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Analyzing Land Use - Land Cover using Remote Sensing and GIS Techniques in Southern Sector of Mesopotamia Plain

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Abstract
The majority of the study area lies within the Mesopotamia For deep of Outer (Unstable) Platform of Arabian Plate. While the southwestern corner lies within the Inner (Stable) Platform .The remote sensing techniques are used in order to produce Land Use – Land Cover (LU–LC) map for study area scale 1:250000 depending on SPOT satellite image 2010. The classification procedure which was developed by USGS and followed with field checking in 2011. Land Use-land cover map is created depending on maximum likelihood classifications (ML) of SPOT image. This image was classified into six main classes, these are: Urban and Built-up land class, vegetated land class, Agriculture none vegetated land class, Water class; like rivers, canals, lakes and other waterways, Wet lands and Barren lands class which are divided into three sub-classes (Mixed Barren Land, Sand Dunes and Dry Marsh). The accuracy assessment for classification is 89.67% and a kappa coefficient is 0.8448 by using ERDAS Imagine V. 9.2 Program. The LU–LC raster image is converted to vector structure, using Arc GIS 9.3 Program in order to create a digital LU–LC map.
Keywords: Land use - Land cover (LULC), Mesopotamia Plain, Remote Sensing (RS), classification, SPOT.

1. Introduction

Remote Sensing (RS) technologies can be used to acquire spatially variable data for several applications. A number of these technologies can supply data to help to solve problems, and can often be accomplished at a lower relative cost than many other traditional methods. Remote sensing data of the earth's surface could be made readily available in digital format (Richards and Jia, 1998). These advantages have attracted great interest in the scientific and engineering community (Lyon, 1995). The reasons of remote sensing priorities over traditional methods are because of several unique aspects including the capability to measure spatial, spectral, and temporal information as opposed to point data, ability to assess the state of the earth's surface over large areas, and to assemble long-term data sets and the capability to measure inaccessible areas; as the case in most arid regions (Qi et al., 1994; Ritchie and Rango, 1996). The "landscape-scale" requires methods to gather spatially distributed information and this requires repeated sampling of the variables of interest to acquire information over large areas. The costs and logistics of these actions can be high, and work is usually constrained by available resources. However, remote sensing is considered the most efficient technology to handle these problems and to observe the spatially distributed variables (Lyon, 1995). Integrating remote sensing images and other data in Geographic Information Systems (GIS) may provide a way to produce more accurate land-use and land-cover maps.
In this study supervised classification was used to analyze and output data related to the land-use and land-cover, it included a description of physical conditions of classes. The base of this study depended SPOT images taken in 2010).

1.1 Objective of the study

The main aim of this paper is preparing a digital Land Use – Land Cover map to classify the Land Use – Land Cover in the study area.

1.2 Location of the study area

The study area is located in the southern part of Iraq (Southern Sector of Mesopotamia plain) as shown in (Fig. 1). It is limited by the following coordinates:

Longitude	45°00'	46°30'
Latitude	31°00'	32°00'

Within the study area the main cities are Al-Nasriya and Samawa, (both of them represent governorate center), beside many towns like Al-Rifai, Nasr, Shatra, Al-Gharaf, Khidhr and Rumitha also there are many small villages. The main Rivers is Euphrates River drains the study area between Samawa and Al-Nasriya cities, Shatt Al-Diwaniya and Shatt Al-Atshan are the main distributaries of Euphrates River within the study area, besides, there is Sawa Lake and Almasab Al-Aam canal. Although Tigris River is not within the study area, its distributaries, Al-Gharraf river and Shatt Al-Shattra drain eastern part of the study area.

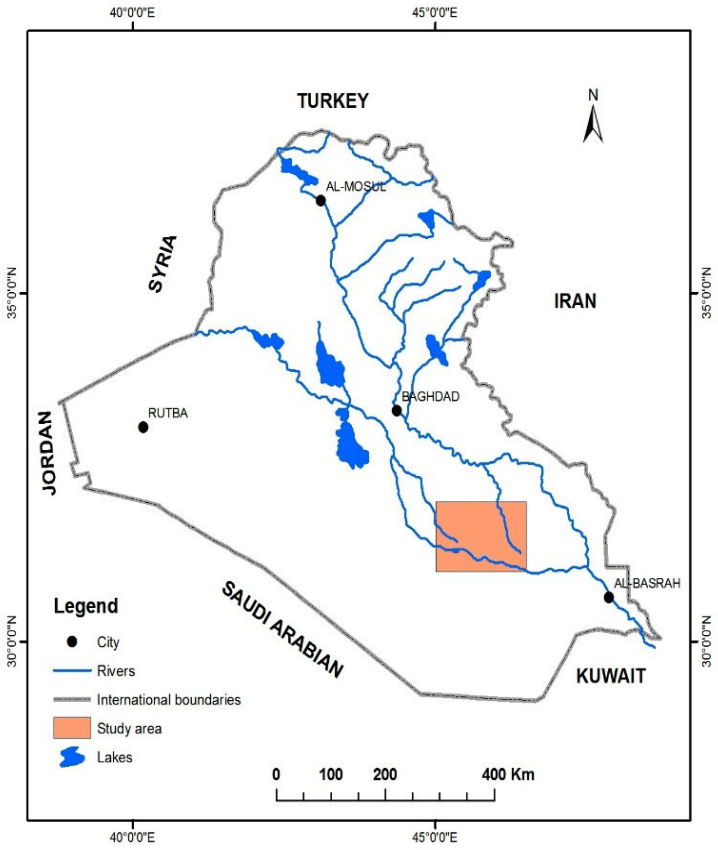

Figure 1. Location map of the study area

1.3 Climate of the study area

The study area has an arid climate (Fig. 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 Al-Nasriya Meteorological Station.

Table 1. Climatic data of Al-Nasriya Meteorological Station of 2007

Criteria	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min. Temp. C°	4.7	9.6	12.9	19	26.5	27.9	29.3	29.4	25.7	21.1	13.2	7.9
Max. Temp. C°	15.7	21.8	25.7	31.6	41.1	44.4	45.7	46.2	43.2	38.0	27.9	19.5
Relative humidity %	69	58	46	45	28	20	20	22	24	36	43	60
Wind speed M/Sec	2.4	2.8	3.1	3.4	2.9	4.3	3.4	3.6	4	2.4	2.4	2.8
Ave. Rainfall (mm)	45.2	0.9	33.7	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.2	21.8

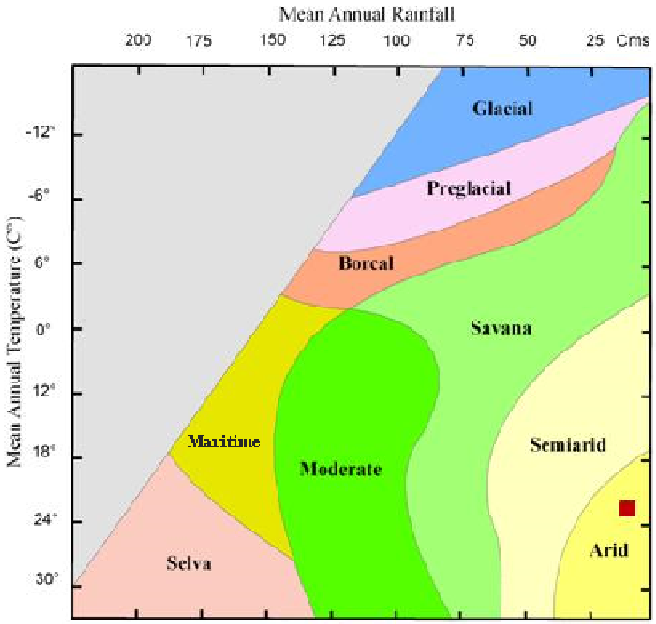

Figure 2. Climatic boundaries of the morphogenetic regions
(After Peltier, 1950 in Fookes, 1971)

1.4 Geological Setting

The majority of the study area lies within the Mesopotamia For deep of Outer (Unstable) Platform of Arabian Plate. While the southwestern corner lies within the Inner (stable) platform (Fouad 2010).

Most of the study area is covered by Quaternary sediments especially in the Mesopotamia Plain. The exposed geological formations range in age from Middle Eocene to late Eocene in the southwestern part of the study area, which is a part of the Southern Desert.

2. Methodology

2.1 Data and Software

ERDAS Imagine V. 9.2 and ArcGIS V.9.3 softwares have been used to perform the data and analysis. The study area covered by eleven scenes of SPOT4, (Table 2), (Fig.3).

2.2 Pre-processing

The preparation of LU–LC study at scale of 1:250 000 is generated depending mainly on the available data and other relevant studies and reports.

Eleven SPOT images were mosaic and subset using Area of Interest file (AOI). They haven't sufficiently accurate pixel-to-pixel registration are without atmospherically corrected. The images were corrected according to WGS84 datum and UTM N38 projection using nearest neighbor re-sampling. LU–LC study is produced depending on digital interpretation of SPOT data using supervised classification maximum likelihood method to produce the final digital LU–LC study.

Table 2. SPOT image characteristics

Instrument	2HRVIRs
Sensor	SPOT 4
Acquisition date Path / Row	06-Aug-2010 17-Aug-2010 27- Aug-2010 139-286 142-286 141-286 22-Aug-2010 17-Aug-2010 07-Aug-2010 140-286 142-288 141-288 22-Aug-2010 06-Aug-2010 17-Aug-2010 140-288 139-287 142-287 07-Aug-2010 22-Aug-2010 141-287 140-287
Multispectral bands (µm)	4 bands (B1)- 0.50 - 0.59 (Green) Resolution (20m) (B2)- 0.61 - 0.68 (Red) Resolution (20m) (B3)- 0.79 - 0.89 (Near IR) Resolution (20m) (B4)- 1.53 - 1.75 (SWIR) Resolution (20m)
Panchromatic band (µm)	(M)- 2.08-2.35 (mid-infrared) Resolution (10m)
Ground resolution	20m*20m for multispectral bands, 10*10m for Panchromatic band
Dynamic range (bit)	8 bit

(SPOT System (http://www.spotimage.fr/home/system/welcome.htm)

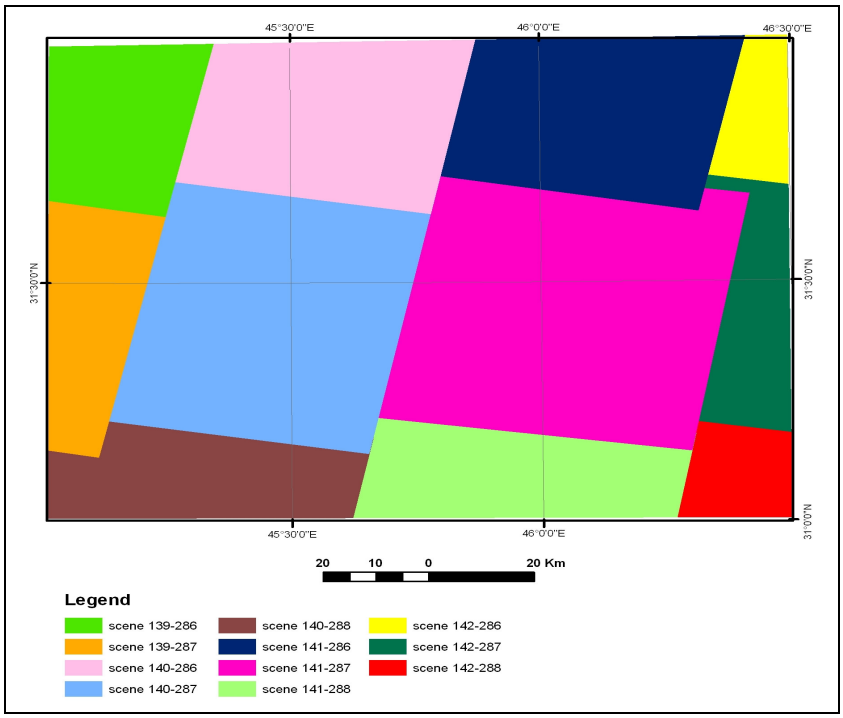

Figure 3. Index map of SPOT Scenes

3. Land Use - Land Cover Classification

3.1 Land Use – Land Cover Standards

The classification Land Use – Land Cover units of the study area based on the Land Use-Land Cover, USGS Codes developed by Anderson *et al.* (1976) for use with remotely sensed images. These codes are organized into four hierarchical levels. At the top of the hierarchy, first level includes:

1. Urban and built-up Land
2. Agricultural Land
3. Brush transitional between open and forest
4. Forest Land
5. Water

6. Wetlands
7. Barren Land
8. Tundra
9. Permanent Snow and Ice

Each sub-level contains maximally 9 categories (1-9). Level one has the lowest resolution, or detail of the Landscape, while level four has the highest resolution. The study area includes five classes based on level one.

3.2 Creating Land Use – Land Cover Study

Land Use – Land Cover of study area is created depending on digital interpretation of SPOT4 data using Maximum Likelihood classification (ML). Anderson *et al.* (1976) classification (USGS classification) has been used to classify the Land classes

3.2.1 Urban and Built-up Land

Urban or Built-up Land is comprised of areas of intensive use with much of the land covered by structures. Included in this category are cities, towns, villages, strip developments along highways, transportation, power transmission lines, communication facilities, and areas such as those occupied by mills, shopping centers, industrial and commercial complexes, and institutions that may, in some instances, be isolated from urban areas (Anderson *et al.* 1976).

There is a huge urbanization in the study area, which can be clearly distinguished using spot satellite images. Two main cities are located within the study area ,Al-Nasriya and Samawa, (both of them represent governorate center), beside many small towns such as Al-Gharaf, Shatra, Nasr, Al-Rifai, Khidhir, Rumitha in addition to small villages and scattered houses distributed on the whole parts of the study area. The boundaries of the main cities are delineated and updated in the present study depending on Humanitarian Information Centre of Iraq (HIC, 2004).

3.2.2 Vegetated Land

Vegetated Land includes all vegetation cover which growth naturally or by human activates like agricultural land. The agriculture land in the study area is based mainly on grain yield production such as barley, wheat and rice. In addition comprised cropland and pasture orchards, date palms, reeds, sedges and shrubs, mostly comprised of herbaceous plant species that were mainly less than 1 m in height, which are distributed as scattered plants or small communities on the whole parts of study area .

3.2.3 Agricultural Land (Non -Vegetated)

The Agricultural Land Non-Vegetated, includes idle cropland which has been left idle, either tilled or untilled, during the whole or greater portion of the growing season (Anderson *et al.,* 1976). There are three types of Agricultural Land (Non-Vegetated) in the study area; Cropland harvested, Cultivated land for the growing season and idle cropland, which left as a result of haphazard use of irrigation system and overuse of water in irrigating .

3.2.4 Water

Water areas are, comprising water bodies and streams that are permanent open water. They include; Streams, Canals, Lakes, Reservoirs, (Anderson *et al.*, 1976). Currently the available water resources in the study area are from surface water, which involve the main rivers; Euphrates River drains the study area between Samawa and Al-Nasriya cities, Shatt Al-Diwaniya and Shatt Al Atshan are the main distributaries of Euphrates River within the study area. Although Tigris River is not within the study area, its distributaries, Al-Gharraf river and Shatt Al-Shattra are in the study area, Moreover there is Almasab Al-Aam canal and Sawa Lake .

3.2.5 Wetland

Wetlands are those areas where the water table is near or above the land surface for a significant part of most years. Wetlands frequently are associated with topographic lows, even in mountainous regions. Examples of Wetlands are marshes, and swamps situated on the shallow margins of bays, lakes, ponds, streams, and manmade impoundments; such as reservoirs (Anderson *et al.,* 1976). There are two types of Wetlands in the study area: Natural Wetland, which are distributed in the study area. The second type of Wetlands, which is formed due to human activity; represented by irrigated agricultural lands .

3.2.6 Barren Land

Barren Land of LU–LC category used to classify lands with limited capacity to support life and having less than 5 percent vegetative cover. Vegetation, if present, is widely scattered. Generally, the surface of Barren Land is Salt Flats; sand dunes; mud flats; beaches; bare exposed rock, bare soil, or salt-affected soils (Anderson *et al.*, 1976). Subcategories of Barren Land in the study area include Mixed Barren Land, Salt Flats and Sand Dunes each one of these sub categories is described hereinafter:

3.2.6.1 Mixed Barren Land

The Mixed Barren Land category is used when a mixture of Barren Land features occur and the dominant land use occupies less than two-thirds of the area. For example, in a desert region where combinations of Salt Flats, sandy areas, bare rock, surface extraction, and transitional activities could occur in close proximity with areal

extent, which is too small for each to be included at studying scale. Where more than one-third intermixture of another use or uses occurs in a specific area, then it is classified as Mixed Barren Land (Anderson *et al.*, 1976).
The mixed barren land is mainly represented by Quaternary sediments which mainly cover the Mesopotamian Plain , it has different types of sediments which can be depending on recent environment sediments, variation of soil texture from place to another, soil moisture, salt content and degree of consolidation represented by mixed eroded materials of sand, silt and clay. It's distributed in different areas in the study area, some mixed barren lands are considered as the oldest sediments of Quaternary age and consists of secondary gypsum and gypiferous soil particularly around Sawa Lake.

3.2.6.2 Sand Dunes

The study area is characterized by two broad units of aeolian sands sediment sand can be subdivided into two types; Sand dunes covering uplands relief, and sand sheets covering low land relief.
Two main aeolian fields of sand dunes exist in the study area. The first aeolian field is located in central part of study area between Euphrates River and Al-Gharraf River. The second aeolian field is located in southwestern part of study area, both of them extend in NW– SE direction, they are well developed in the study area. The most prevailing form of sand dunes is Barchan type, especially in the central part of the study area. Other types are less common; such as transverse and elongated dunes. Sand sheet are associated with sand dunes and extending to surrounding areas.Nabkhas are commonly developed around shrubs and other low vegetations. Nabkhas exist everywhere in the study area, especially in the southwestern part of study area .

3.2.6.3 Dry marsh

Dry marshes represent shallow depressions distributed in different parts of the study area. The marsh sediments are of fine texture, greenish and bluwish grey and black colour are dominant, consisting of silty clay and clayey silt. Dry marshes are rich in organic materials and carbonate fragment due to containing shells therefore they appear in satellite image of spot in white color .

4. Relationship between Land Cover and Spectral Reflection Data

After a set of signatures are derived, different rule scan be used to classify each pixel of an image of the study area. Eight classes are determined depending on signature and limits of the minimum and maximum digital number and displayed as mean for each reflection class. The results of signature and mean plot of spot image are shown in (Figs 4 and 5).

Class #	>	Signature Name	Color	Red	Green	Blue	Value	Order	Count	Prob.	P	I	H	A	FS
1		Agricultural land non- vegetated		1.000	1.000	0.000	4	41	5	1.000	X	X	X	X	
2		Sand dunes and sand sheet		1.000	0.647	0.000	5	42	136	1.000	X	X	X	X	
3		Water		0.000	0.000	1.000	6	43	14	1.000	X		X	X	
4		Urban and built-up		1.000	0.000	0.000	1	44	6	1.000	X	X	X	X	
5		Mixed barren land		0.753	0.753	0.753	2	45	6	1.000	X	X	X	X	
6		Dry marsh		0.933	0.510	0.933	3	46	17	1.000	X		X	X	
7		Vegetation land		0.000	1.000	0.000	7	47	12	1.000	X	X	X	X	
8	>	Wet land		0.341	0.445	0.275	8	48	7	1.000	X	X	X	X	

Figure 4. Signatures results of SPOT image

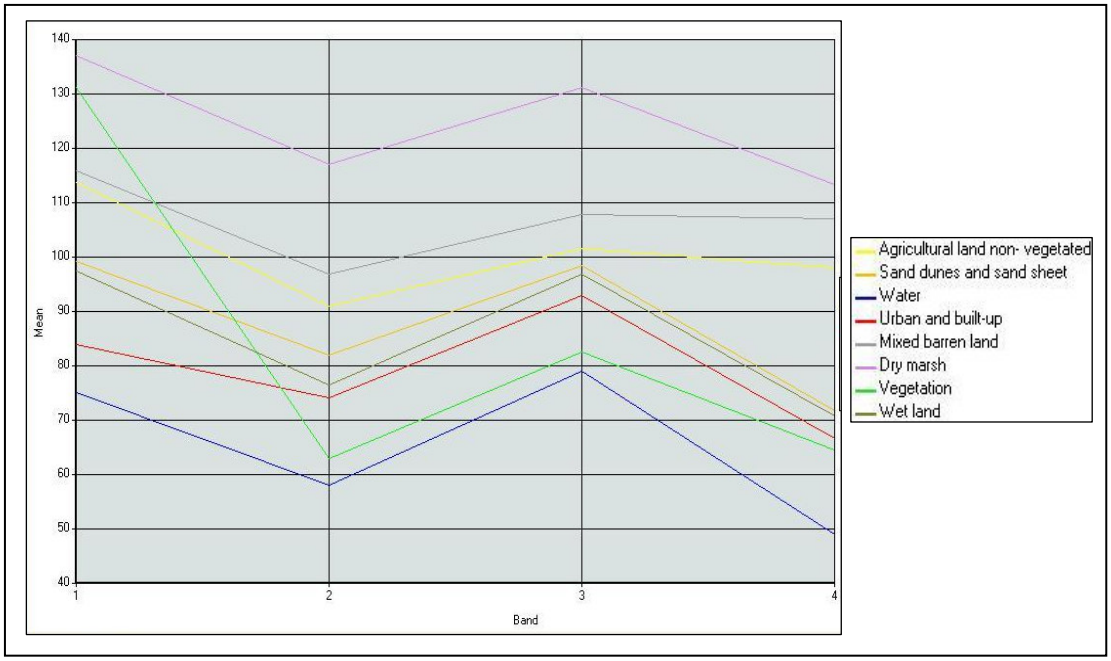

Figure 5. Mean plots for classes signature

4.1 Classification Accuracy Assessment and Achievement Map 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 (Congalton, 1991).

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 study, actually represents that class on the field (ground)" and it was calculated by dividing the diagonal value for each class by its row total. Whereas, 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 (Al-Amiri,2008).

(Table 3) includes data of Accuracy Assessment of the 8 classes resulted from the supervised classification of the SPOT of the study area. Validity of this classification of results was performed based on 300 check points, which were used for validation of classification the image. The achieved Overall Classification Accuracy is 89.67% and a Kappa coefficient is 0.8448. (Fig 6) shows the achieved digital LU–LC map of the study area.

Table 3. Accuracy assessment and Kappa (K^) coefficient of spot image

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy	Kappa
Urban and built-up	**11**	**9**	**8**	**72.73%**	**88.89%**	**0.8847**
Mixed barren land	**102**	**111**	**94**	**91.26%**	**84.68%**	**0.7668**
Agricultural land non-vegetated	**22**	**15**	**14**	**77.78%**	**93.33%**	**0.9291**
Sand dunes and sand sheet	**79**	**78**	**72**	**91.14%**	**%92.31**	**0.8956**
Vegetated land	**16**	**15**	**15**	**93.75%**	**100.00%**	**1.0000**
Wet land	**33**	**35**	**31**	**93.94%**	**%88.57**	**0.8716**
Dry marsh	**26**	**25**	**24**	**92.31%**	**96.00%**	**0.9562**
Water	**11**	**12**	**11**	**100.00%**	**87.50%**	**0.8720**
Totals	**300**	**300**	**269**			
Overall Classification Accuracy = 89.67% , Overall Kappa Statistics = 0.8448						

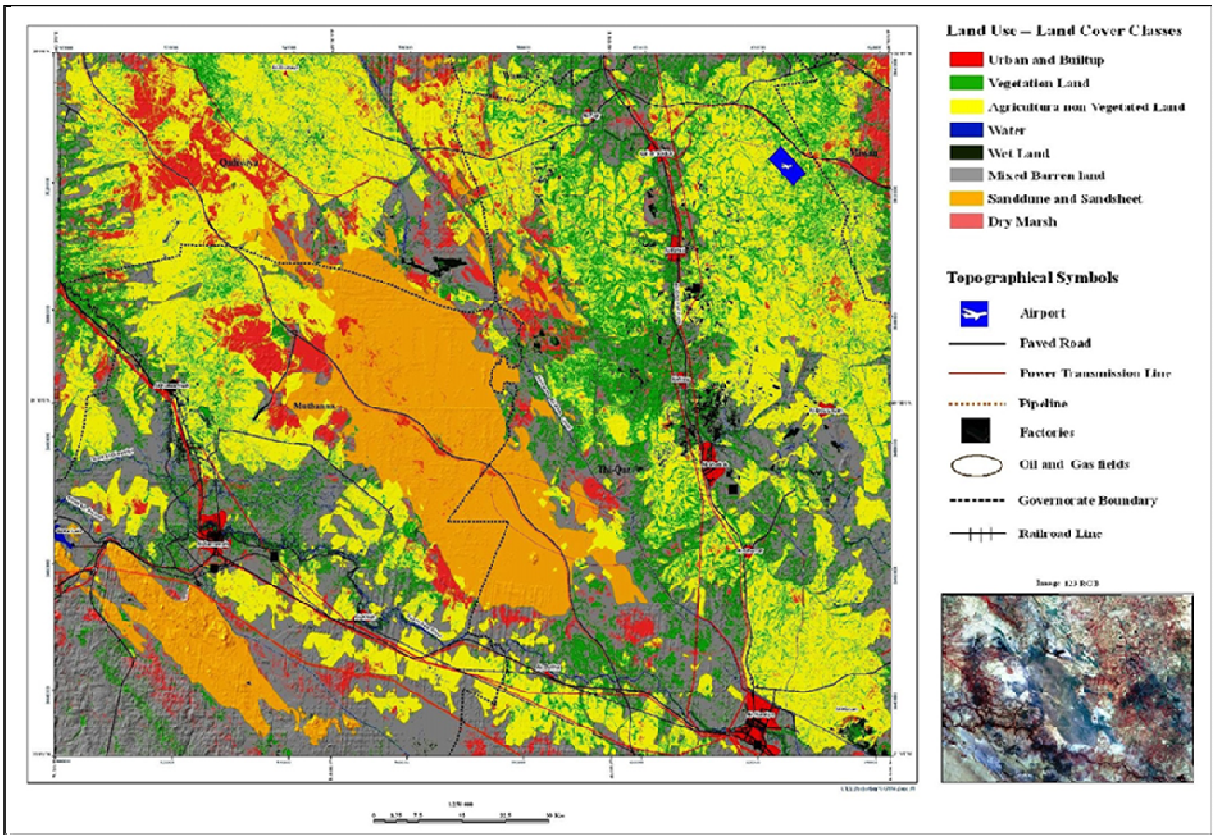

Figure 6. Digital LU–LC map of the study area

4.2 Statistics Distribution

The statistics of the coverage area for each individual class are shown in (Table 4) and (Fig.7). The most prevailing class is Barren land (49.44%). whereas the lesser class is Wetland (0.82%).

Table 4. Rate and area of classes in the study area

Class Name		Area (Km²)	Area (%)
Barren Land	Mixed Barren Land	4801.2	30.35
	Sand Dunes sand sheet	1881.5	11.90
	Dry marsh	1137.7	7.19
Total Barren Land		7820.4	49.44
Agricultural Land Non-Vegetated		5502.5	34.79
Vegetated Land		2077.8	13.14
Wetland		130.3	0.82
Water		152.6	0.96
Urban and Built-up		133.6	0.84
Total		15817.2	100.00

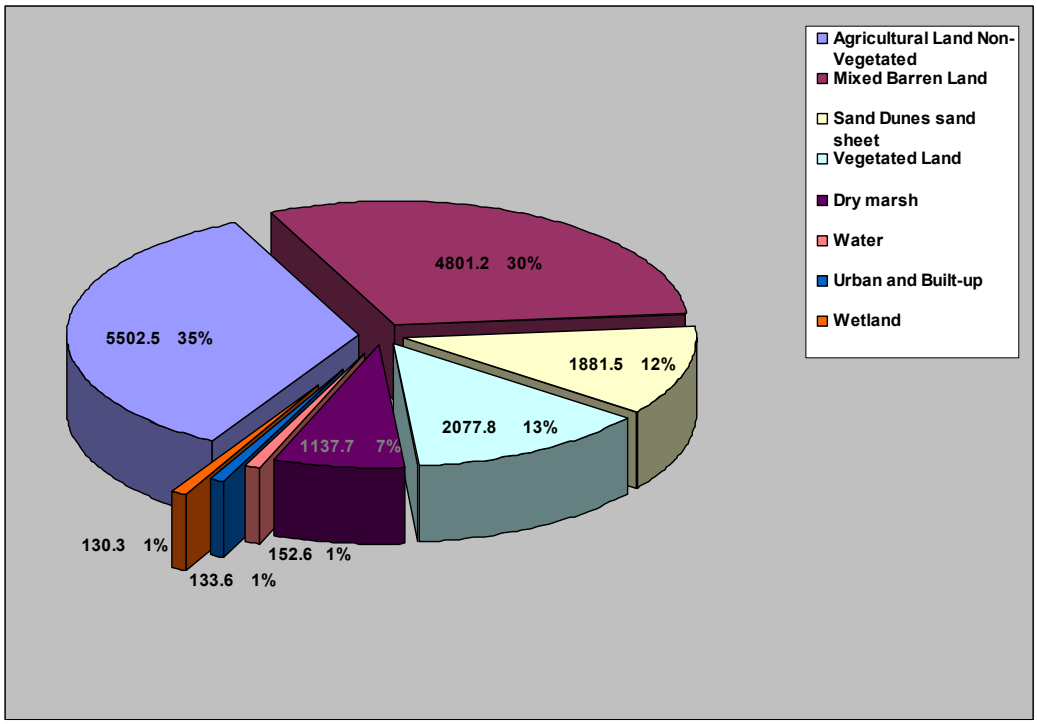

Figure 7. Plot diagram showing rate (%) and area (Km²) of each class in the study area

5. Conclusion

From the executed work, the followings could be concluded.

- Six main types of LU–LC were recorded in the study area, these are; Urban and Built-up Land, Vegetated land, Water, Agricultural Land Non-Vegetated. Wet land and Barren Land subdivided into Dry marsh subclass, mixed barren land subclass and Sand dunes and sand sheet subclass.
- The most common type within the study area is the Barren land (49.44% of the total study area) it occurs in different parts of the study area. This phenomenon indicates that about 49.44% of the study area suffer from desertification environmental problem.
- Using a maximum likelihood classifier method led to get a high accuracy.

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