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STUDYING OF THE ENVIRONMENTAL CHANGES IN MARSH AREA USING LANDSAT SATELLITE IMAGES

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ABSTRACT

The marshes of Mesopotamia at the southern part of Iraq represent a unique component of our global heritage. During the last decades the Iraqi marshes subjected to many changes, these changes have great impact on marshes environmental and ecosystem.

The goal of this research is to detect the environmental changes in Iraqi marshes that represented main land cover in the area for the period 1973-2004, by using multi-temporal and multi-spectral satellite images. Landsat images have been used as a tool for detecting and studying land cover changes and its impact on the environment of Iraqi Marsh area.

The results showed that clear changes have occurred in the area, reducing in vegetation cover and surface water area with increasing of barren dry and wet lands.

Key Words: Marsh of Iraq, Environmental changes, Land cover, NDVI, Landsat images

INTRODUCTION

Iraqi marshes were considered the largest wetland in the Middle East and characterized by varied environment such as rivers, lakes and vegetation covers. People lived in/around wetlands and interior of marshes, building reeds house on artificial floating island of reeds, moving around by boat, selling reed mats, and living on fish, water buffalo, and rice[3].

The wetlands are locations in which human civilization began with the Sumerian culture more than 5000 years ago. Scholars regard the marshes as the site of biblical "Garden of Eden" the "Great Flood" and the birthplace of the patriarch Abraham. On the shores the marshes the legendary Epic of Gilgamesh was enacted World- renowned archaeological sites on the fringes of the marshes including Ur, Lagash and Nina[7] .

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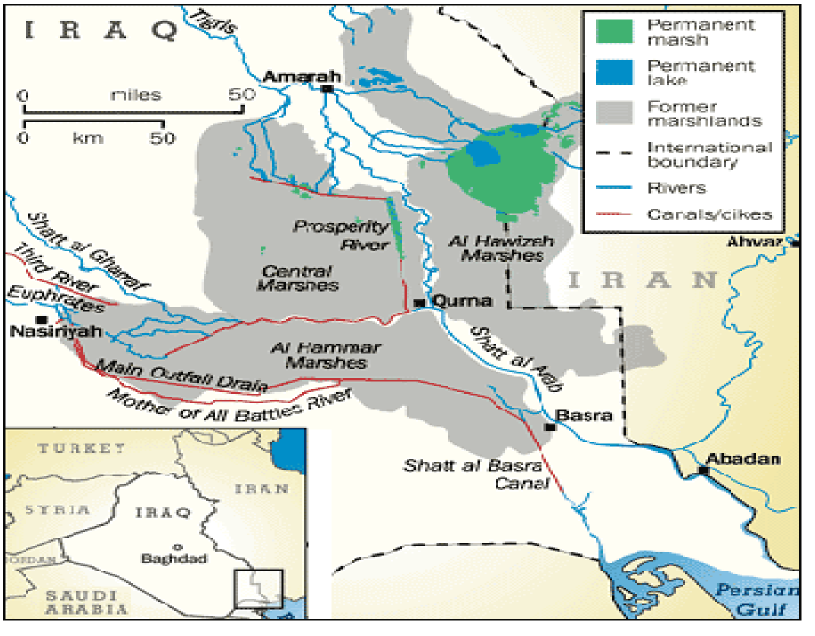
Iraqi marshes lies in the southern part of Iraq, the Iraqi marshes cut across three of Iraq's eighteen provinces: Misan (originally Al-Amarah), Dhi-Qar (originally Al-Nasiriyah), and Al-Basrah. The heartland of the marshes comprised three principal areas:

a-The Al-Hammar marshes are located south of the Euphrates, extending from near Al-Nasiriyah in the west to the outskirts of Al- Basrah on the Shatt Al-Arab .

b-The Central marshes located immediately above the confluence of the two Mesopotamian rivers, bounded by Tigris river to the east and the Euphrates river in the south, the area is roughly delimited by a triangle between Al-Nasiriyah, Qalat Saleh and Al-Qurnah.

c-The Al-Hawaizah marshes, located east of the Tigris river and extending into Iran (where they are known as the Al-Azim marshes).

Figure-1. location of study area[7].



DATA USED

Multi-temporal and Multi-Band Landsat images have used in this work as it shown in table (1).

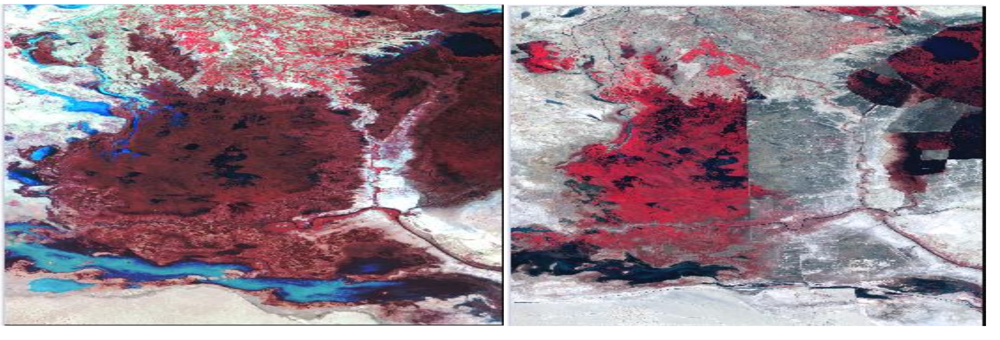
IMAGES MOSAIC

Digital Image mosaic technique was applied in this study due to the area of study was too large to cover by one image, so two images are used together to give a general view of the entire region of the study area. Figure (2) shows the output mosaic images of the study area.

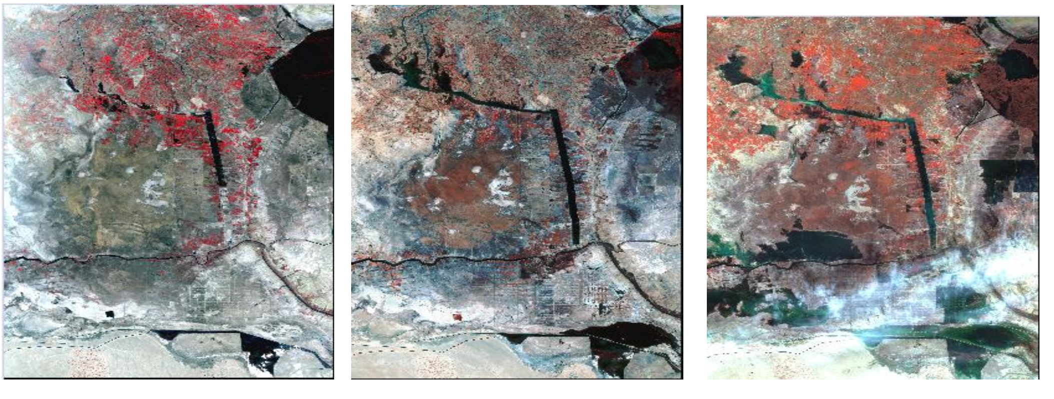
Table-1. Landsat images used

Spatial Resolution(m)	Bands	Acquisition Date	Data Type
80	1,2,4	1973	Landsat MSS
30	2,3,4	(7/9/1990)	Landsat TM
120	6	(7/9/1990)	Landsat TM path166 row38
120	6	(7/9/1990)	Landsat TM path 166 row39
30	2,3,4	(26/3/2000)	Landsat ETM+
60	6	(26/3/2000)	Landsat ETM+ path 166row38
60	6	(26/3/2000)	Landsat ETM+ path166 row39
30	1,2,3,4	(6/5/2003)	Landsat ETM+ path166 row38
30	1,2,3,4	(6/5/2003)	Landsat ETM+ path166 row39
60	6	(6/5/2003)	Landsat ETM+ path166 row38
60	6	(6/5/2003)	Landsat ETM+ path166 row39
30	1,2,3,4	(2/2/2004)	Landsat ETM+ path166 row38
30	1,2,3,4	(2/2/2004)	Landsat ETM+ path166 row39
60	6	(2/2/2004)	Landsat ETM+ path166 row38
60	6	(2/2/2004)	Landsat ETM+ path166 row39

Figure-2. Mosaic Landsat images for study



A- MSS , 1973 *B- TM , 1990*



C- ETM + , 2000 *D- ETM+ ,2003* *E- ETM+, 2004*

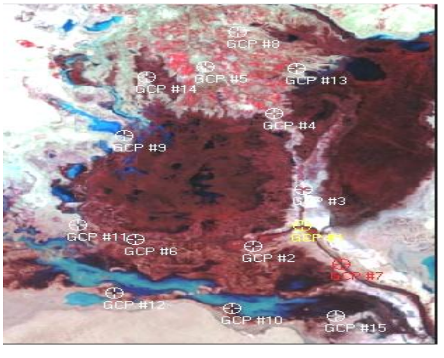
IMAGE REGISTRATION

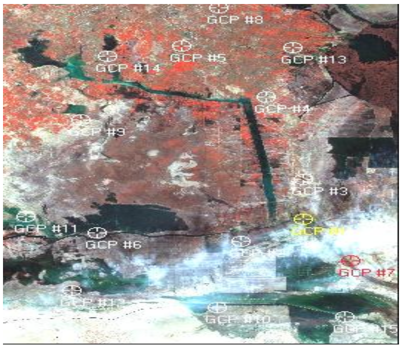
Registration is an important stage in the change detection technique using satellite data. Landsat ETM+ (2004) image have used as a reference image to register Landsat MSS (1973), Landsat TM (1990) and Landsat ETM+ (2000).

For Landsat MSS 1973 image registration (15) GCPs are selected, RMS error is 0.045 pixel. In case of Landsat TM (1990) image, (25) GCPs distributed on all image are used, RMS error is 0.64 pixel, and for Landsat ETM+(2000) image (25) GCPs distributed on the image are used with RMS error 0.069 pixel.

linear transformation (1st order polynomial) was applied . Nearest-neighbors method was used for resampling. Figure(3) shows an example of selection GCP on reference image (ETM+ 2004) and registered image (MSS 1973).

Figure-3. Distribution of the GCPs





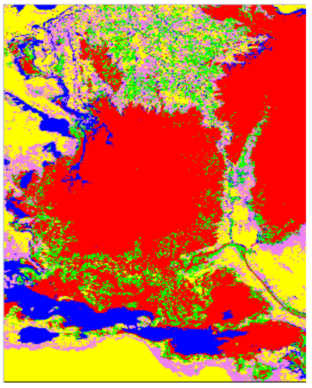
A- Landsat image MSS (1973) *B- ETM+(2004) (reference image)*

IMAGE CLASSIFICATION

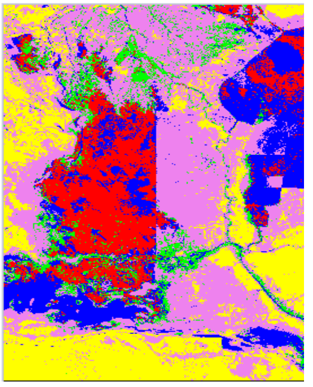
Classification is the process of grouping pixels or regions of the image into classes representing different ground-cover types. Both unsupervised and supervised classification techniques are used for Landsat images classification. The study area images were classified to five classes (water, wet land, barren land, marsh vegetation and agriculture) using supervised classification technique.

Maximum Likelihood classification method was used to classify the Landsat images that represent study area at different times. The Landsat images were classified to five classes represent water, wet land, barren land, marsh vegetation, agriculture. Figure (4) and table (2) shows the result of supervised classification.

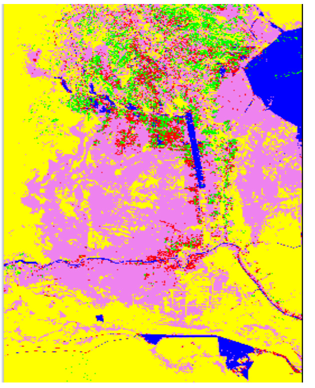
Figure -4. Supervised classification of Landsat images



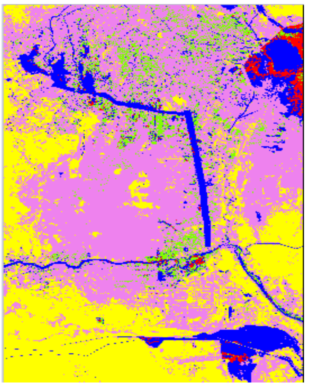
A- Landsat MSS 1973



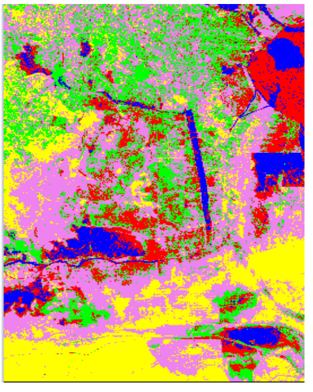
B- Landsat TM 1990



C- Landsat ETM+ 2000



D- Landsat ETM+2003



E- Landsat ETM+ 2004

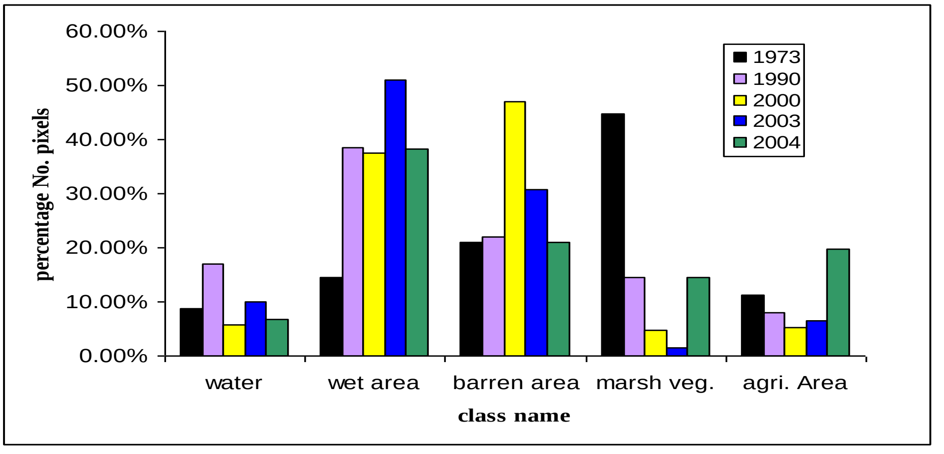
Class Name	*color*
Water	
Wet area	
Barren land	
Marsh vegetation	
Agriculture	

Table-2 . Supervised classification statistics summery report for landsat images

Class Name	Color	Landsat MSS 973	Landsat TM *(1990/9/7)*	Landsat ETM *(2000/3/26)*	Landsat +ETM *(2003/5/6)*	Landsat +ETM + *(2004/2/2)*
		No. Pixels	No. pixels	No. pixels	No. pixels	No. pixels
Water		*814737 %7.8*	*2493157 %9.16*	*564469 %7.5*	*1424095 %10*	856476 6.7%
Wet land		*1370967 %6.14*	*5657289 %5.38*	*3746737 %6.37*	*7250615 %1.51*	*4911379 %3.38*
Barren land		*1963580 %9.20*	*3257187 %1.22*	*4675944 %9.46*	*4366522 %8.30*	*2674964 %9.20*

Marsh vege.		***4207292*** ***%7.44***	***2140654*** ***%6.14***	***463932*** ***%7.4***	***215395*** ***%5.1***	***1840023*** ***%6.14***
Agri. land		***1057114*** ***%2.11***	***1160986*** ***%8***	***523088*** ***%2.5***	***942019*** ***%6.6***	***2531445*** ***%8.19***

Figure-5. Comparative analysis for (1973-2004) land cover classes



It is clear from the above result that the marsh vegetation and water areas started to decrease since year 1990 and reach the lowest value in year 2000 because the desiccation marshes. This desiccation causing increase the barren and wet area, so that in year 2000 barren area increase by 24.8% more than year 1990. Re-flooding the marshes in mid of year 2003 increase the water area by about 4.3% more than year 2000

NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)

Normalized difference vegetation index has been found to be good indicator for vegetation and land use/ land cover changes. It has been found that clear correlation between NDVI and surface temperature. NDVI can be computed from this formula [1].

$$\text{NDVI} = \frac{\text{Near IR band} - \text{Red band}}{\text{Near IR band} + \text{Red band}} \qquad (1)$$

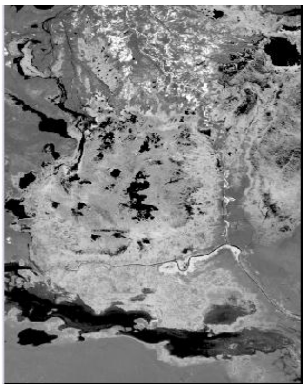
The original NDVI had the values between -1 and +1, but we transformed NDVI values into 8 bit (0 – 255) using this equation:

$$\text{Scaled NDVI} = \left(\frac{\text{NDVI} - \text{MIN}}{\text{MAX} - \text{MIN}}\right) * 255 \qquad (2)$$

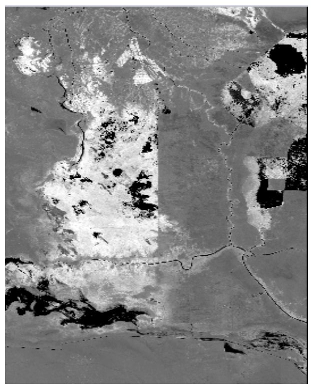
Where NDVI = is the range -1 to +1, Min = Minimum value of NDVI and Max = Maximum value of NDVI.

The NDVI image computed from Landsat MSS 1973, Landsat TM (1990), Landsat ETM+ (2000), Landsat ETM+ (2003), Landsat ETM+(2004) images shows in figure(6 **) ,**

Figure-6. NDVI ratio images from Landsat data

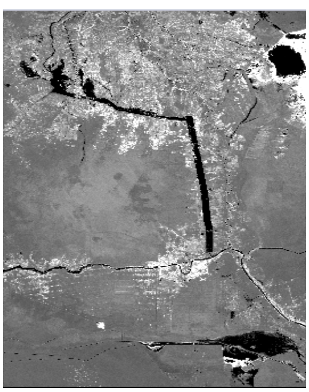


A- MSS 1973



B- TM 1990

C- ETM+ 2000



D- ETM+ 2003

E- ETM+ 2004

Table-3. Average NDVI for land use classes

Class Name	1973 NDVI value	1973 NDVI scaled	1990 NDVI value	1990 NDVI scaled	2000 NDVI value	2000 NDVI scaled	2003 NDVI value	2003 NDVI scaled	2004 NDVI value	2004 NDVI scaled
Water	*- 73.0*	*34*	*-0.56*	*56*	*- 0.48*	*66*	*- 0.41*	*75*	*- 0.07*	*118*
Wet land	*04.0*	*133*	*149.0*	*12.146*	*-039.0*	*57.122*	*-135.0*	*25.110*	*095.0*	*6.139*
Barren	*07.0*	*136*	*180.0*	*60.150*	*034.0*	*79.131*	*-0.121*	*12.112*	*095.0*	*68.140*
Marsh veg.	*521.0*	*194*	*510.0*	*56.192*	*226.0*	*36.156*	*055.0*	*56.134*	*103.0*	*42.161*
Agriculture	*611.0*	*205*	*637.0*	*68.208*	*392.0*	*48.177*	*247.0*	*04.159*	*469.0*	*34.187*

Figure-7. Average NDVI for land use classes

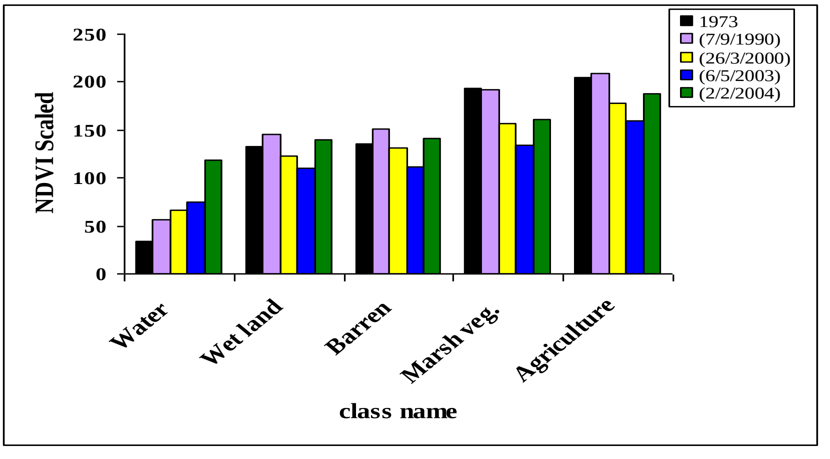


Table 3 and figures 6 and 7 shows that vegetation area(such as marsh vegetation and agriculture) had the highest NDVI value. While other areas (wet soil, barren) had the lowest NDVI because there were just a few green spaces in the area.

CONCLUSIONS

1- Environmental changes in Iraqi marsh during the period 1973-2004, effects on vegetation and water (ecosystem). Clear changes have occurred in marsh draining, reducing vegetation and water with increasing in barren and wet lands.

2- The results show that marsh vegetation decreased about 30.10% in year 1990, 40% in year 2000, 43.2% in year 2003, 30.10% in year 2004; comparable with year 1973. While wet area increase about 23.90%, 23.00%, 36.50% , 23.70% for years 1990, 2000, 2003 and 2004 respectively comparable with year 1973. Barren area increase about (1.20 -26.00)% during the period 1990-2000, after that decrease when re-flooding marshes.

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