Assessment of vegetal cover changes using Normalized Difference Vegetation Index (NDVI) and subtractive (NDVI) time-series, Karbala province, Iraq

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Abstract

　Karbala province regarded one part significant zones in Iraq and considered an economic resource of vegetation such as trees of fruits, sieve and other vegetation. This research aimed to utilize Normalized Difference Vegetation index (NDVI) and Subtracted (NDVI) for investigating the current vegetation cover at last four decay. The Normalized Difference Vegetation Index (NDVI) is the most extensively used satellite index of vegetation health and density. The primary goals of this research are gather a gathering of studied area (Karbala province) satellite images in sequence time for a similar region, these image captured by Landsat (TM 1985, TM 1995, ETM+ 2005 and Landsat 8 OLI (Operational Land Imager) 2015. Preprocessing such gap filling consider being vital stride has been implied on the defected image which captured in Landsat 2005 and isolate the regions of studied region. The Assessment vegetal cover changes of the studied area in this paper has been implemented using Normalized Difference Vegetation Index (NDVI), Green Normalized Difference Vegetation Index (GNDVI) and change detection techniques such as Subtracted (NDVI) method also have been used to detect the change in vegetal cover of the studied region. Many histogram and statistical properties were illustrated has been computed. From The results shows there are increasing in the vegetal cover from 1985 to 2015.

تقييم التغيرات في الغطاء النباتي باستخدام مؤشر الغطاء النباتي (NDVI) وطرح (NDVI) خلال سلسلة زمنية، محافظة كربلاء، العراق

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الخلاصة

تعتبر محافظة كربلاء من المناطق المهمة في العراق في مواردها الاقتصادية للنباتات مثل اشجار الفاكهة والنخيل والاشجار الاخرى. يهدف بحثنا الحالي الى استخدام مؤشر الغطاء النباتي (NDVI) و طرح (NDVI) لبحث التغير بالغطاء النباتي لمحافظة كربلاء للعقود الاربعة الاخيرة. يعتبر مؤشر الغطاء النباتي (NDVI) هو احد أكثر المؤشرات المستخدمة من الأقمار الصناعية على نطاق واسع من دراسة كثافة الغطاء النباتي. في هذا

البحث تم جمع مجموعة من الصور الفضائية لمنطقة الدراسة في اوقات مختلفة لنفس المنطقة، هذة الصور اخذت بواسطة القمر الصناعي لاندسات (TM1985, TM 1995, ETM+ 2005 and Landsat-8 OLI 2015). وقد تم اجراء مجموعة من التصحيحات على الصور الملتقطة منها ترميم الصورة المشوهة الملتقطة بالقمر لاندسات ETM+7 لعام 2005 باستخدام قيمة المعدل لملأ الفراغات في الصورة وعزل المنطقة المدروسة. تقييم الغطاء النباتي في هذا البحث يتضمن مجموعة من تقنيات المعالجة الصورية لمراقبة التغيرات في الغطاء النباتي لمنطقة الدراسة من هذه التقنيات استخدام مؤشر الغطاء النباتي (NDVI) و (GNDVI) كما تم استخدام طريقة طرح الصور من بعضها لكشف التغير بالغطاء النباتي للمنطقة الدراسة. تم استخراج العديد من الاشكال البيانية والاحصائية للنتائج حيث أظهرت النتائج زيادة بالغطاء النباتي من 1985 الى 2015.

Introduction

Change detection is the technique, which is used for the assessment of resources, where multi-date images are compared to find out the type and amount of change have occurred. The various applications of change detection are in agricultural, hydrological, forestry and environmental. The change detection method used was Normalized Difference Vegetation Index (NDVI) differencing [1, 2]. Several vegetation indices have been developed of which, NDVI is the most commonly used one despite the development of many new indices that take into account soil behavior. It is used to distinguish healthy vegetation from others or from non-vegetated areas using red and near-infrared reflectance values and this was integrated in the post-classification analysis to discriminate between the green cover and barren land [3]. Image differencing is based on subtracting two different time periods of the same location or scene. Image Differencing is a relatively simple and effective tool amongst common change detection techniques. It is a simple process of subtracting the two different times pixel by pixel to create the difference image. In this case, a difference image was created between the Normalized Difference Vegetation Index (NDVI) images The NDVI method gives superior results for vegetation varying in densities and also for scattered vegetation from a multispectral remote sensing image. [2]. Digital image processing of satellite data provides tools for analyzing the image through different algorithms and mathematical indices. Features are based on reflectance characteristics, and indices have been devised to highlight the features of interest on the image. There are several indices for highlighting vegetation bearing areas on a remote sensing scene. NDVI is a common and widely used index. It is an important vegetation index, widely applied in research on global environmental [4]. Many researchers have reported the use of NDVI for vegetation monitoring assessing the crop cover, drought monitoring, and agricultural drought assessment at national and global level Vegetation index (VI) is a simple and effective measurement parameter, which is used to indicate the earth surface vegetation covers and crops growth status in remote sensing field [5, 6].

The principle source of image which might have been received of the studied region was the USGS Global Visualization Viewer of the Earth Resource. Karbala province is the studied areas which enclosed by Path / Row (or Lat 32 N^o / Long 44.0E^o) as shown in Fig. 1 and Table 1.
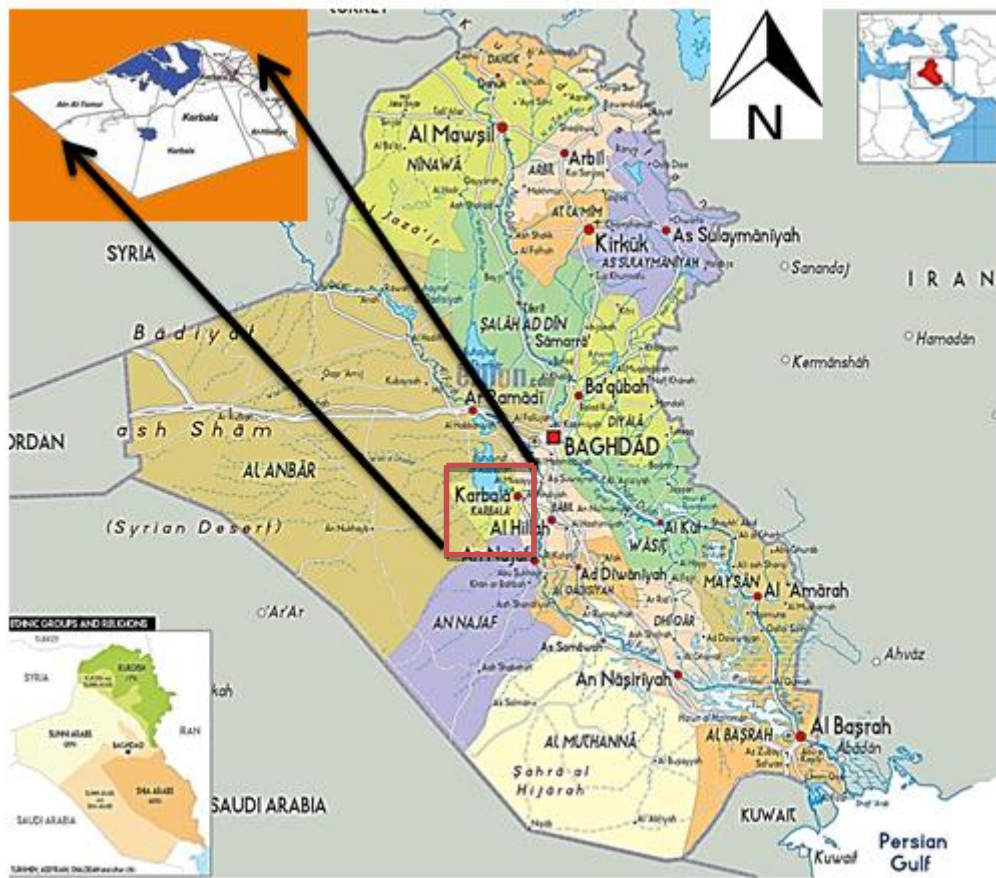
Studied areas and data gathering

Fig. 1: The studied area.

Table 1: The longitude and latitude of studied area

Location	Longitude	Latitude
Karbala	44°0'38,555"E	32°37'18.936"N

Representing by utilizing Landsat 4-5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+) and Landsat 8 OLI (Operational Land Imager) sensor onboard satellite, acquire pictures of the Earth nearly continuously different year from 1985 to 2015. For more information see Table 2. And the series of studied region images since 1985 to 2015 period can be shown in Fig. 2. An essential preprocessing has been performed on affected picture 2005 called gap filling because the Scan Line Corrector (SLC) which adjusts for the forward movement of Landsat-7 has failed on May 31, 2003, and all the resulting efforts to recover the SLC were not effective [7]. The restoration process shown in Fig. 2.

Table 2: The Landsat and date of captured each original image.

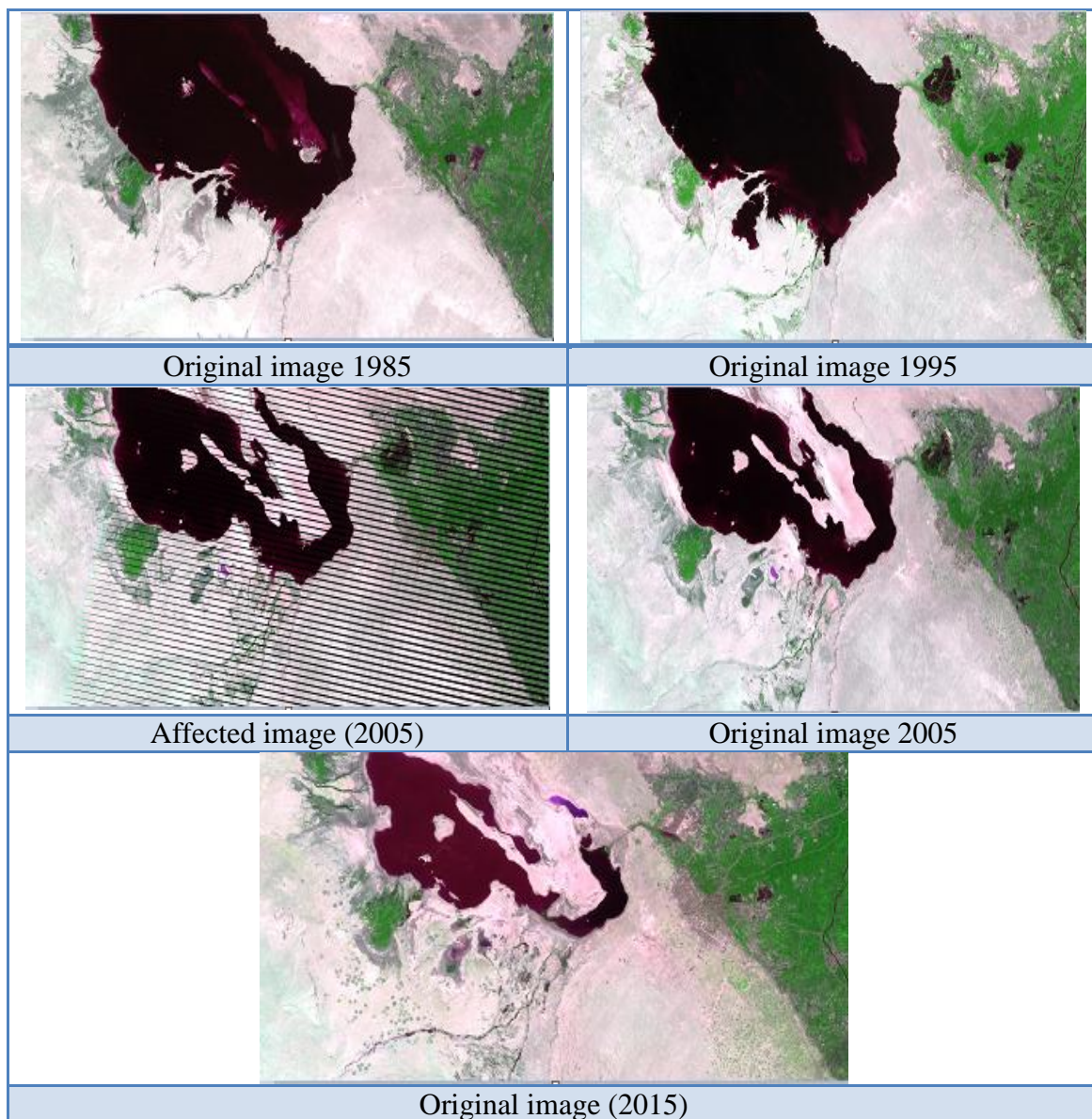| Original images	Source
Karbala (1985)	Landsat 4-5 Thematic Mapper (TM) 9-JAN-1985
Karbala (1995)	Landsat 4-5 Thematic Mapper (TM) 16-JUL-1995
Karbala (2005)	Landsat 7 Enhanced Thematic Mapper Plus (ETM+) Scan Line Corrector off (SLC-Off) _2003-present, 24-NOV-2005
Karbala (2015)	Landsat 8 OLI (Operational Land Imager) and TIRS (Thermal Infrared Sensor), 28-NOV-2005

Original image 1985	Original image 1995
Affected image (2005)	Original image 2005

Original image (2015)

Fig. 2: The original of Karbala province images in (1985, 1995, 2005 and 2015) period.

Methodology

The methodology includes many images processing such as NDVI, Green Normalized Difference Vegetation Index (GNDVI) and Subtracted NDVI, by using ENVI program.

1. Normalized Difference Vegetation Index (NDVI)

In this section, the NDVI technique is used for extracting various features presented in the 3-band satellite image (Green, Red and NIR). The NDVI is a simple numerical indicator that can be used to analyze the remote sensing measurements, from a remote platform and assess whether the target or object being observed contains live green vegetation or not, From the Eqs. (1) and (2). NDVI and Green Normalized Difference Vegetation Index (GNDVI), is calculated as [8].

$$NDVI = \frac{NIR - Red}{NIR + Red} \qquad (1)$$

$$GNDVI = \frac{NIR - Green}{NIR + Green} \qquad (2)$$

The NDVI is an index used to identify vegetation and its health through the Levels of chlorophyll detected in the leaves. Healthy vegetation absorbs most of the incoming visible light, and reflects a large portion (about 25%) of the near infra-red (NIR) light, but a low portion in the red band (RED). Unhealthy or sparse vegetation reflects more visible light and less NIR light[9]. The range is theoretically between -1 and 1, where increasing positive values indicate increasing green vegetation and negative values indicate non-vegetated surface features such as water, barren land, ice, snow, or clouds [2]. A variation of NDVI has been developed which uses the green band portion of the electromagnetic spectrum rather than the red band. This is referred to Green Normalized Difference Vegetation Index (GNDVI), the benefit of GNDVI over NDVI is that the green band can cover a broader range of chlorophyll in plants than the red band. This applies to mature plants, and can be useful for monitoring yield crop in the late growing season [10]. The results of applying NDVI and GNDVI can be shown in Figs. 3-5.
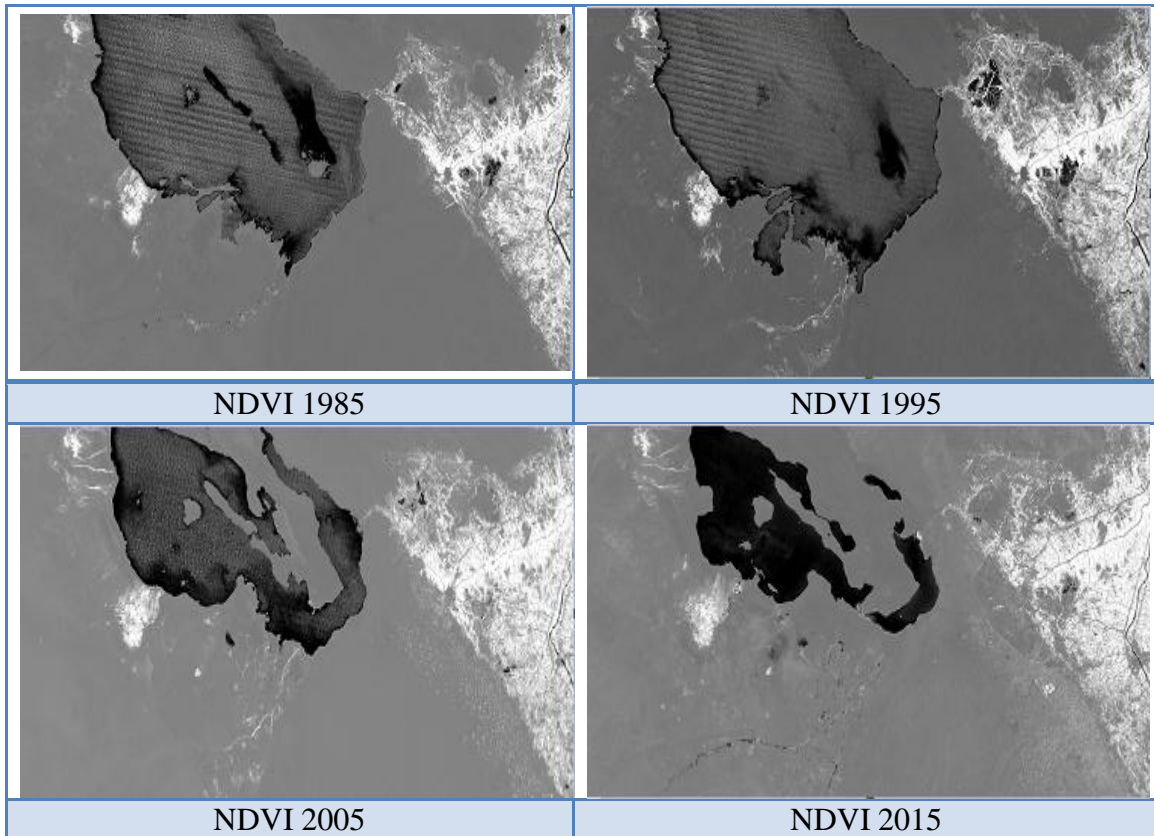
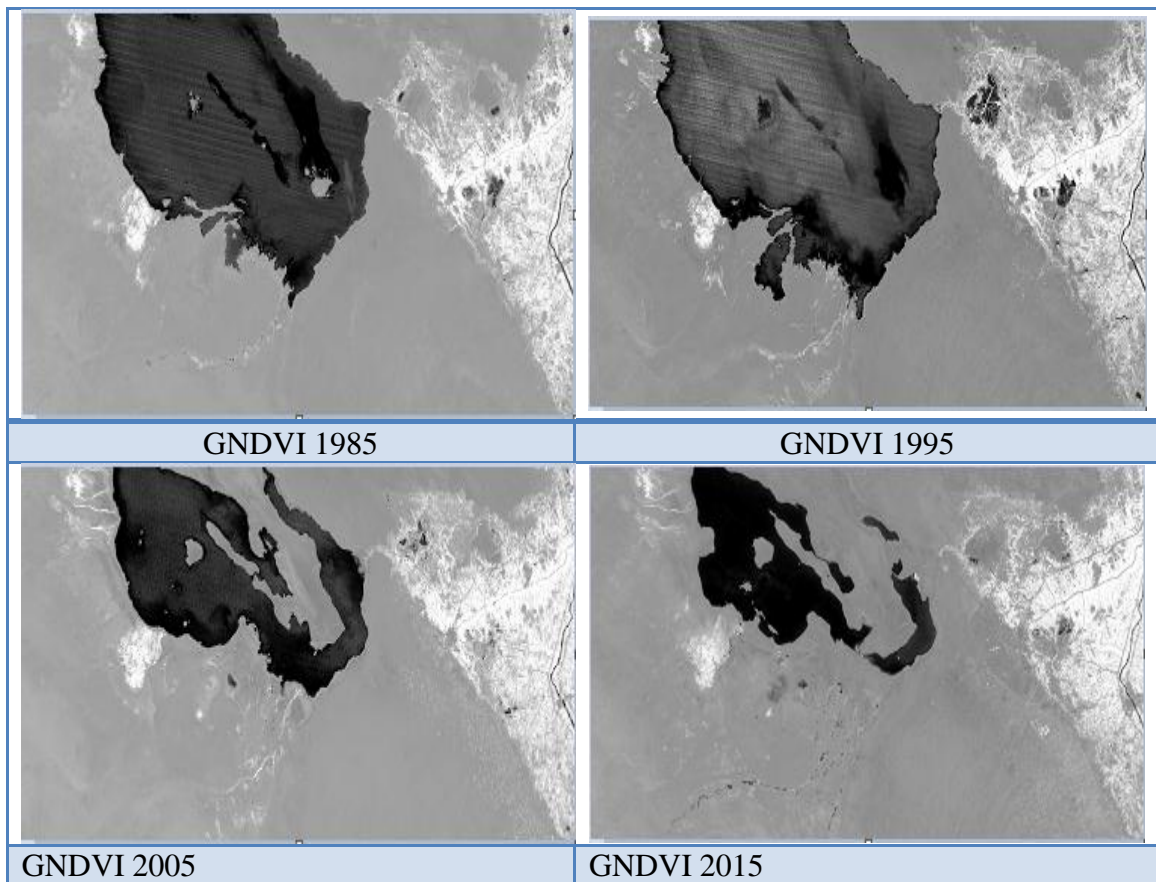*Fig. 3: The image resultant by applying NDVI method.*

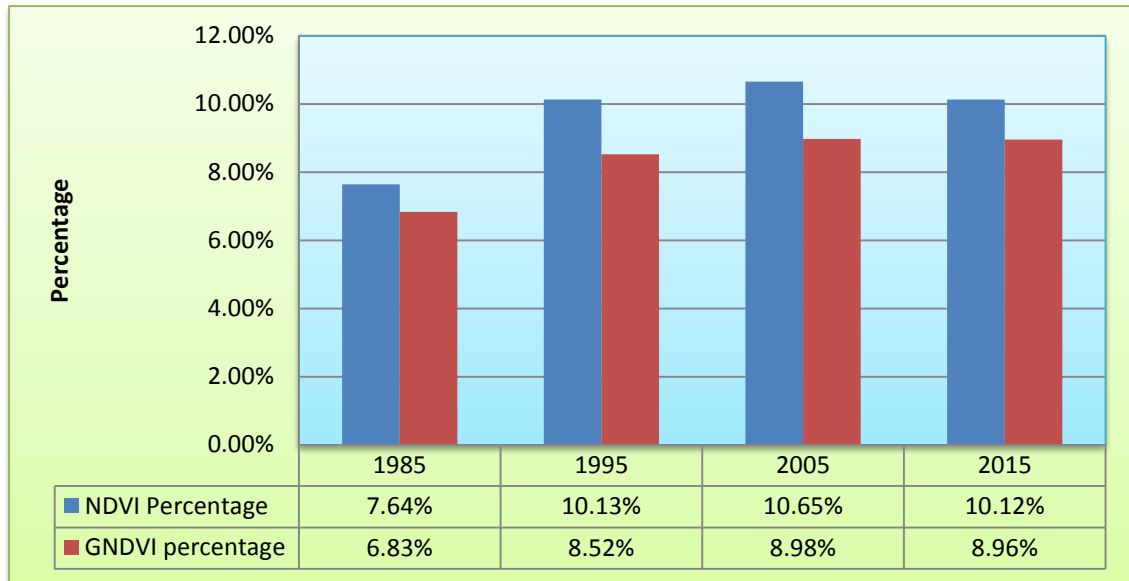*Fig. 4: The image resultant by applying GNDVI method.*

Fig. 5: The statistical of NDVI and GNDVI percentage results of the vegetal regions.

2. Subtractive (NDVI)

In the image differencing method, the second image is subtracted from the first image to provide the difference and highlight changes. The second image is more recent and the differences reflect changes over time. The subtractive method computes products and creates difference images that you can open from the available bands list[11]:

- Straight subtraction of each spectral band.
- For best results, use images with similar view geometries.

It can be applied to a wide variety of types of images and geographical environment. It is generally conducted on the basis of gray. A subtraction image is gained form the subtracting of the gray value of corresponding pixels of images after image registration. The gray value of the subtraction image is to show the extent of changes of two images. The formula is:

$$Dx_{ij}^k = x_{ij}^k(t_1) - x_{ij}^k t_2 \qquad (3)$$

where i, j as pixel coordinates, k for the band, $x_{ij}^k(t_1)$ for the pixel (i, j) value of k-band image, t_1, t_2 for the time of the first and the second image, Dx_{ij}^k The resulting image represents the intensity difference of t_1 to t_2 [12]. Normalized Difference Vegetation Index (NDVI) subtractive between time1 (2015) and tim2 (1985, 1995, and 2005) as shown in Fig. 6.

| Subtractive (NDVI) 2015-1985 |

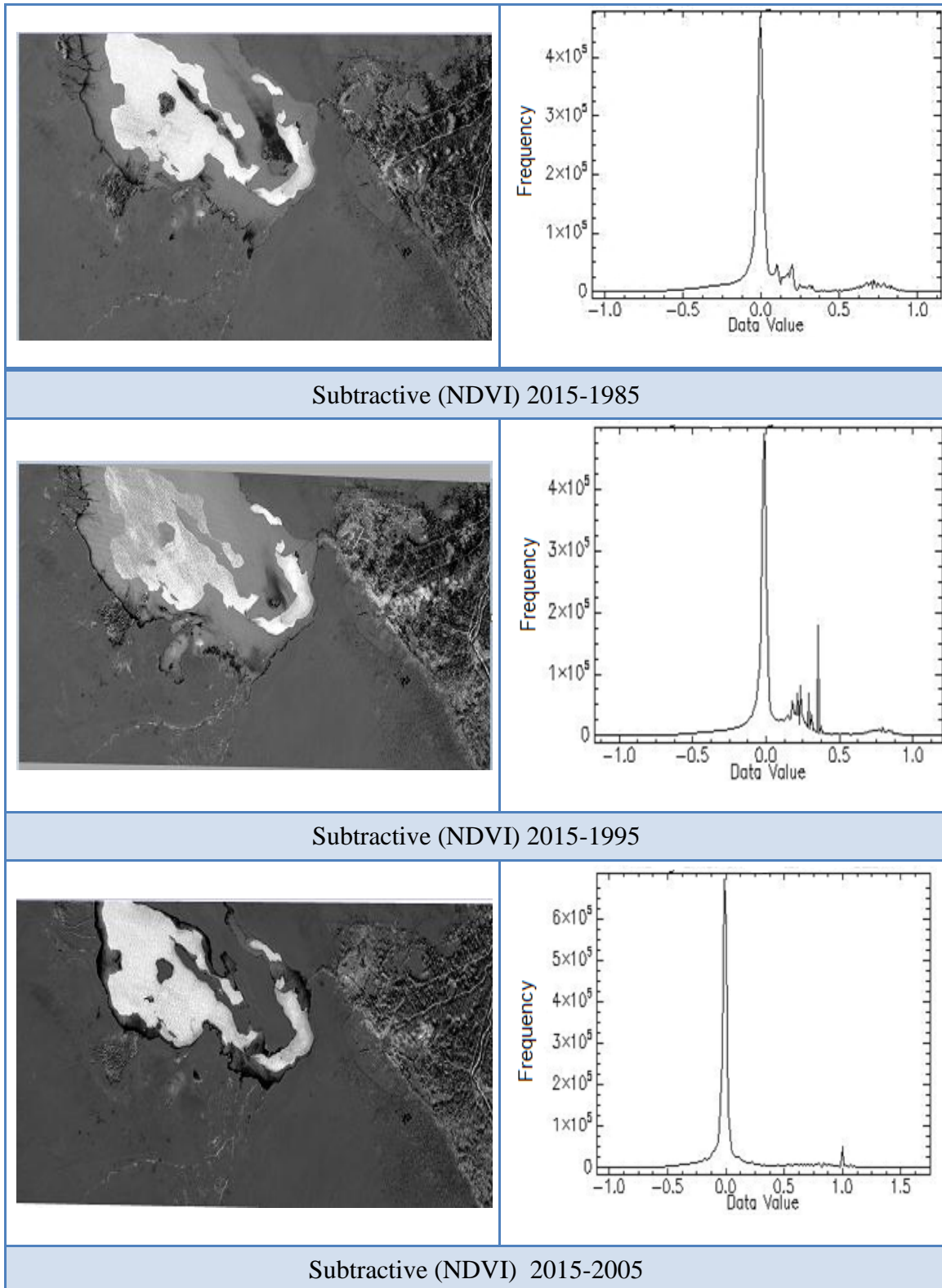| Subtractive (NDVI) 2015-1995 |

| Subtractive (NDVI) 2015-2005 |

Fig. 6: Normalized Difference Vegetation Index (NDVI) for time1 (2015) and tim2 (1985, 1995, 2005).

Discussions

The change detection analysis is an efficient way of describing the changes observed in each land use and land cover features within a certain time interval. It gives the spatial distribution and data of features changes. This research interested with detects the

vegetal cover of Karbala province utilizing diverse remote sensing techniques. Many monitoring techniques utilized to identify the vegetal cover of studied region, (NDVI) and (GNDVI) has been applied and the results show increase of the vegetation region in 2015 compared with the past years (1985, 1995, and 2005) and the expanding of vegetal cover have been done gradually from 1985 to 2015 period. Compute the (NDVI) and (GNDVI) give the same behavior about the increasing of vegetal cover but the value of the NDVI is greater than the value of GNDVI. This increase is indicating to interest of people in the cultivation of arid lands and increases the water share of the province and the statistical distribution of this region can be shown in Fig. 4. Also this research include change detection utilizing subtractive methods, where these techniques depend on compute the NDVI of the two compared image and find the distinction between them were considerable variations in vegetal cover and the results can be seen in Fig. 6 the main change observed for the time period of 1985-2015 was that the agricultural land was increased in some regions can be shown in histogram of Fig. 6.

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