USING REMOTE SENSING AND GIS TECHNIQUES TO STUDY AND ASSESS ENVIRONMENTAL CHANGES IN AL-HABBANIYA LAKE AND SURROUNDING AREA

***Mousa A. Ahmed , Dr.Walid A. Ahmad, *Younus. Al-Saady**
Geology department, college of science, university of Baghdad, Baghdad, Iraq
* Senior Geologist, Remote Sensing Division, Department of Information Technology, State Company of Geological Survey and Mining, Baghdad, Iraq

ABSTRACT

The study area lies in the central part of Iraq, in Al-Anbar Governorate, it covers about (4400) km^2.It includes Al-Habbinya Lake which represent touristic region and waterish reserves used for water balance management of Euphrates River.

Remote sensing and GIS techniques were adopted as practical tools for long term monitoring of Al-Habbinya Lake (1990-2001) to study Environmental change detection in the study area using ERDAS 9.1 Imagine and Arc GIS 9.1 programs.

Supervised classifications were applied for the LANDSAT5 and LANDSAT7 images to classify the data and determine the change which took place during the period (1990-2001).

The outcomes of these processes are two classification maps display eight classes of the land cover types for TM (1990) image in total classification accuracy reached 91.14% and a kappa coefficient 0.8989, eight classes of the land cover types for ETM (2001) image in total classification accuracy reached 93.06% and a kappa coefficient 0.9221.

The obtained result shows increase in area of vegetation, muddy soil, moist land and decrease in area of water, bare soil, bare soil with gravel, and sabkha during the period from 1990 to 2001.

استخدام التحسس النائي وتقنياتGIS لدراسة وتخمين التغيرات في بحيرة الحبانيه والمناطق المحيطة بها

***موسى عبداللطيف احمد، د.وليد عبدالمجيد احمد، *يونس السعدي**
قسم الجيولوجي، كلية العلوم، جامعة بغداد، بغداد-العراق
***(جيولوجي اقدم) شعبة التحسس النائي، قسم تكنولوجيا المعلومات**

المستخلص

تقع منطقة الدراسة في محافظة الانبار، وسط العراق، وتغطي حوالي 4400 كيلومتر مربع. وهي تشمل بحيرة الحبانيه التي تمثل منطقة سياحية ومحميات مائيه تستخدم لتنظيم وادارة التوازن المائي لنهر الفرات.

وقد اعتمدت تقنيات الاستشعار عن بعد ونظم المعلومات الجغرافية كادوات عملية للرصد طويل الامد لبحيرة و Arc GIS 9.1 لدراسة كشف تغيرات البيئة في منطقة الدراسة (1990–2001) الحبانيه باستخدام البرامج

تم استخدام التصنيف LANDSAT 5 & LANDSAT 7 لتصنيف البيانات وتحديد التغيرات التي للمرئيات

حدثت خلال الفترة (1990–2001). وقد كانت نتائج هذه العمليات هي خريطتي تصنيف تعرض ثمانية اصناف في دقة تصنيف كلية وصلت الى 91.14% ومعامل كابا 0.8989 من انواع الغطاء 1990–TM النباتي للصورة

وثمانية اصناف من انواع الغطاء النباتي للصورة ETM-2001 في دقة تصنيف كلية وصلت الى 93.06% ومعامل كابا 0.9221 .

النتيجة التي تم التوصل اليها تظهر زيادة في مساحة الغطاء النباتي والتربه الطينية والاراضي الرطبة والنقص في مجال المياه، والتربه العارية، والتربه العاريه المغطاة بالحصى، والسبخة خلال الفترة (1990-2001).

1. INTRODUCTION

The remote sensing techniques and GIS software are used to detect the environmental changes which happen during the period from (1990-2001).

The present study applied the remote sensing technique like advanced classification to detect the environmental changes in the study area using TM, ETM data and GEOSURV ancillary data.

The aim of this study is to Determine the environmental changes in Al-Habbaniya lake and surrounding area from 1990 – 2001.

1.1. Location

The study area lies in the central part of Iraq, within Al-Anbar Governorate it covers about (4400) Km^2, it is determined by the fallowing coordinates (Fig.1.1)

43° 02′04″- 43° 52 ′37 ″ E , 33° 08′ 46″- 33° 39′ 16″ N

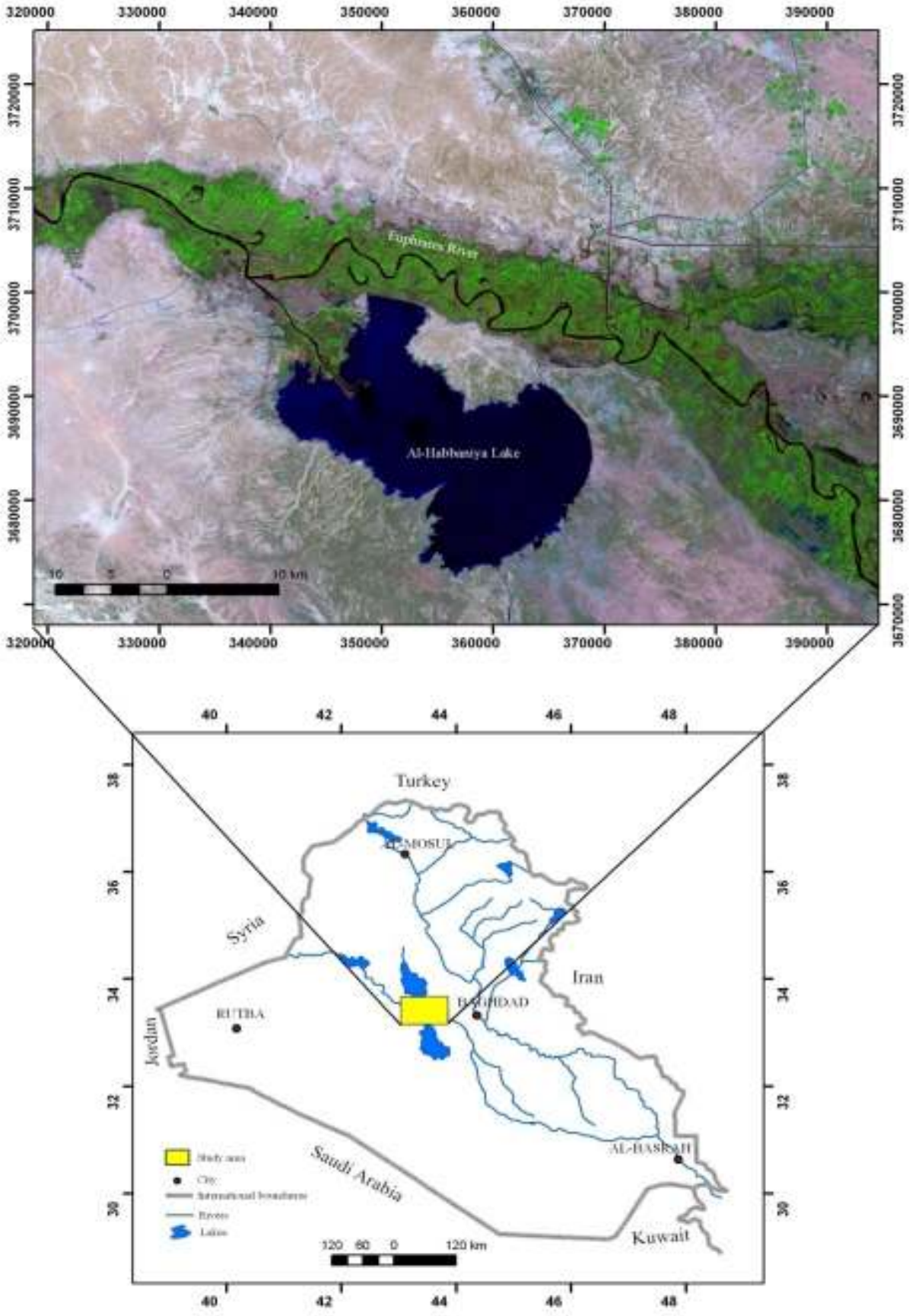
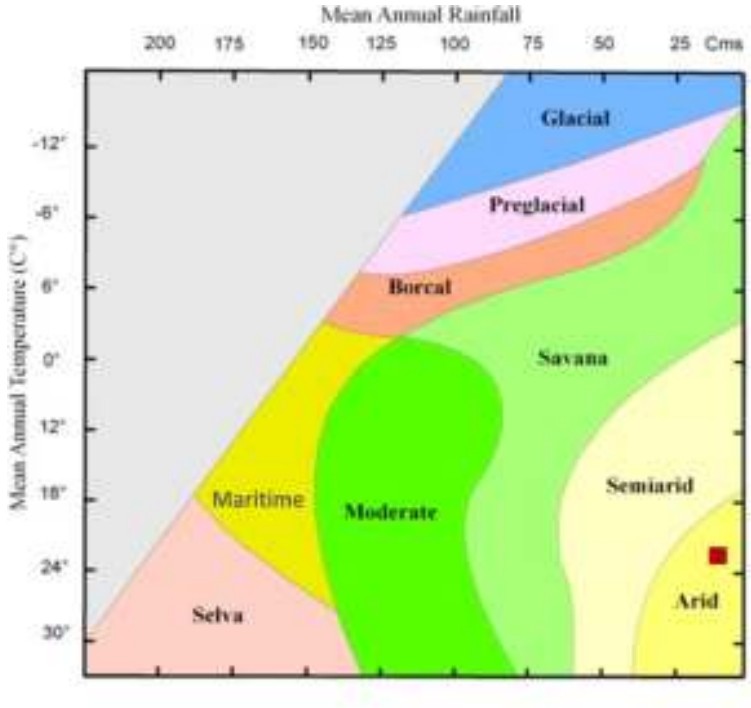


Fig. 1.1: Location map of the study area

1.2. Climate

The study area has an arid climate during the period from 1990 to 2002(Fig.1.2) and characterized by hot summer and cold winter with seasonal rainfall. The major portion of rainfall is received during months of November to April. The present study depends basically on the climate data obtained from Iraqi Meteorological Organization. **(I.M.O, 2005)**



(Fig.1.2) Climatic boundaries of the morphogenetic regions
(After Peltier, 1950 in Fookes1971)

1.3. Geological Setting

The study area lies on the eastern margin of the inner (stable) platform of Arabian plate (Fouad , 2010). It is mostly covered by Quaternary sediments with local exposed of Lake Neogene Formations such as: Injana Formation and Fatha Formation
(Yacoub and Dikran, 1993),(Sissakian and Salih, 1995)

1.4. Methodology

1.4.1. Data

The present study depends on the following available data:

1: Thematic Mapper (TM5) data of Landsat Acquisition in 4/3/1990, Scene169-37 in spatial resolution 30m (Fig.1.3).

2: Enhancement Thematic Mapper (ETM) data of Landsat7 Acquisition in 18/3/2001, Scene.169-37 (Fig.1.4) in spatial resolution 30m have been used. The specifications of both images are given in (Lillisand and Kiefer, 2000).

1.4.2. Software

ERDAS Imagine V. 9.1 and ArcGIS V.9.1 softwares have been used. ERDAS Imagine 9.1 software was used for image processing and change detection. Arc GIS 9.1 software was used for data analysis and map composition.

1.4.3. Pre-processing

One scene of TM images and one scene of ETM images, these data are mosaic and 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 (Lillisand and Kiefer, 2000)

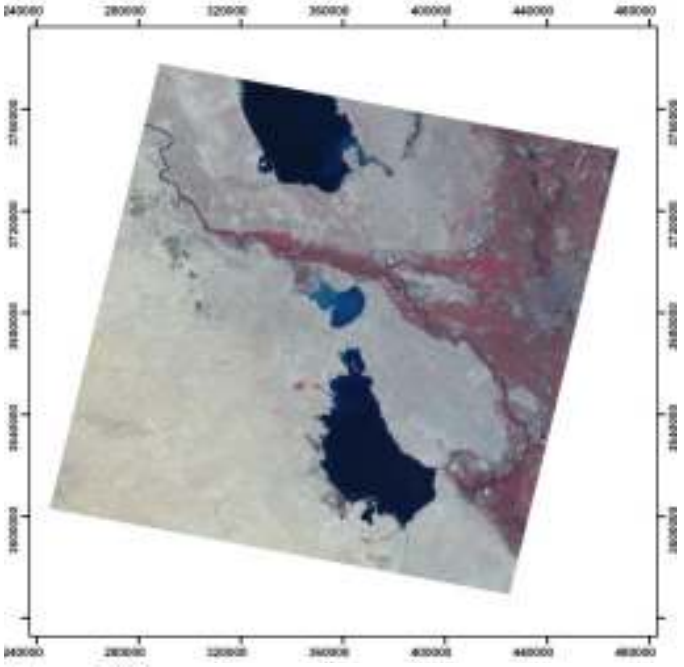


Fig.1.3: Landsat (ETM) Image 1990

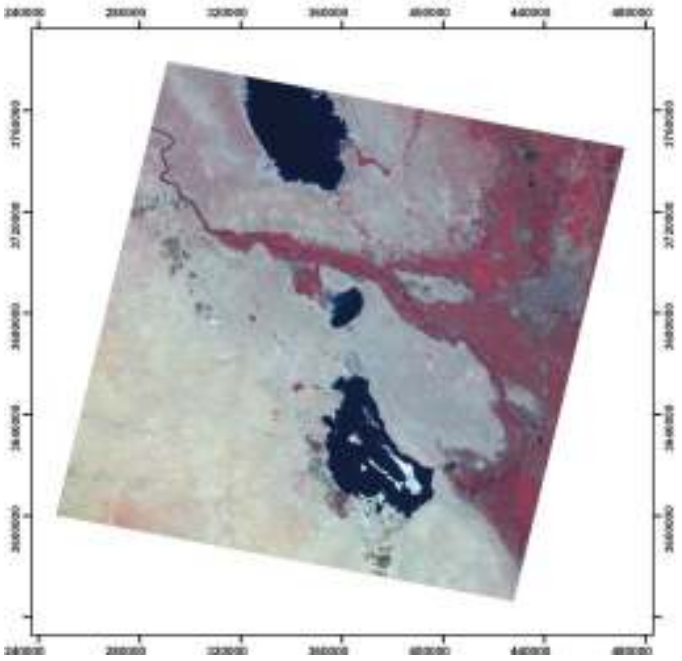


Fig.1.4: Landsat (ETM) Image 2001

2. CLASSIFICATION

2.1. Supervised Classification

Supervised classification methods are most commonly used in remote sensing and based on the knowledge of the area to be classified .Multispectral classification is the process of sorting pixels into a finite number of individual classes, or categories of data. (ERDAS Imagine 2005).

The maximum likelihood classifier (MLC) method is a well known supervised classification algorithm is used in this study as a parametric rule to table image pixels of Landsat, TM, ETM images that is based on the assumption that the probability density function for each class is normal. Parallelepiped non parametric rule was use to assist the maximum likelihood classification study in a parallelepiped computation.

2.2. Classification Map of the LANDSAT–TM (1990)

The Landsat-TM image showed the classification map in (Fig 2.1). The following descriptions of the eight land cover types:

- Deep water class
- Shallow water class
- Vegetation class
- Sabkha class
- Bare soil with gravel class
- Muddy soil class
- Moist land class
- Bare soil class

(Fig.2.2) is showing mean plots for class's signature. The number of random points is 63 points. The Overall classification Accuracy achieved was 93.06% and a kappa coefficient was 0.9221.

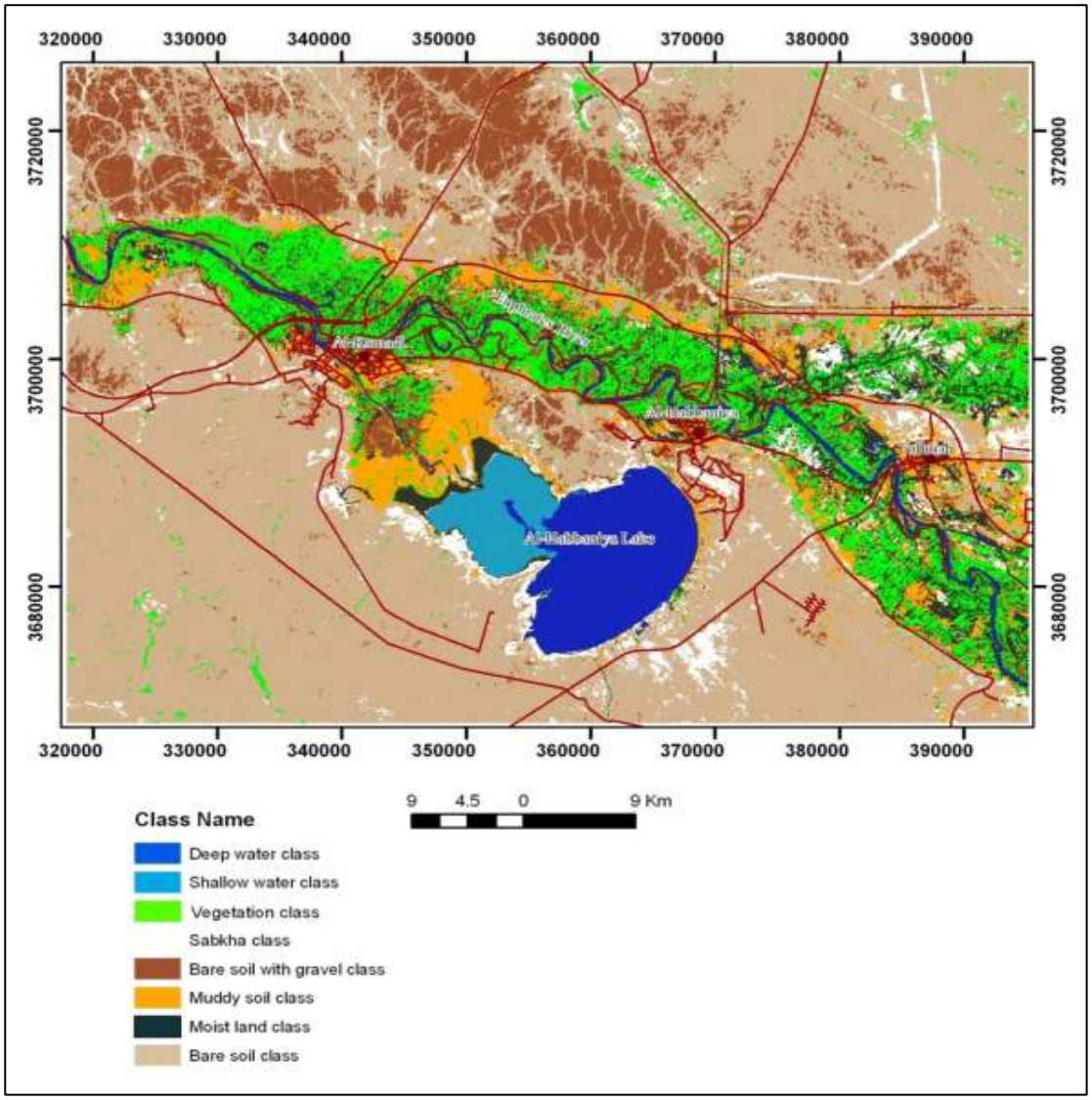


Fig.2.1: Classification Map of the LANDSAT–TM (1990)

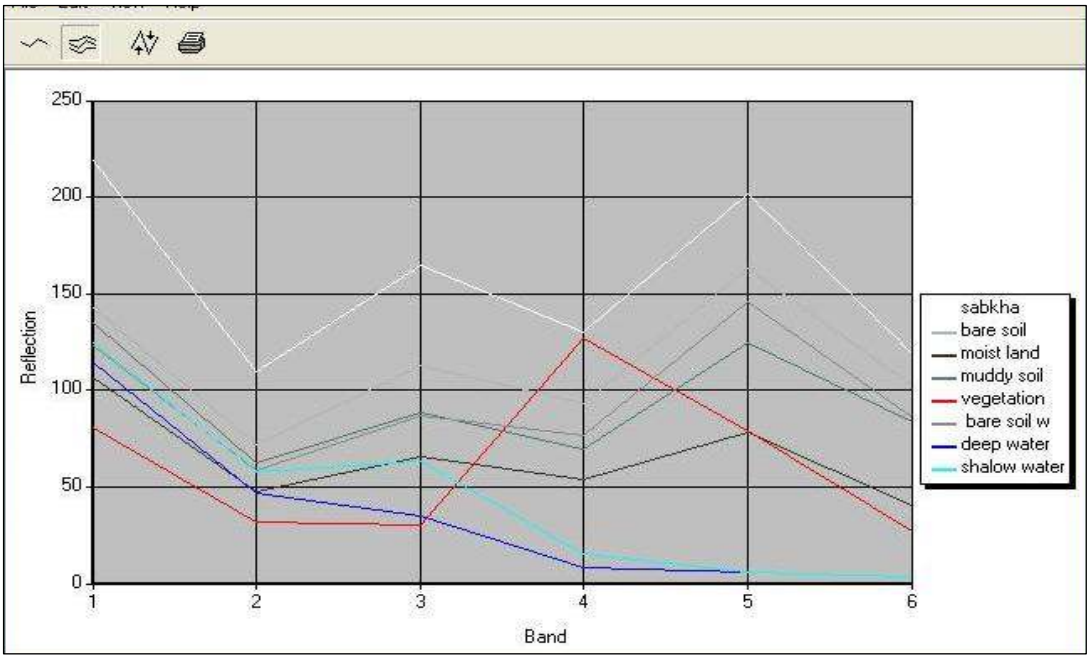


Fig.2.2: Mean plots for classes signature

2.3. Classification Map of the LANDSAT–ETM (2001)

The Landsat-ETM image showed the classification map in (Fig 2.3) .The following descriptions of the eight land cover types:

-Deep water class
- Shallow water class
- Vegetation class
- Sabkha class
- Bare soil with gravel class
- Muddy soil class
- Moist land class
- Bare soil class

(Fig2.4) is showing mean plots for class's signature. The number of random points is 79 points. The Overall classification Accuracy achieved was 91.14% and a kappa coefficient was 0.8989.

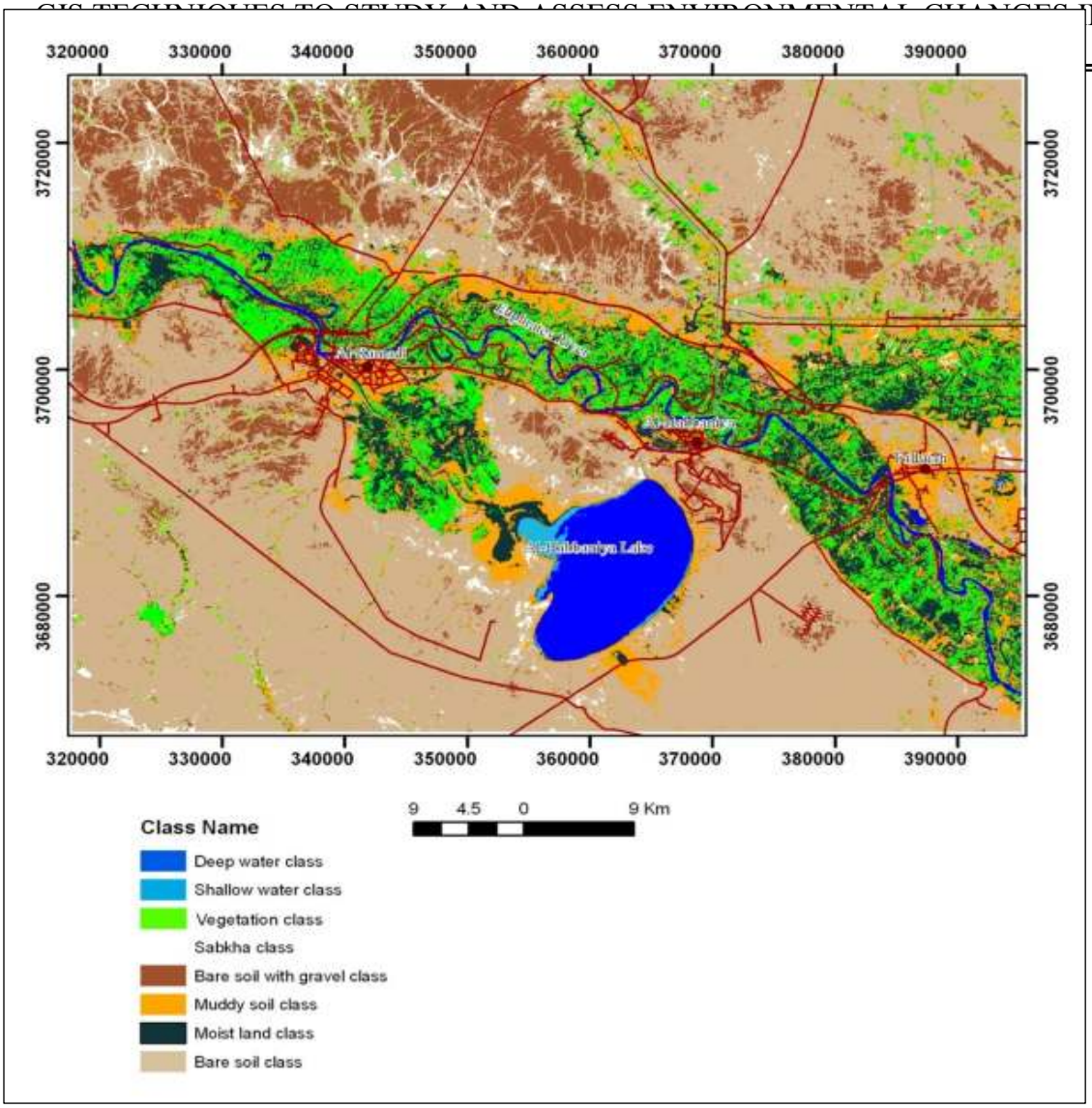


Fig.2.3: Classification Map of the LANDSAT–ETM (2001)

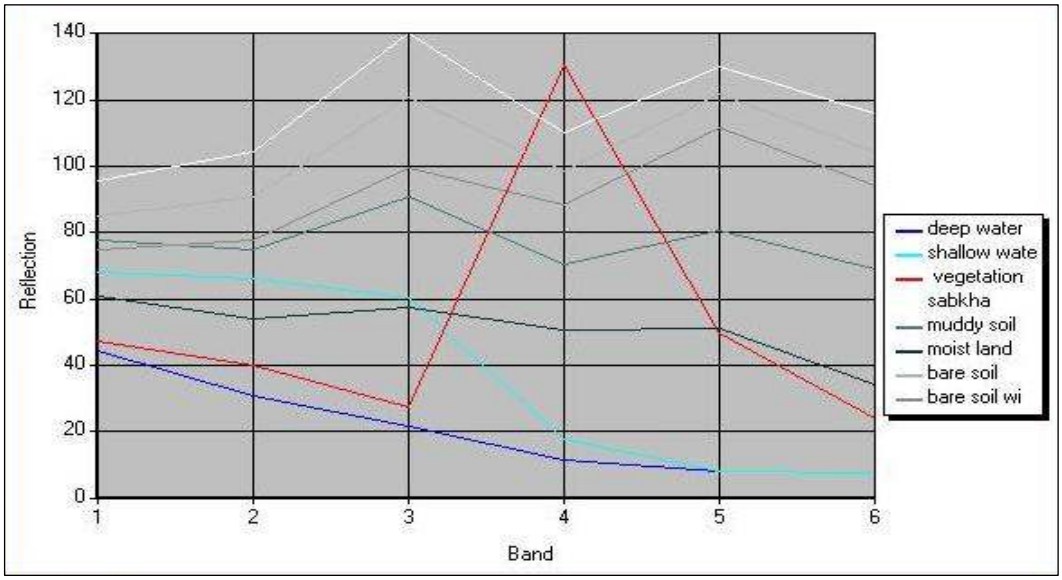


Fig.2.4: Mean plots for classes signature

3. LAND COVER CLASSIFICATION

The land cover map is created depending on digital interpretation for Landsat TM, ETM data using maximum likelihood classification. The study area could be classified in to seven classes.

3.1. Water class (Deep / Shallow water)

The images of water areas depends on the scale of data, scale and resolution characteristics of the remote sensor data used for interpretation of land cover. It includes, Streams, Canals, Lakes, and Reservoirs.(Anderson et.al., 1976). This class locates under high change in the study area and depending on comparison between two Satellite images.

The water bodies are well distinguished by spectral reflection and appear in black color within 432 and 453 RGB. The lake in the study area is Al-Habbaniya and the main river is Euphrates. The satellite image of TM (1990) and ETM (2001) shows the water concentrate on the central of part of the study area. The main source of water of Al-Habbaniya Lake is from the artificial drainage canal from Euphrates River.

The Irrigations system in the study area have been developed during nineties period, many irrigation canals have built-up in the study area for Agriculture purpose like (Tigris-Al-Tharthar canal) which led to increase the vegetations lands.

The amount of water decrease between 1990-2001.That is attributed to closing the Al-Warar regulator, that lead to dropped water level of Al-Habbaniya Lake

At the present time Al-Habbaniya Lake are used as reservoir of water and touristic place. (Table 3.1) is showing the variations of water area.

Table3.1.Shows the variations of water area

Date / Class	Surface Area in km²	
	1990	2001
water	252.699	188.176

3.2. Vegetation class

This class represented in the study area as a different types of vegetation .The distinguish between these types is impossible depend on efficiency the used data because the limited of spectral range .but we can recognize agriculture land from visual interpretation depend on the shapes, distribute and occurrence of irrigation system. The vegetation land increased from 434.466 km² in 1990 to 438.309 km² in 2001. This expansion of agriculture over time is as result of human activities.

The main type of crop land includes barley, wheat, vegetables, date palms. and other types. Also there are different types of wild vegetation that distribute in different location of the study area (Field observation by the author)

The different of vegetation area in (1990, 2001) are illustrated in (Table 3.2) which refers to improve Agriculture especially in 2001.

Table 3.2.Variations of vegetation area

Date / Class	Surface Area in km²	
	1990	2001
vegetation	434.466	438.309

3.3. Bare soil class

The Bare soil class covers a huge area distribution in the different location of the study area. The results of images processing are showing change in the area of this class. In general the area of bare soil is decreased from 1990 to 2001 as result of change in aquiculture lands due to new irrigation project, see (Table3.3). The texture of soil in this class is consisting of sand, salt, gypsum and clay where the gypsum presents the higher percentage.

Table 3.3.Variations of bare soil area

Date / Class	Surface Area in km²	
	1990	2001
Bare soil	231.209	223.386

3.4. Bare soil with gravel class

This class distribution is in the different location of the study area particularly in the northern part of the study area. The results of images analysis are showing change in the area of this class (Table3.4). In general the area of bare soil gravel is decreased from 1990 to 2001.

Table 3.4.Variations of bare soil with gravel area

Date / Class	Surface Area in km²	
	1990	2001
Bare soil with gravel	609.058	591.222

3.5. Sabkha class

Sabkhas occurre on the flat-floored bottoms of interior desert depression which do not qualify as Wetland are included in this category. On satellite imagery, dry Salt Flats tend to appear white or light toned because of the high concentrations of salts at the surface as water has been evaporated (Ahmed and Al-Saady, 2009).

The Sabkha has a different spectral reflection depending on water content, graduated to be like the water reflection, the salt flat that content high salinity distributed mainly around Al-Habbaniya Lake and some areas distribution in particular in some wide valleys mixed with soft soil in the study area

The variations of Sabkha area for two periods are showing in (Table3.5).

Table 3.5.Table 2.9.Variations of Sabkha area

Date / Class	Surface Area in km²	
	1990	2001
Sabkha	292.253	88.696

3.6. Muddy soil class

The muddy soil class is developed alongside the Euphrates River and in middle part of the study area. The results of images processing are showing change in the area of this class. In general the area of muddy soil is increased from 1990 to 2001.as in (Table3.6).

Table 3.6.Variations of muddy soil area

Date / Class	Surface Area in km²	
	1990	2001
Muddy soil	305.553	530.068

3.7. Moist land class

This class distribution in the study area on extend Euphrates River and in middle part of the study area (the western part of Al-Habbaniya Lake).The results of images processing are showing change in the area of this class as in (Table 3.7). In general, the area of moist land increased from 1990 to 2001 due to the drop of water level in Al-Habbaniya Lake and some regions in the study area.

Table 3.7.Variations of moist land area

Date / Class	Surface Area in km²	
	1990	2001
Moist land	252.912	391.372

Conclusion

The study area underwent significant environmental changes during the eleven years. The obtained result shows increase in area of vegetation, muddy soil, moist land and decrease in area of water, bare soil, bare soil with gravel, and sabkha during the period from 1990 to 2001.

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