Study of Land Use Changes for Marsh Region by using Landsat Images and by Calculate Normalize Difference Vegetation index (NDVI)

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Abstract

Iraqi marshes were considered the largest wetland in the Middle East and characterized by varied environment (such as river, lakes and vegetation covers). During the last decades the Iraqi marshes subjected to many artificial and natural changes. These changes have impacts on its ecosystem (land cover, vegetation and aquatic environment).

The aim of this paper is detect environmental changes in the Iraqi marsh for the period (1973-2004), by using multi-temporal and multispectral images with calculated, Normalized Difference Vegetation Index (NDVI).

Series of Landsat images shows that the Iraqi marshes are desiccated vegetation cover and water decrease during the period 1990- 2003. While 2003 shows re-flooding the area. The results show that NDVI is good indicator for vegetation area.

Keywords: land uses, Iraqi marshes, Landsat images, NDVI,

دراسة تغيرات الاستخدام الارضي لمنطقة الاهوار باستخدام صور لاندسات وبحساب دليل الخضرة (NDVI)

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<u>الخلاصة</u>

تعتبر الاهوار من اكبر المسطحات المائية في الشرق الأوسط ، وان أهوار جنوب العراق من أهم هذه المسطحات ومن أغنى مناطق العالم بالحياة البرية. تتمثل الاهوار بالبحيرات الضحلة الكثيفة الإعشاب والمغطاة بالقصب والبردي. تعرضت هذه المنطقة إلى عدة تغيرات سواء كانت هذه التغيرات طبيعية أو اصطناعية وأثرت التغيرات الحاصلة على النظام البيئي لمنطقة الاهوار(الغطاء الأرضي و النباتي و البيئة المائية).

يهدف البحث الحالي إلى كشف التغيرات البيئية الحاصلة في منطقة الاهوار للفترة-1973) (2004 باستخدام صورالقمر الصناعي (لاندسات) متعددة الأطياف وبتواريخ مختلفة وباستخدام دليل الخضرة (**NDVI**) الذي يعتبر دليل لكشف التغيرات في المساحات الخضرية.

لوحظ من خلال النتائج وصور لاندسات المستخدمة أن منطقة الاهوار قلت فيها مناطق الغطاء النباتي والمياه خلال الفترة (٢٠٠٣-١٩٧٣) التي تؤثر على البيئة الطبيعية لمنطقة الاهوار، بالإضافة إلى ذلك نلاحظ رجوع المياه في سنة ٢٠٠٣ . ومن النتائج لوحظ أن دليل الخضرة يعد مؤشر جيد لوجود المساحات الخضراء.

<u>الكلمات المفتاحية</u>: استخدامات الارض، الاهوار العراقية، صور القمر لاندسات، دليل الخضرة NDVI.

Introduction

Change detection is a process of identifying differences in the state of objects or phenomena by observing them at different time (multi-temporal analysis) [1], therefore change detection became useful tool for detecting land cover changes. It has enabled to observe changes over large areas and provided long-term monitoring capabilities. In general digital change detection techniques using temporal remote sensing data are useful to help analyzed these data, and provided detailed information for detecting change in land cover, this modern technique used in our study. The area under study is Iraqi marshes that considerable one of the distant areas.

Iraqi marshes lies in the southern part of Iraq, The principal Marshes are divided from each other by the Euphrates and Tigris rivers : The **Hammar Marshes** are located south of the Euphrates River, and to the west of its confluence with the Tigris. The **Central Marshes** are situated north of the Euphrates River and west of the Tigris River, and the **Al-Hawizeh Marshes** lie east of the Tigris River, straddling the border with Iran [2]. These marshes were once the largest wetlands in southwest Asia and covered more than 15,000 square kilometers (km^2), an area nearly twice the size of the original Everglades [٣]. Figure (1) shows the location of study area that used in this work. Locally it extends between (47.4º- 48º) longitude and (30.5º- 31.5º) latitude.

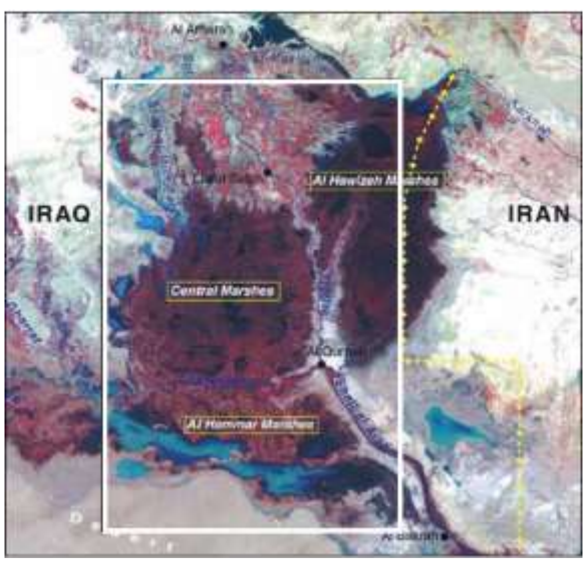


Figure (1) Location of study area that used in this study [4]

Previous Studies

Weng, (2001), Measure the surface temperature changes from 1989 to 1997, and compute Normalized Difference vegetation index (NDVI) for 1989 and 1997 in Zhujiang Delta of south China [5].

Zhou, et al (2003), analyzed the relation between satellite- based measures vegetation greenness and climate by land cover type through 1982 and 1999. Estimated statistically meaningful relation between NDVI and climate in the north of America and Eurasia [6].

Akkartal, et al (2004), Changes vegetation biomass in some region of Turkey for period (1987-2003) was analyzed by using five different types of vegetation indices included Simple Ratio (SR), Difference Vegetation Index (DVI), Normalized Difference Vegetation Index (NDVI), Transformed Normalized Difference Vegetation Index (TNDVI), Perpendicular Vegetation Index (PVI).The multi-temporal and multi-sensor satellite data have shown a great success in vegetation biomass analysis [7].

Riadh K. (2005), Studied change detection of environmental system using satellite images in Shatt Al-Arab region and part of Hawr Al-Hammar during 30 years through the comparative of different Landsat images [1].

Myung, et al (2006), Analyzed the pattern of the land cover change, surface temperature as well as NDVI distribution in the agriculture area for Ansung-Watershed area of Korea using multi-temporal of Landsat satellite image (1987, 1993, 2000) [8] .

Theoretical Concepts

Vegetation index depend on the spectral reflectance of vegetation, which is very different in near-infrared and red bands. Healthy vegetation should absorb the visible light and reflect most of the near-infrared; on the other hand unhealthy vegetation reflects more visible light and less near-infrared light [7]. The reflection on visible band is related with the pigments in the leaves of plants (chlorophyll), but in the near infrared it depends on the cell structure [9]; (as shown in figure (2) illustrate the spectral reflectance of health vegetation).

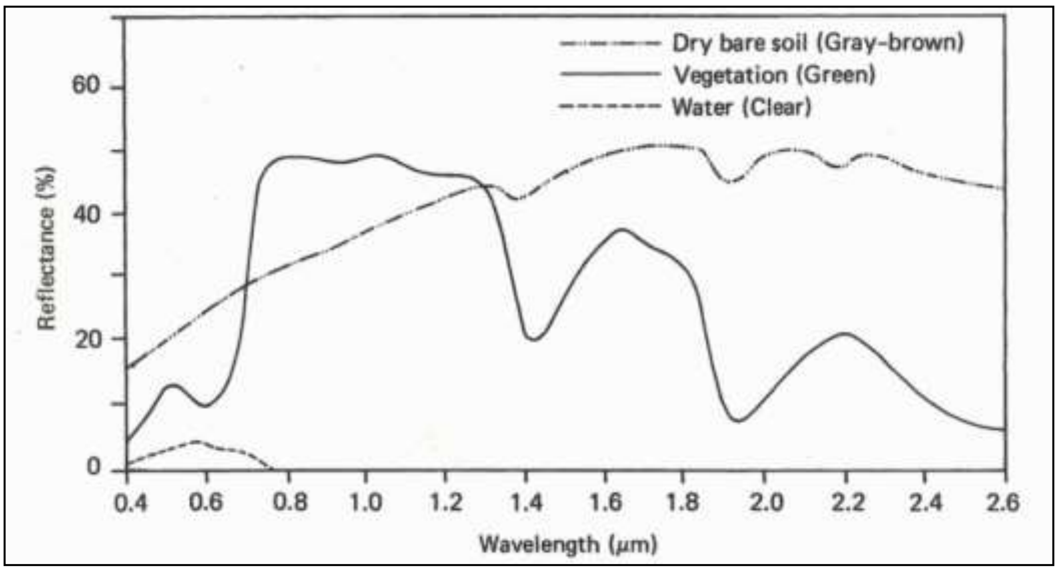


Figure (2) Spectral reflectance curves for water, soil, and vegetation [10]

NDVI is defined by the following [11]:-

NDVI = (Near IR band – Red band)/ (Near IR band + Red band)…. (1)

The resulting of index value is sensitive to the presence of vegetation on the earth's land surface and can be used to address issues of vegetation, amount and condition. Eq. (1) produces values in the range -1 (no vegetation) and +1 (high vegetation). Vegetated areas will generally high values index because of their relatively high near IR reflectance and low visible reflectance; and these areas appeared in image light tones. In contrast water, clouds, and snow have larger visible reflectance than near IR reflected, these features yield negative values. Rock and bare soil areas have similar reflectance in the two bands and result in NDVI near zero. These features in NDVI images appeared black tones. In order to maximize the range values and provide numbers that appropriate to display in 8 bit image, NDVI value must be scaled. This scaling convert atone display. Scaling NDVI value display by the following experimentally equation:-.

$$\textbf{Scaled NDVI} = \{(\text{NDVI}-\text{MIN})/(\text{MAX}-\text{MIN})\}*255 \ldots (2)$$

Where:

NDVI = is the range [-1 to +1]

Min = minimum value of NDVI

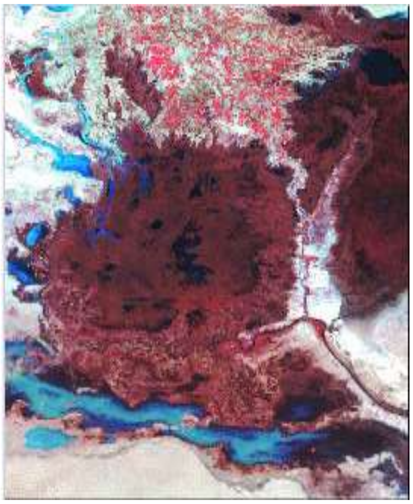
Max = maximum value of NDVI

Using this eq. (2) computed value is scaled to the range of 0 to 255, where computed -1 equals 0 and computed approximately 0 equals 128 and computed 1 equals 255. According this range NDVI values less than 128 represent no vegetation areas and values equals or greater than 128 represent vegetation areas. Red and near IR data from the following satellite sensors can be for used NDVI:

- Landsat MSS bands 234 (0.6-0.7μm) and (0.7-0.8μm) or (0.8-1.1μm)
- Landsat TM and ETM+ band 3 (0.63-0.69μm) and band 4 (0.76-0.9μm)

The proposed system

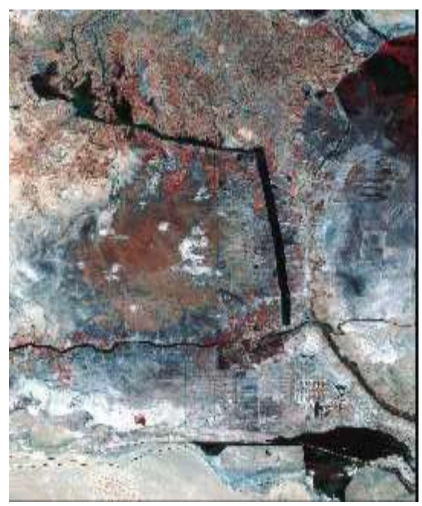
Multi-sensor, multi-temporal and multi-spectral images were used to detect changes in Iraqi marshlands, through out interpretation and analyzing these images by using ERDAS IMAGINE8.4. The Landsat MSS dated 1973, Landsat TM dated (7/9/1990) and Landsat ETM+ dated (26/3/2000), (6/5/2003) and (2/2/2004). Figure (3) shown images used for this study.



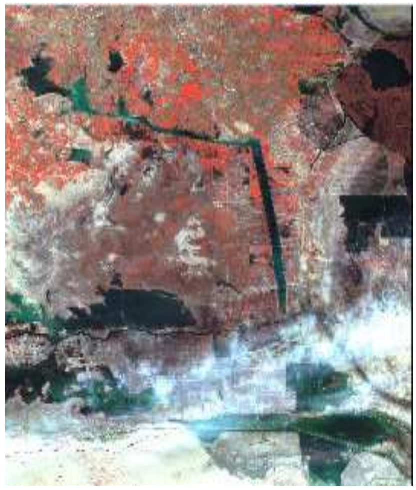
A-Landsat MSS image 1973
band(1,2,4) for study area

B- Landsat TM image
(7/9/1990) band (2,3,4) for study area

C- Landsat ETM+ image
(26/3/2000)band (2,3,4) for study area



D- Landsat ETM+ image
(6/5/2003)band(1,2,3,4) for study area



E- Landsat ETM+ image (2/2/2004) band (1,2,3,4) for study area

Figure (3) Landsat images for study area

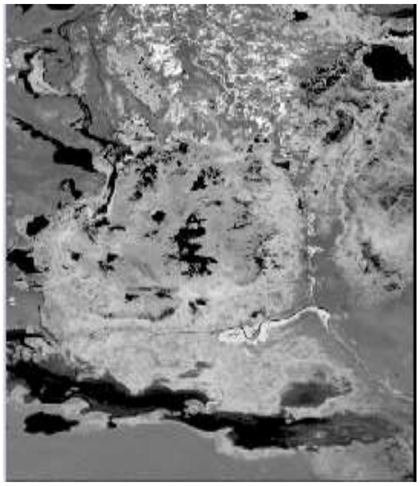
<u>Extraction of NDVI</u>:

NDVI used and computed from the eq. (1) .The original NDVI has the values between -1 and +1, but in this study it was transformed into images 8 bit (0 – 255) according equation (2) .

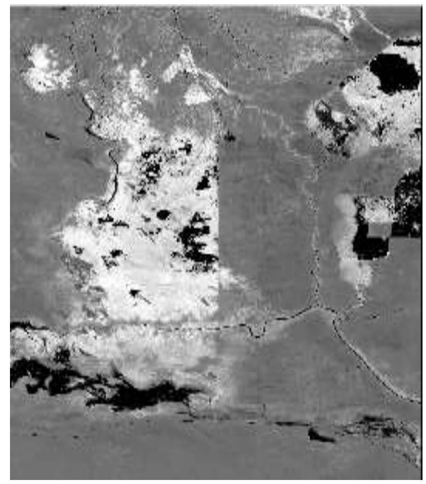
The NDVI image computed from Landsat MSS 1973, Landsat TM (7/9/1990), Landsat ETM+ (26/3/2000), Landsat ETM+ (6/52003), and Landsat ETM+ (2/2/2004) images. Figure (4) shows NDVI images for study area. These images display dark area (low value NDVI) which represents no vegetation such as water, wet land and barren land; while bright area (high value NDVI) represent high vegetation such as agriculture land and vegetation marsh land .

Its clear from NDVI images that the bright areas (that represent vegetation) for Al-Hawizah, Al-Hammar, and Central marshes in 1973 and 1990 images, converted to dark areas in 2000, 2003 and 2004 due to desiccation of these marshes. In NDVI image for Landsat ETM+ (26/3/2000) bright areas absent in Al-Hammar marsh and Central marsh. In NDVI image for Landsat ETM+ (6/5/2003) small part of vegetation marsh (bright area) began reflooding in Al-Hawizah and Al-Hammar marshes. In NDVI image for image Landsat ETM+ (2/2/2004) small part of vegetation began reflooding in Al- Central marsh as shown in figure (4, E).

Figure (5) shows false color NDVI images; the areas of high NDVI value appear in blue color (marsh vegetation and agriculture) and low vegetation (low value NDVI) appears in red color. It is clear that water and wet area in red or yellow color and barren land in green or yellow color.



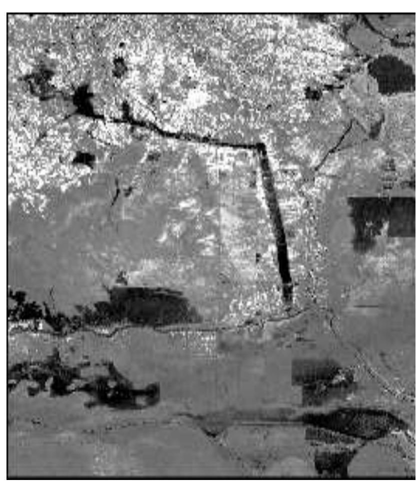
A- NDVI for image Landsat MSS 1973



B- NDVI for image Landsat TM (7/9/1990)

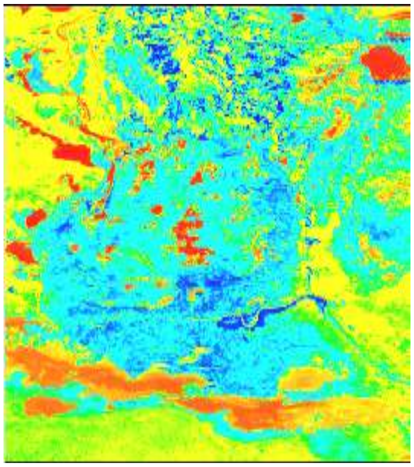
C- NDVI for image LandsatTM(26/3/2000)

D- NDVI for image Landsat TM(6/5/2003)

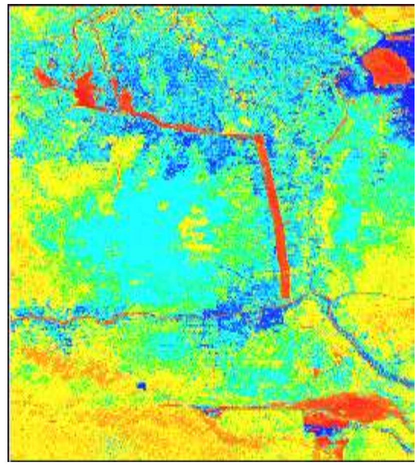


E- NDVI for image Landsat ETM+ (2/2/2004)

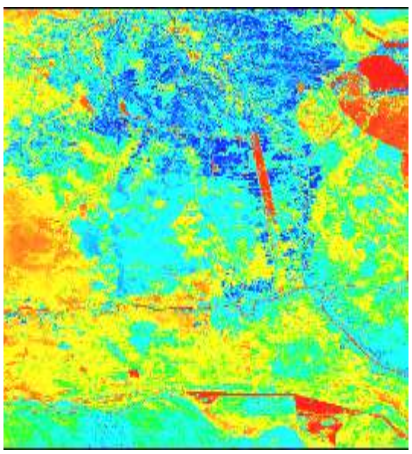
Figure (4) Show NDVI images for image Landsat



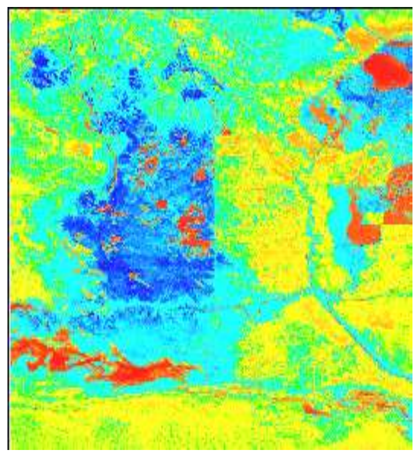
A- False color for NDVI image1973



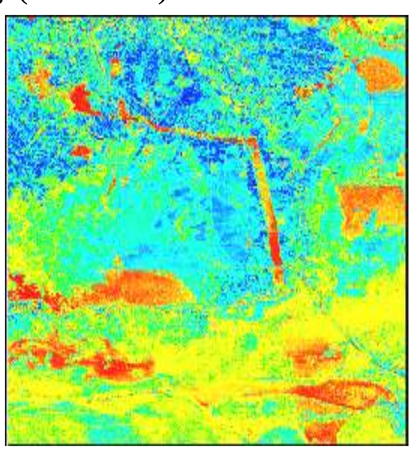
B- False color for NDVI image(7/9/19900)



C- False color for NDVI image(26/3/2000)



D-False color for NDVI image (6/5/2003)



E- False color for NDVI image (2/2/2004)

Figure (5) Show NDVI images with false color

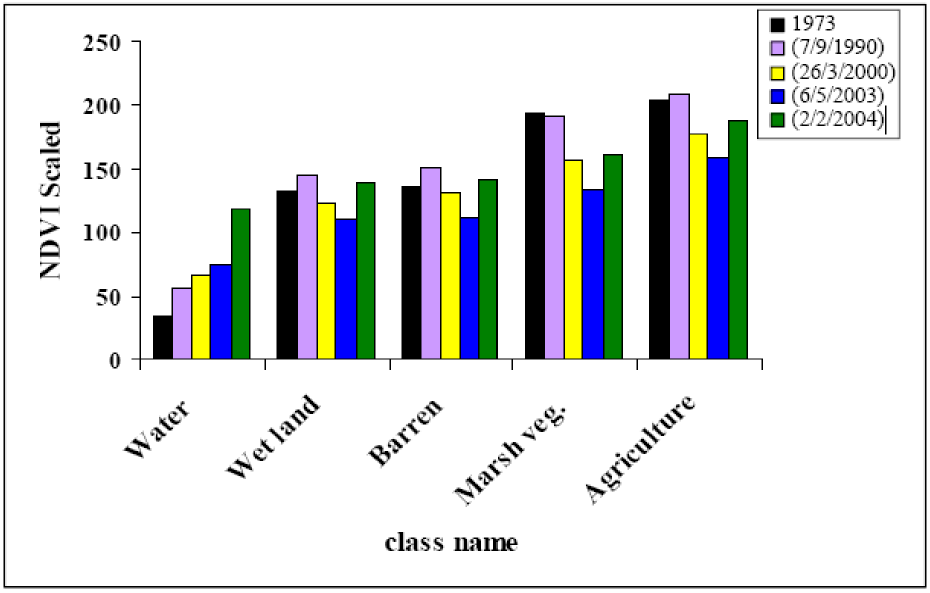


Figure (6) Average NDVI for land use classes

According to figure (6) which show relation between average NDVI and land use classes, the classes that have vegetation cover show high NDVI value (such as marsh vegetation and agriculture). Water and wet soil have lower NDVI than other land classes.

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. Normalized difference vegetation index (NDVI) has been found to be good indicator for vegetation and land use/ land cover changes.

3. Normalized difference vegetation index (NDVI) depends of spectral reflectance of land use cover.

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