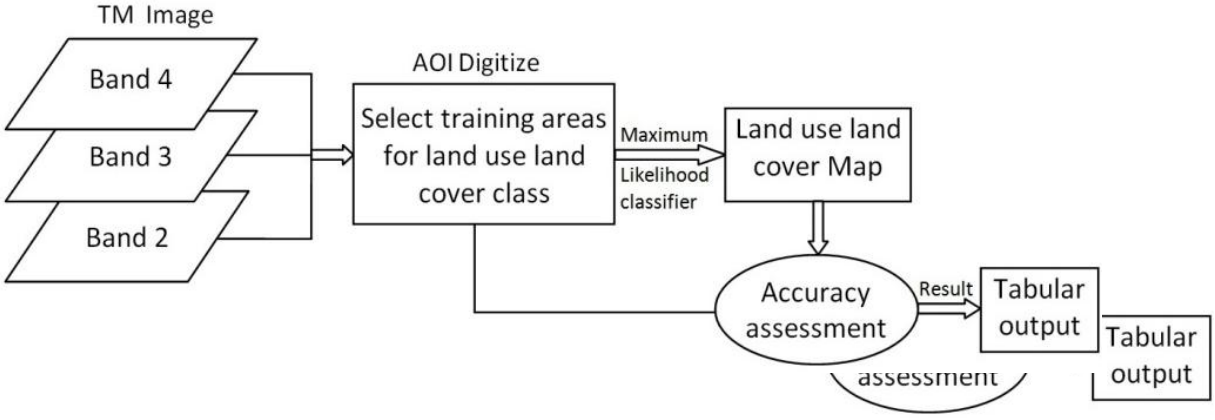

Figure 3- General flow chart for a supervised LULC classification of TM image

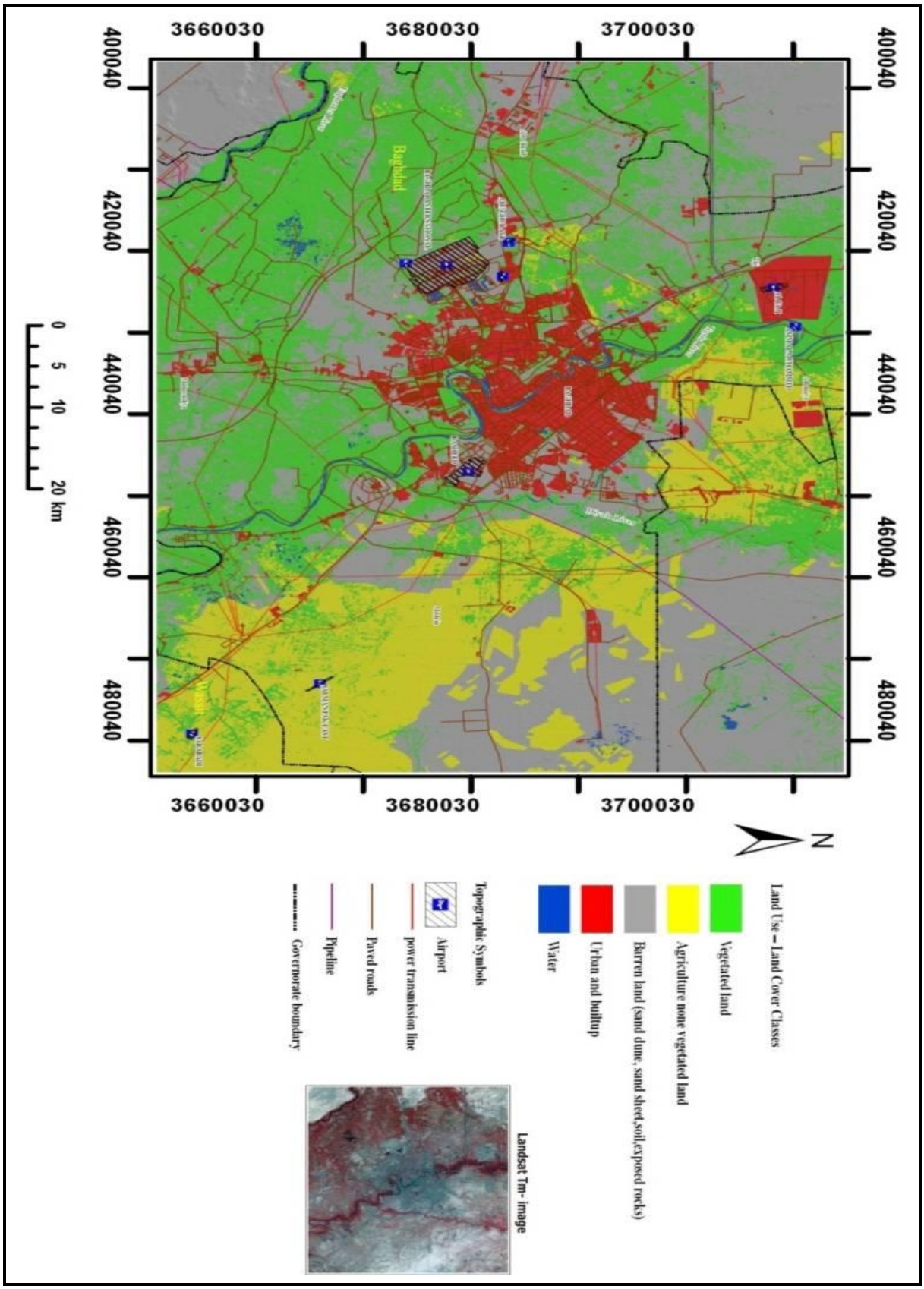

Figure 4- Digital LULC map of study area

8.1. Urban and built-up Land Class

There is a huge urbanization in the study area, which can be clearly distinguished using TM satellite images. The map area has a high intensive urban land, the highways and railways are characterized by

areas of activity connected in linear patterns, it covered by structures. This category includes: Capital Baghdad and towns (Mahmoudiya and Salman pak) besides small villages and scattering houses distributed in different places in the study area. Many scattered individual buildings could not be represented on the final map, because they are out of the map scale or due to the resolution of the image.

8.2. Vegetated Land Class

Vegetated Land includes all vegetation cover which growth naturally or by human activates like agricultural land. The agriculture land in the map area is based mainly on grain yield production such as barley, wheat. In addition comprised cropland and pasture, Palms orchards, figure 5-, fruit groves and Shrubs mostly comprised of herbaceous plant species that were mainly less than 1 meters in height which distributed as scattered plants or small communities on the whole parts of map area.

Figure 5- Vegetation in the study area

8.3. Water Class

The water bodies are well distinguished by spectral reflection and appear in black color within Spectral bands combination 432 RGB. Water class include; Streams, Canals, Reservoirs. The main Rivers are Tigris, Euphrates, figure 6- and Diyala.

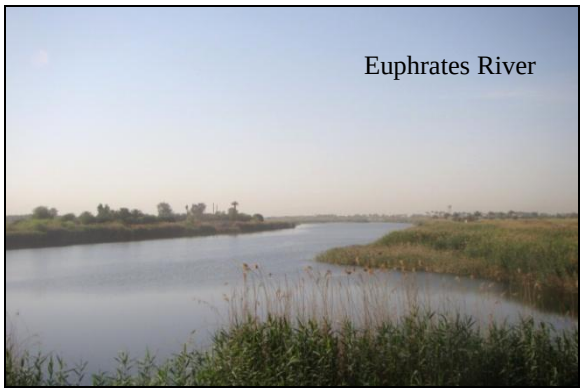

Figure 6- Water in the study area

8.4. Barren Land Class

Barren land is a land use-land cover category used to classify lands with limited capacity to support life and in which less than one-third of the area has vegetation or other cover. In general, it is an area of thin soil, sand, or rocks and vegetation if present, is more widely spaced and scrubby. This class represents huge area distribution in the different location of the study area. The texture of soil in this class consists of sand, silt, gypsiferous soil and clay. The secondary gypsum occurs in higher percentages with scattered gravel, figure 7.

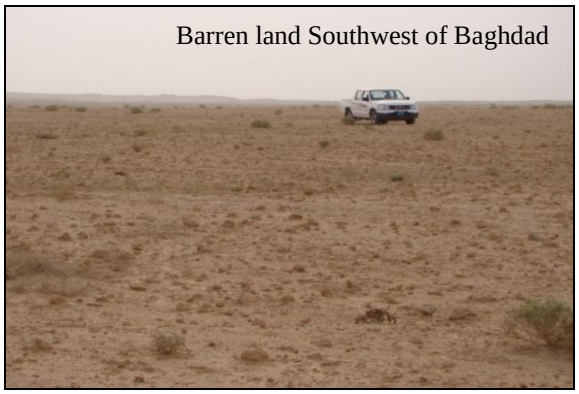

Figure 7- Barren land in the study area

8,5. Agricultural None Vegetated Land Class

The Agricultural non vegetated Land class is LULC category; it includes all Agricultural Lands without vegetation cover such as idle cropland, Harvested land, cultivated land and other lands. There are three types of agricultural non vegetated land in the study area; cropland harvested, cultivated land and idle cropland, figure 8- which is left as a result of bad use of irrigation system, water deficit and increase of soil salinity.

Figure 8- Agricultural non vegetated land in the study area

9. Relationship between Land Cover and Spectral Reflection Data

Creating spectral signature classes is an iterative process and its objective is to aggregate a set of statistical data that describe the spectral signature of each information class [16]. To create satisfactory spectral signatures for each class and subclass an adequate amount of training sites were digitized in satellite image. After a set of signatures are derived, different decision rule scan be used to classify each pixel of an image of the map area. Five classes are determined depending on signature and limits of the minimum and maximum digital number and displayed as mean for each reflection class, figure 9.

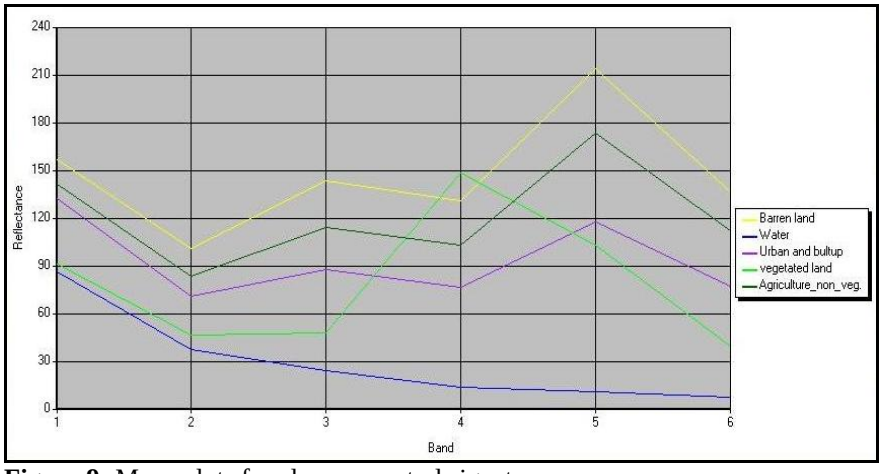

Figure 9- Mean plots for classes spectral signature

10. Classification Accuracy Assessment Results

Classification is a general term for comparing the classification to geographical data that are assumed to be true, in order to determine the accuracy of the classification process. Usually, the assumed-true data are derived from ground truth data. It is usually not practical to ground truth or otherwise test every pixel of a classified image. Therefore, a set of reference pixels is usually used. Reference pixels are points on the classified image for which actual data are (or will be) known. The reference pixels are randomly selected [17].

The Overall Accuracy (OA) of the classification results was calculated by dividing the total correct sum of main diagonal cells by the total number of pixels checked in the error matrix. The User Accuracy (UA) is "the probability that a pixel classified on the map, actually represents that class on the field (ground)" and it was calculated by dividing the diagonal value for each class by its row total. The Producer Accuracy (PA) indicates the percentage of a reference pixel being correctly classified, and it was calculated by dividing diagonal value for each class by its column total [18]. The Overall classification Accuracy achieved was 93.70% and a kappa coefficient is 0.8833.

11. Statistics Distribution

The identified five classes of the LULC types in the map area that acquired from the supervised classification have various distributions. The thematic classification map was converted to vector class, using Arc GIS software and the area of each class is tabulated in table 3.

Figure 10- shows the plot diagram of coverage area (in km²) for each class in the map area. The data reveals that the large coverage area are vegetated land 2033.7 Km^2 and barren land 2001.63 Km^2 while the lesser class is water 68.82 Km^2.

Table 3- Statistics Distribution of classes in map area

Classes Name	**Area Km^2.**
Barren land	2001.63
Water	68.82
Urban and built up	404.11
Vegetated land	2033.7
Agricultural non vegetated	1197.99
Totals	5706.25

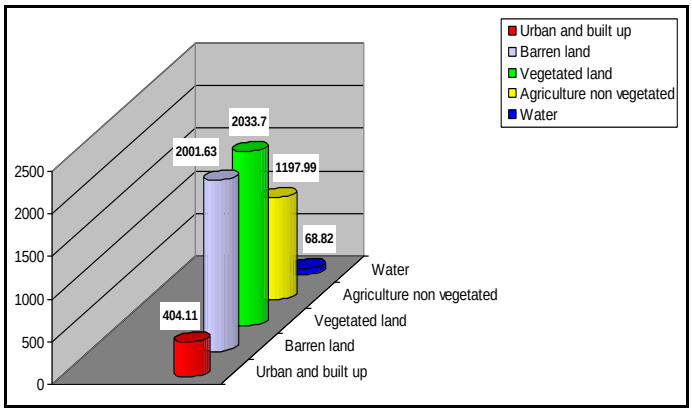

Figure 10- Plot diagram showing area of each class

12. Conclusions

This study has revealed that the spatial technology of remote sensing and GIS together with field-based detection and ancillary data could provide powerful tools for evaluating land use and land cover. Remote sensing is especially proper for initial mapping and continued monitoring of LULC large areas. In this context, techniques for improving the classification of LULC with satellite remote sensing data include the use of appropriate digital data. In order to achieve this task, selection of the most proper satellite image, band combination and classifier are very important. These aspects were applied to this study and it has been seen that maximum likelihood classifier was the most suitable classification method for LULC mapping purpose. In addition, this study showed it is possible to

produce a digital map of LULC and it can be constantly updated. The authors recommend using spectrometer device to measure the spectral signature for different features of LULC will be more effective to the assessment and monitoring LULC processes, also using high resolution and more advanced remote sensing data as ancillary data such as High spatial resolution Quick Bird data is very useful to recognize and determine the classes particularly urban and built up class.

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