Determination of Irrigated Field Units in North Al-Jazeera Irrigation Project Using Remote Sensing Data

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ABSTRACT

This paper presents the role of digital image processing (DIP) for the investigation of effectively and actually irrigated areas through the signature of vegetative growth; The techniques of digital image processing for remotely sensed images including subsetting, enhancement, stacking, and vegetation index calculation determining the real irrigated areas in NorthAl-jazeera irrigation project. Landsat ETM+ (Enhanced Thematic Mapper) images were obtained, which captured in 7/4/1999, 3/6/2000, 13/6/2001 and 19/4/2002. ERDAS IMAGINE 9.1 software was used for the purposes of digital image processing and for Normalized Difference Vegetation Index calculation (NDVI).The study showed the planted and not planted field units and the level of vegetative growth from NDVI values.

Keywords: Irrigation project management, Digital image processing, GIS.

أيجادالوحدات الحقلية المروية في مشروع ري الجزيرة الشمالي باستخدام بيانات الاستشعار عن بعد

الخلاصة

تعرض هذه الدراسة دور معالجة البيانات الفضائية في التحري عن المناطق المروية جيدا من خلال التحري عن التوقيع الطيفي لمستوى النمو الخضري للمحاصيل المزروعة. استخدمت تقنيات المعالجة الرقمية للبيانات الفضائية والمتضمنة الاقتطاع، التحسين، دمج المركبات، وحسابات مؤشر النبات في تحديد الحدود للمناطق المروية فعلا في منطقة مشروع ري الجزيرة الشمالي. استخدمت بيانات القمر الصناعي الأمريكي لاندسات للمتحسس +ETM (راسم الخرائط الموضوعية المحسن) والملتقطة بتاريخ1999/4/7 و2000/6/3 و2001/6/13إضافة إلى 2002/4/19. كما استخدم برنامج ERDAS IMAGINE 9.1 لأغراض المعالجة الرقمية للبيانات ولحساب مؤشر النبات (NDVI). بينت الدراسة الوحدات الحقلية المزروعة من غير المزروعة ومستوى النمو الخضري للوحدات الحقلية من خلال قيمة مؤشر النبات لها.

الكلمات الدالة: إدارة المشاريع الاروائية، المعالجة الرقمية للبيانات الفضائية، نظام المعلومات الجغرافية.

Introduction

Remote sensing technology has been recognized as useful means of supplying up to date information on activities, within the agriculture environment [1].It is found to be an effective tool for irrigation studies compared with conventional methods which use point based, time consuming and cumbersome. Remote sensing based inventory of irrigated crops is useful for timely estimation of the crop areas by multi date images, to find water demand over space and time, to monitor crop condition during the irrigation season, to forecast crop yields before the end of the season and for evaluating overall performance of irrigation projects.[2].

Objectives

1- To demonstrate the capabilities of remote sensing data and GIS for

irrigation projects mapping and management, assessment and monitoring of environmental impact.

2- To prepare an updatable geo database for the north Jezira irrigation project.

Study Area

North Al-Jazeera (Fig. (1)) irrigation project lies between 36° 33´ 40", 36° 53´ 20" N and 42° 0´ 20", 42° 33´ 40" E, North West of Mosul city. The area was irrigated through the main canal , which draws its water from the pump station of Mosul Dam Lake. It is a
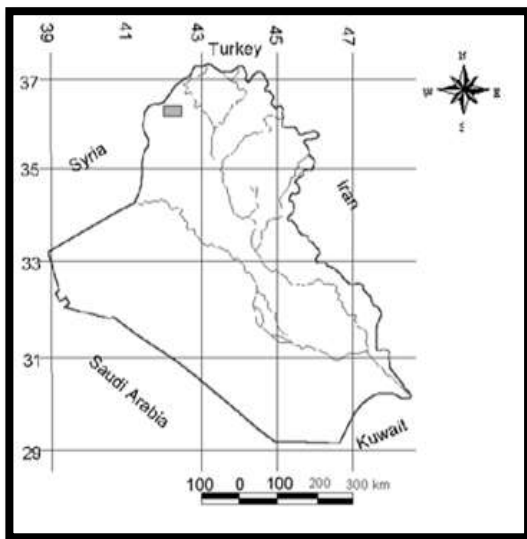

Fig.1: Study Area

large supplemental irrigation project established in order to serve 60,000 hectares using a linear-move sprinkler

Irrigation system[3].The area is defined as a moderate rainfall zone, having mean annual rainfall ranging from 350 mm in the south to 500 mm in the north. About 75% of the project is cropped with wheat each year under a limited amount of irrigation, ranging from 100 to 150 mm. The wheat-growing season in this area generally begins during November and ends in early June. The project was also planted with vegetables in which their growing period is during May to October.[4].

Methodology

There are two methods to detect the healthy vegetated areas:

1. Image processing techniques
2. Vegetation Index calculation

1- Image processing techniques: It is a computer manipulation of the digital-number values of an image to extract as much
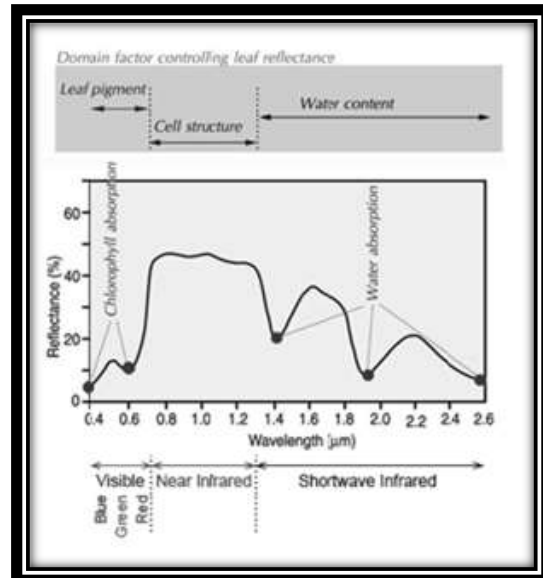

Fig.2 The reflection curve shows the high reflection of the chlorophyll at near infrared band[6]

information as possible from the images, the choice of specific techniques or algorithms to use depends on the goals of study.

2- ERDAS IMAGINE 9.1 software was used for the purpose of digital image processing with procedures as follows:

a- Data Selecting: Enhanced Thematic Mapper plus (ETM+)Satellite images were selected on the basis of the reflectivity of green plants: red band(0.63–0.69) μm, green band (0.525–0.605) μm and near Infrared band (0.75 -0.9)μm.[5]. Near infrared band is the most important band because the maximum reflection of electromagnetic radiation from vegetation occurs in the near infrared so, the planet in this band will be appear very light. Fig.(2).

b- Subsetting: Subsetting of an image can be useful when working with large images. Subsetting is the process of "cropping" or cutting out a portion of an image for further processing to decrease the volume data and reduce the processing time[7].The study area of North Al-Jazeera irrigation project was clipped from the whole scene of the north Iraq which is captured by the landsat ETM+ satellite in7/4/1999, 3/6/2000, 13/6/2001 and 19/4/2002.

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c- Enhancement: A uniform expansion was applied on the original range of intensity value to fill the total range of the output image (0-255), linear stretch enhancement was applied on the images with clustered intensity values of digital numbers and stretches its values linearly over the 0-255 range to increase the contrast of the image.[8]. (Fig.(3) and (4)). To demonstrate the benefit of the linear stretch enhancement, Fig.(3) shows the histogram of the images.

d- Color composite: The next step after enhancement process is to combine three band images into one multispectral image, the red color was given to the near infrared band because the red color is very clear, the green color to the red band and the blue
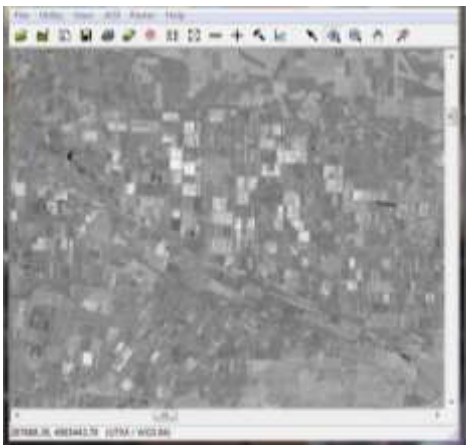
appears shiny red because of the high reflectivity for the vegetation cover in near

Fig. (4-a) : Histogram of the original the original image

Fig. (4-b) : Histogram of the Linear stretched image the original image
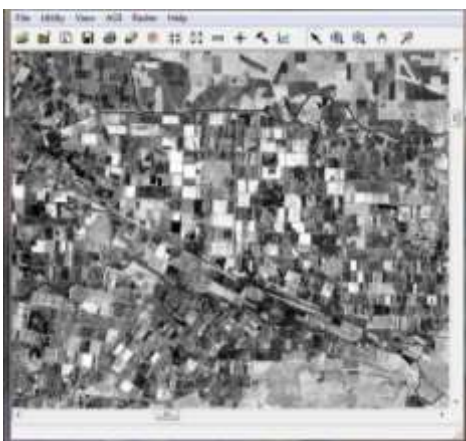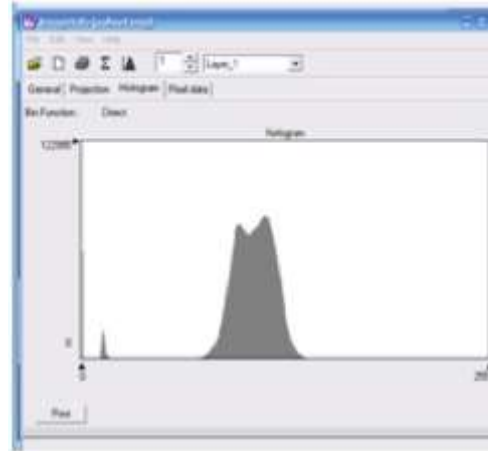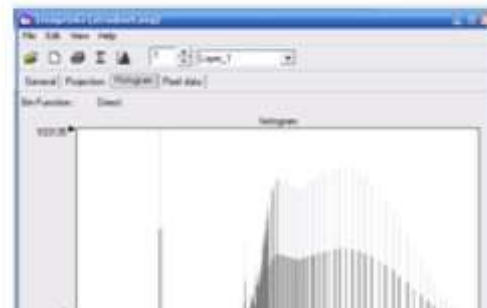

Fig. (3-a) : The original image

Fig. (3-b) : The stretched image

color was given to the green band. Fig.(5) shows the multispectral image or false color composite (RGB, 432), the planted units

infrared band (band 4).

Normalized Difference Vegetation Index (NDVI): Normalized Difference Vegetation Index calculation finds areas of heavy vegetation cover from a remotely sensed image. In order to calculate it; two bands are needed, visible red and near infrared bands.[9]. These bands are chosen because vegetation, especially healthy vegetation, is very reflective in the near infrared range and it provides good contrast with water. In order to distinguish healthy vegetation from other reflective sources, the visible red is chosen, which contrasts vegetation from bare soil, rocky surface, and man-made features. Heavy plants have a high NDVI value because of their high reflectance of infrared light, and relatively low reflectance of red

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light.[10].From the visible red and near infrared layer, a Normalized Difference Vegetation Index (NDVI)was calculated in ERDAS Imagine 9.1 software using this formula. [11].

$$NDVI = (IR - R)/(IR + R) \ldots \ldots \ldots (1)$$

Where:

IR: Near infrared band, wavelength between (0.75 -0.9)$\mu m.$

R: Visible red band, wavelength between (0.63 – 0.69) $\mu m.$

The irrigated crops appears dark green in NDVI image while the brown areas represents dry rangeland with minimal vegetation. Fig.(6).

Results and Discussion

This paper describe a methodology for extraction of an information from the remote sensing data for mapping and monitoring of irrigation projects and its need for irrigation and monitoring the extent of growth of crops and determine the time of fertilization, harvesting, etc. of agricultural operations. In this study digital image processing and NDVI calculation plays a very important role for interpretation of satellite image, they show a complete coincidence of results between them, it is expected that proposed methodology may be a viable solution for frequent updating of information about the irrigation projects.

North Jezira Irrigation project in Rabia region were selected for the application of this study because the project was implemented for several years and the multi data satellite images were available for the same season (spring and summer). The wheat and potato were taken as an example because they were completely growth at these seasons.

The visual interpretation of the images shown in Fig.(5) illustrate the high densities of green plants in the field units portion of this image having a red color in false color composite, but it's not clear enough to distinguish the limits of these units to calculate the area of them, the second set of images shown in Fig.(6) represents these field units very clearly and it is easy to distinguish them, with its values of NDVI which provides a good indication about the type of the crops in depending of the date of the image. NDVI values was an excellent criterion to difference between irrigated and non-irrigated land.

After reclassify the raster images in Fig.(6) upon NDVI maximum value (0.7), and isolate the pixels having 0.7 value only and convert them to vector format using conversion tool in Arc GIS software, new set of images will appear as shown in Fig.(7). These pixels represents the fields units having maximum amount of chlorophyll and good Vegetative growth. The area of the fields was automatically calculated by Arc GIS software and it was (45394.8) hectares for wheat in 7/4/1999, about 75.658% of the total area, and (47658.36) hectares in 19/4/2002 about 79.43% of the total area, while for potato the total area was (15253.8) hectares in 3/6/2000 and (16584.36) hectares in 13/6/2001 about 25.423% and 27.64% respectively. The technique of GIS represent a simple way to calculate an areas automatically and it is more accurate than the traditional procedure by hand.

It's clear that the fields units in images captured in April, Fig.(5) was planted with wheat and barley because these crops having a maximum vegetative growth in April as shown in picture (1) which captured in April 2009 in North Jezira Irrigation Project, and the other set of images captured in June, Fig.(5) were planted with vegetables (Potato) because having a maximum Vegetative growth in June, Picture (2), also captured in June 2009, because the
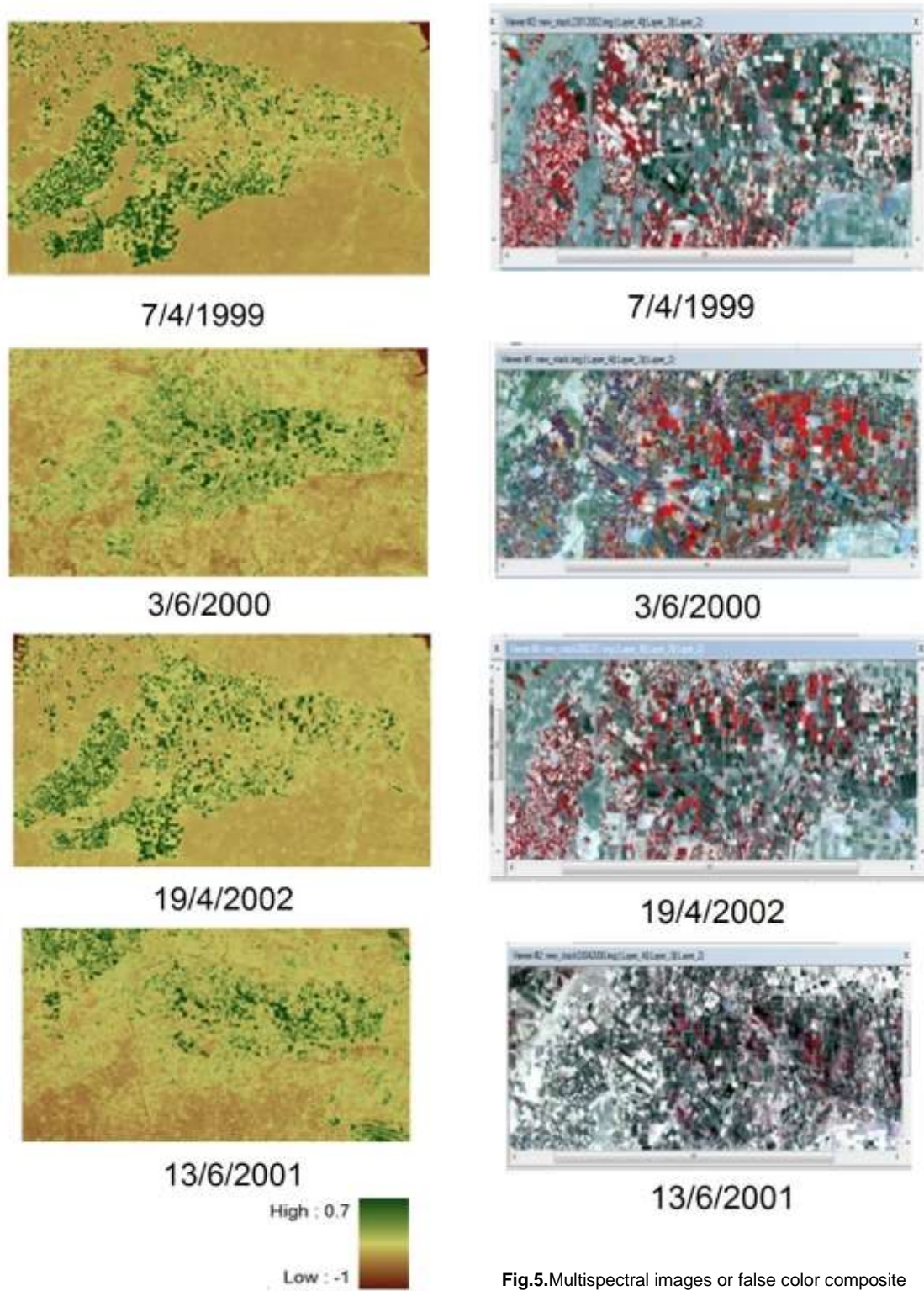
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7/4/1999

3/6/2000

19/4/2002

13/6/2001

High : 0.7

Low : -1

7/4/1999

3/6/2000

19/4/2002

13/6/2001

Fig.5. Multispectral images or false color composite

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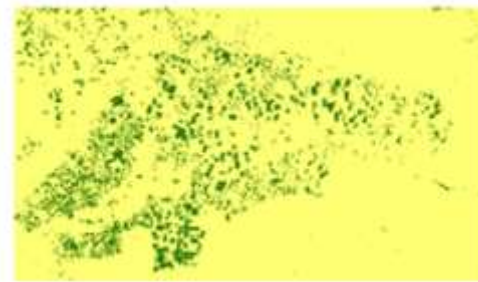Picture (1): North Al-Jazeera irrigation project (April)

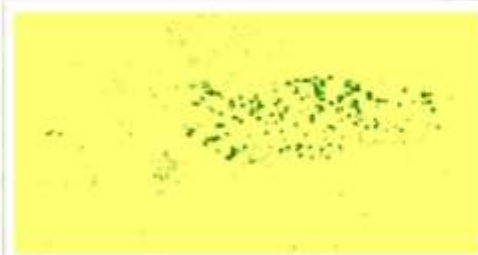Picture (2): North Al-Jazeera irrigation project (June)

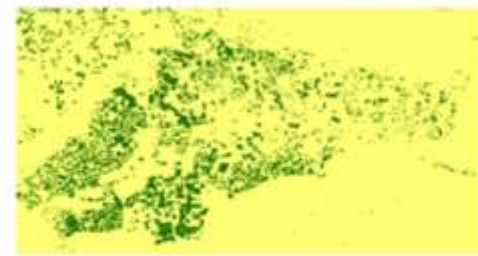agricultural cycle in North Jezira Irrigation Project is similar for all seasons[3].

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19/4/2002

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Fig.(6) : Normalized Difference Vegetation Index values

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