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Detecting and Monitoring the Vegetal Cover of Karbala Province (Iraq) Using Change Detection Methods

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Abstract

Karbala province was one of the most important areas in Iraq and considered an economic resource of vegetation such as trees of fruits, sieve and other vegetation. This research aimed to utilize change detection for investigating the current vegetation cover at last three decay. The main objectives of this research are collect a group of studied area (Karbala province) satellite images in sequence time for the same area, these image captured by Landsat (TM 1995, ETM+ 2005 and Landsat 8 OLI (Operational Land Imager) 2015. Preprocessing such as atmosphere correction and rectification has been done. Mosaic model between the parts of studied area was performing. Gap filling consider being very important step has been implied on the defected image which captured in Landsat 2005. For monitoring the changes in the studied area, many image processing such as supervised classification using Maximum likelihood classifier and support vector machine classifier have been applied. Target detection using matching filter and change detection using subtractive method also have been used to detect the change in vegetal cover of the studied area. Many histogram and statistical properties were illustrated as well as the pixel count and the target area has been computed.

Keywords: Maximum likelihood, support vector machine classifier, matching filter.

كشف ومراقبة الغطاء النباتي لمحافظة كربلاء (العراق) باستخدام طرق كشف التغيرات

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الخلاصة

تعتبر محافظة كربلاء واحدة من اهم المدن الزراعية في العراق وتعتبر من اهم الموارد الاقتصادية للنباتات مثل اشجار الفاكهة والنخيل والاشجار الاخرى. يهدف بحثنا الحالي الى استخدام تقنيات كشف التغيرات في مراقبة الغطاء النباتي لمحافظة كربلاء للعقود الثلاث الاخيرة. ان الهدف الرئيسي من هذا البحث جمع مجموعة من الصور الفضائية لمنطقة الدراسة في اوقات مختلفة لنفس المنطقة، هذه الصور اخذت بواسطة القمر الصناعي لاندسات (TM 1995, ETM+ 2005 and Landsat-8 OLI 2015). وقد تم اجراء مجموعة من التصحيحات على الصور الملتقطة منها تصحيح تأثيرات الغلاف الجوي. وكذلك تم استخدام تقنية الفسيفساء لدمج اجزاء الصورة الخاصة بمنطقة الدراسة. كما تم ترميم الصورة المشوهة الملتقطة بالقمر لاندسات ETM+7 لعام 2005 باستخدام قيمة المعدل لملأ الفراغات في الصورة. تضمن هذا البحث مجموعة من تقنيات المعالجة الصورية لمراقبة التغيرات في الغطاء النباتي لمنطقة الدراسة من هذه التقنيات تصنيف الصور مثل التصنيف الموجة باستخدام طريقة (Maximum likelihood classifier and)

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(support vector machine classifier). وكذلك تم استخدام طريقة مرشحات المطابقة لكشف الاهداف كما تم استخدام طريقة طرح الصورمن بعضها لكشف التغير بالغطاء النباتي للمنطقة الدراسة. تم استخراج العديد من الاشكال البيانية والاحصائية للنتائج كما تم حساب عدد البكسلات للهدف بالاضافة الى مساحة الجزء النباتي من منطقة الدراسة.

1. Introduction

Change detection involves the application of multi-temporal datasets to quantitatively analyze the temporal effects of the phenomenon. Monitoring of agricultural crop conditions and estimating potential crop yields are important processes for operational programs. Assessment of particularly decreased production caused by a natural disaster, such as drought or pest infestation can be critical for countries or locales where the economy is dependent on the crop harvest [1, 2].

Early assessment of yield reductions could avert a disastrous situation and help in strategic planning to meet demands. Change detection is useful in such diverse applications as land use change analysis, monitoring of shifting cultivation, assessment of deforestation, study of changes in vegetation phenology, seasonal changes in pasture production, damage assessment, and crop stress detection, disaster monitoring snow-melt measurements, day/night analysis of thermal characteristics and other environmental changes [3]. The monitoring in this paper has been implemented using classification and change detection techniques, where many preprocessing were applied on the original images such as atmosphere correction, mosaicking and gap filling after that supervised classification was employee to classify and isolate the regions of studied area. change detection using target detection using matching filter and change detection using subtractive methods have been perform to detect the change of the vegetation.

2. Studied Area and Data Gathering

The main source which was adopted to obtain spectral bands of the studied area was the USGS Global Visualization Viewer of the Earth Resource. Karbala province is the studied areas which enclosed by Path / Row (or Lat 33N° / Long 44.0E°). Representing by using Landsat 4-5 Thematic Mapper(TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM₊) and Landsat 8 OLI (Operational Land Imager) sensor onboard satellite, acquire images of the Earth nearly continuously different year from 1995 to 2015. For more information see Table-1. And the series of studied area images since 1995 to 2015 period can be shown in Figure-1. An important preprocessing has been performed on effected image (2005) called gap filling because the Scan Line Corrector (SLC)[4] which compensates for the forward motion of Landsat-7 has failed on May 31, 2003, and all the subsequent efforts to recover the SLC were not successful. The restoration process shown in Figure-1.

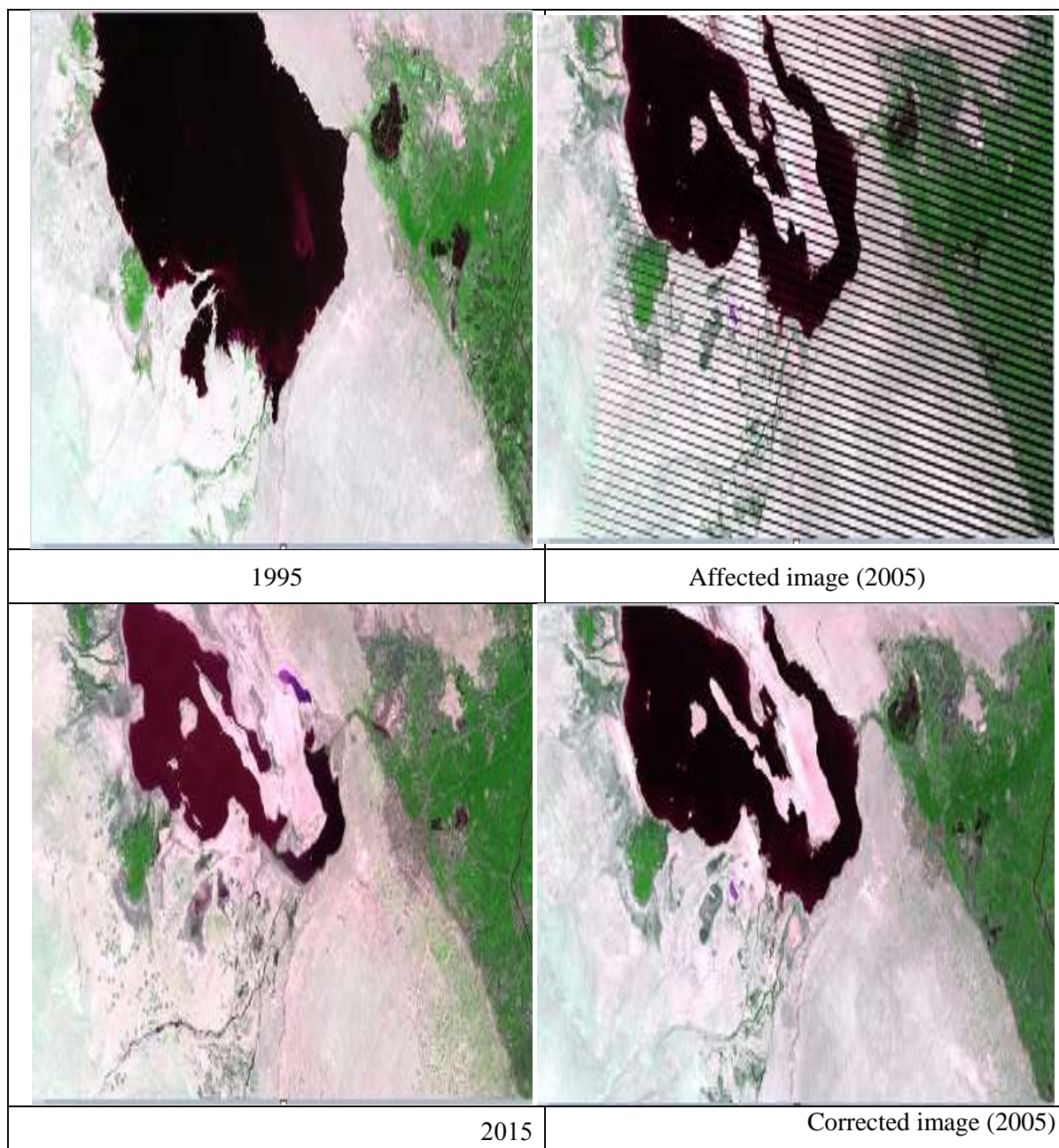


Figure 1-The original of Karbala province images in (1995, 2005, 2015) period.

Table 1- The Landsat and date of captured each original image.

Original images	Source
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

3. Methodology

This research involves data acquisition and data preprocessing. Where preprocessing involves radiometric and geometric corrections. In general, radiometric correction is a prerequisite for

generating high-quality scientific data, making it possible to discriminate between product artifacts and real changes in Earth processes as well as accurately produce land cover maps and detect changes. Atmospheric corrections for multi-temporal optical satellite images are necessary, especially in change detection analyses. Preprocessing also include restoration of defect image such as 2005 image, where gap filling method has been implemented on the fault image to remove the line in it. The methodology includes many images processing such as image classification, change detection and target delineation by using ENVI program.

4. Image Classification

Image classification is the processes by which individual items image pixels are grouped depend on the similarity between the item and the description of the group. Digital image classification techniques generally can be classified in two types supervised and unsupervised classification. In this research supervised based on support vector machine classifier (SVM) and maximum likelihood have been adopted to classify the image [5, 6] Regions of interest for each object of the studied area have been selected to provide the classes of each image[7].

Supervised classification is the proceedings often used in remote sensing image data for quantitative analysis. It was based on using appropriate algorithms for naming each image pixels as representing specific ground cover kinds, or classes. Regardless of the specific method chosen, the fundamental practical procedures commonly include [8]:

1. Select and decide the group of land covers types into which the image is to be divided. These are the information classes and could, for instance, be water, urban regions, croplands, rangelands, etc.
2. Choose prototype or representative pixels from each of the required group of classes. These pixels are said to be region of interest (ROI) or training data. Training sets for each class can be decided through visits the sites of interest, air photographs, maps, or even photo interpretation through viewing a color composite product created from the image data. Often times the (ROI) of training pixels for a given class located in a mutual regions surrounded by a border.
3. Use the training data to estimate the parameters of the particular classifier algorithm to be used; these parameters will be the properties of the probability model used or will be questions that define partitions in the multispectral space.
4. Using the trained classifier, naming or classify every pixel in the image into one of the desirable ground cover kinds (information classes). Here the entire image segment of interest is commonly classified.
5. Produce tabular summaries or thematic (class) maps which summarize the results of the classification.
6. Assess the accuracy of the final product using a labeled testing data set. In practice it might be necessary to decide, on the basis of the results obtained at Step 6, to refine the training process in order to improve classification accuracy.

Where each image represent a specified period of the Karbala age has been classified in to five classes; urban, vegetal, water, desert and soil(reed, green, blue, yellow, and cyan respectively)the results of apply classification techniques can be shown in Figure-2.

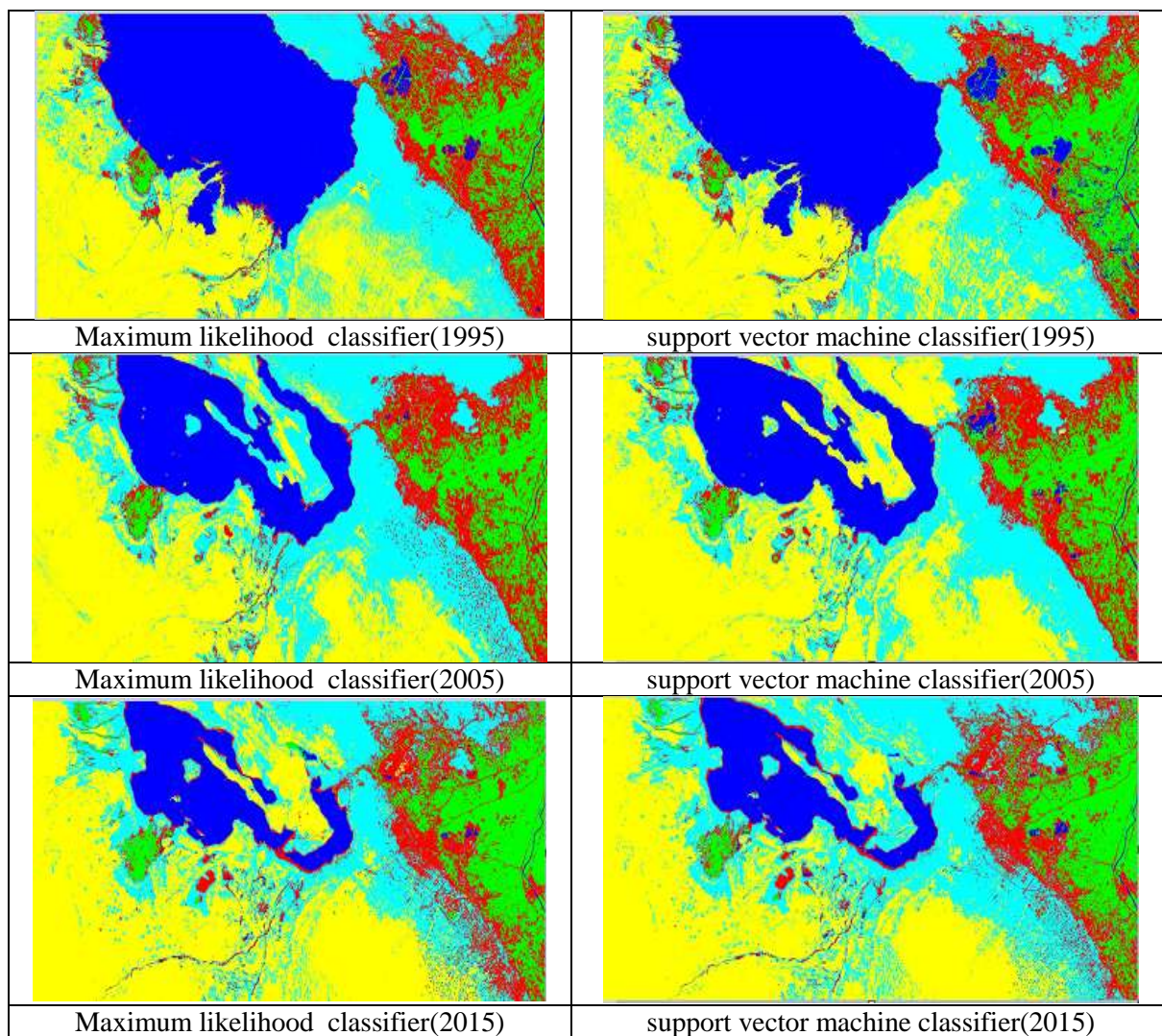


Figure 2- The classified image using maximum likelihood classifier and support vector machine classifier.

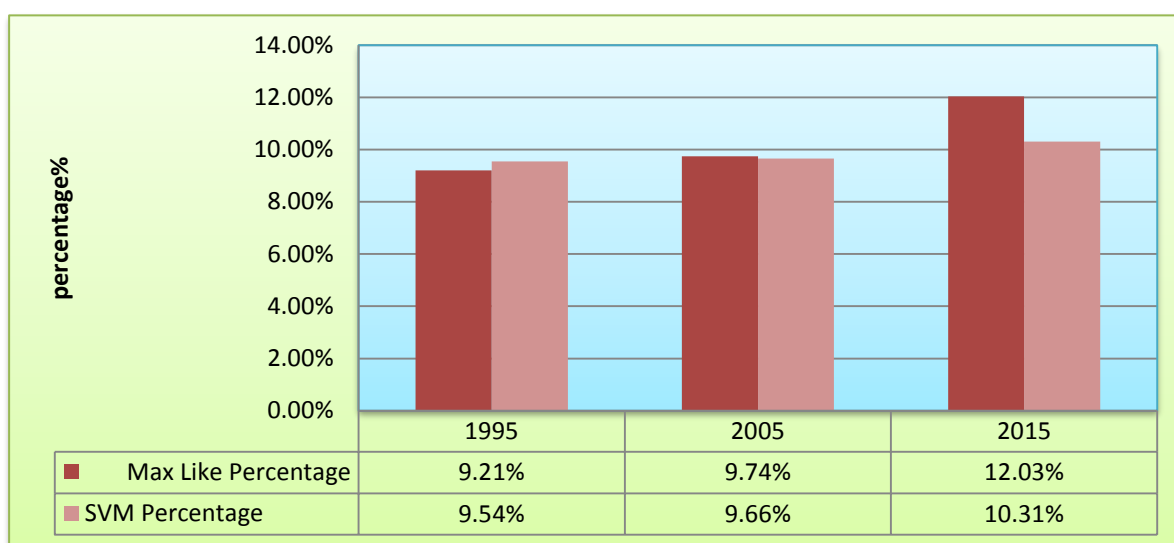


Figure 3- The statistical distribution of vegetation class using maximum likelihood classifier and support vector machine classifier.

5. Target Detection Using Matched Filter (MF)

The target detection wizard guides you through the process to find targets in hyper spectral or multispectral images. The targets may be a material or mineral of interest or they may be man-made objects. In this paper matching filter has been adopted to perform the detection. In this filter the abundance of target was finding using a partial un-mixing algorithm. This technique maximizes the response of the known spectra and suppresses the response of the composite unknown background, therefore matching the known signature [9, 10]. In this section the signature represented by vegetation region and the results of applying this detection can be illustrated in Figure -4. And the main step of perform this detection can be listed below:

Step one: input multi-spectral image for specified period such as image 1995.

Step two: apply atmosphere correction such radiometric correction to convert brightness value to reflectance value.

Step three: using region of interest to select the object which has been detected in this research where vegetal cover has been selected..

Step four: convert the background to zero value.

Step five: apply Minimum Noise Fraction (MNF) transformation on the corrected image.

Step six: use matched filter for target or object detection.

Step seven: apply clumping filter with (3x3) window on final image.

Step eight: output result which have the target detection.

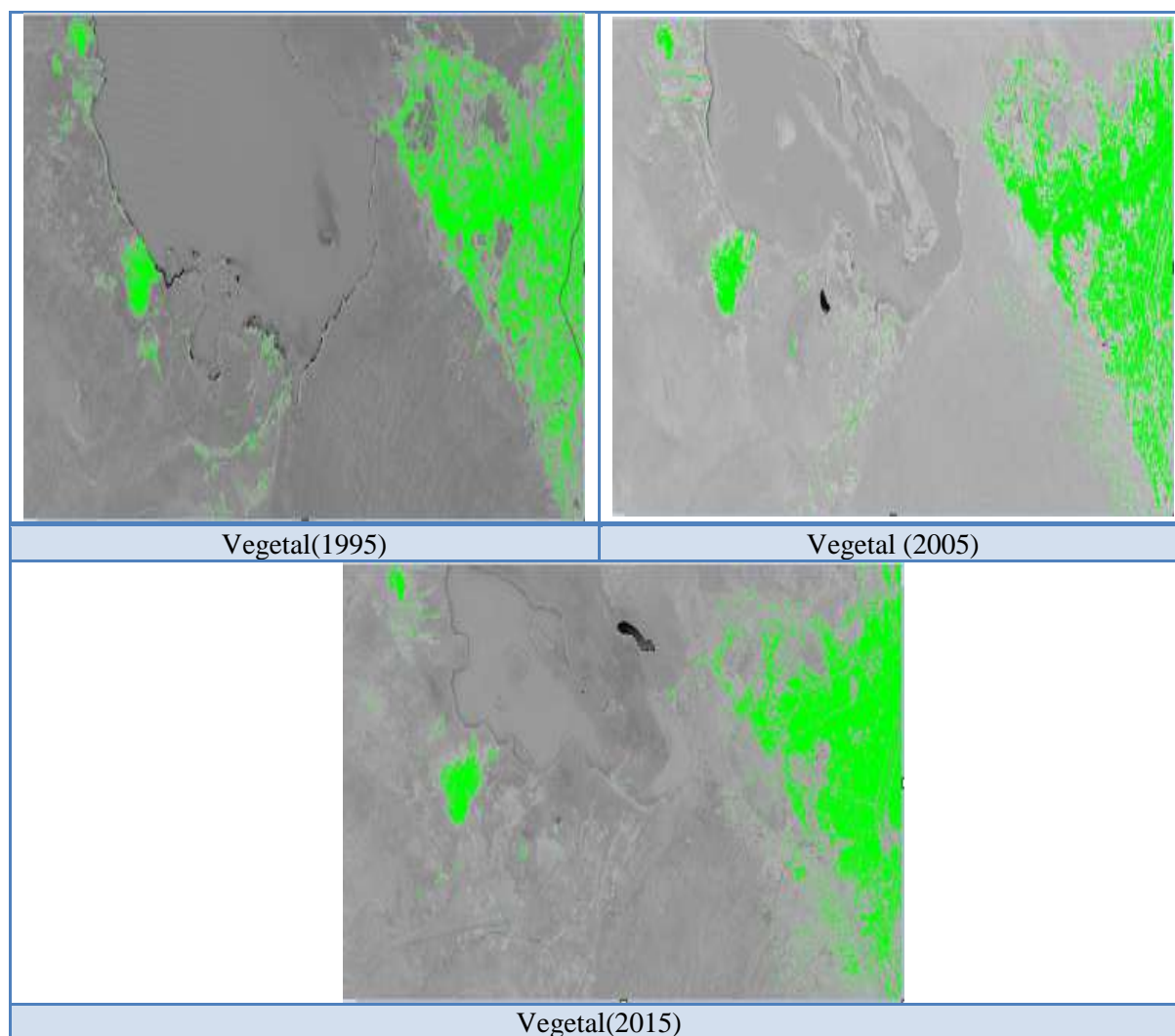


Figure 4- The results of applying the target detection using matching filter for different periods.

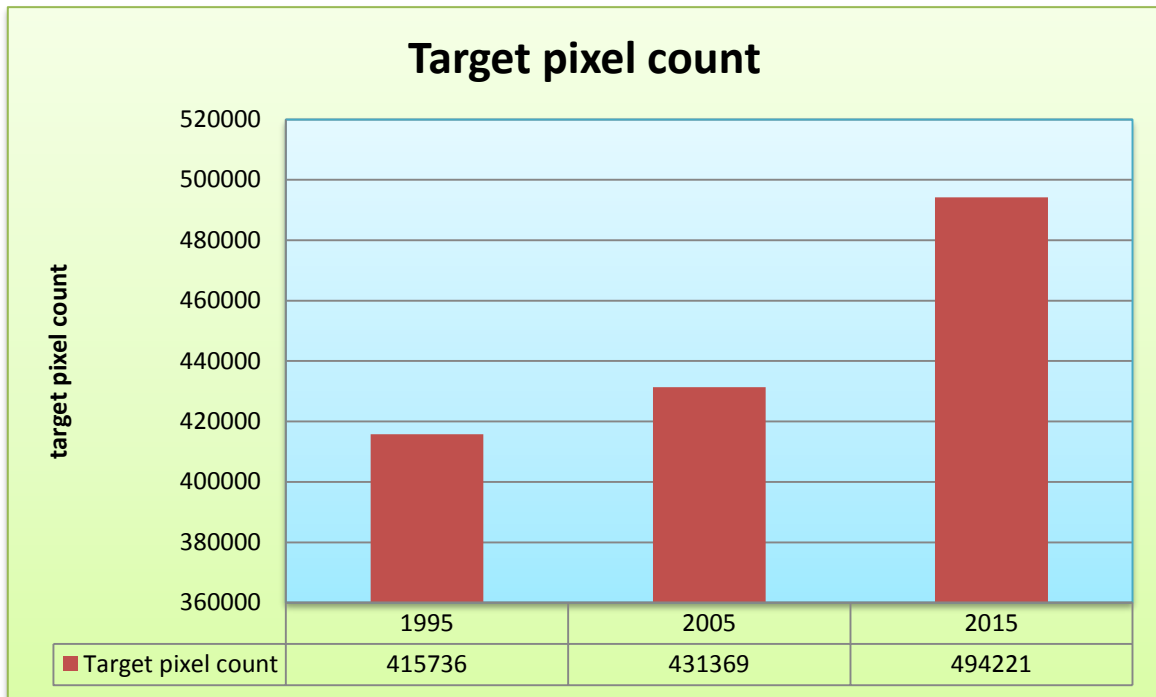


Figure 5- The statistical distribution of vegetation class matching filter.

6. Change Detection Subtractive

Change Detection is a general remote sensing technique that compares imagery collected over the same area at different times, and highlights features that have changed between the two collections. The subtractive method computes the following products and creates difference images that you can open from the available bands list [11].

1. Normalized Difference Vegetation Index (NDVI), subtractive between Time1 (2015) and Time2 (1995, and 2005) as shown in Figure-6.
2. A pixel value of a time series image divides the corresponding pixel of another time series image. In this method, we calculate the ratio of corresponding pixels in each band from two images of different periods after image co-registration, where Red/Blue ratio subtractive between Time1 (2015) and Time2 (1995, 2005) can be shown in Figure-7 and the values of minimum, maximum and standard division can be illustrated in Figure-8.
3. Man Made ratio for Time1 (2015) and Time2 (1995, 2005): A scaled NDVI where minimum values indicate low human activity (for example, vegetation), and max values approaching high human activity (for example, rocks, stones, or other material used for building and road construction). The results can be shown in Figure-9 and the values of minimum, maximum and standard division can be illustrated in Figure-10.

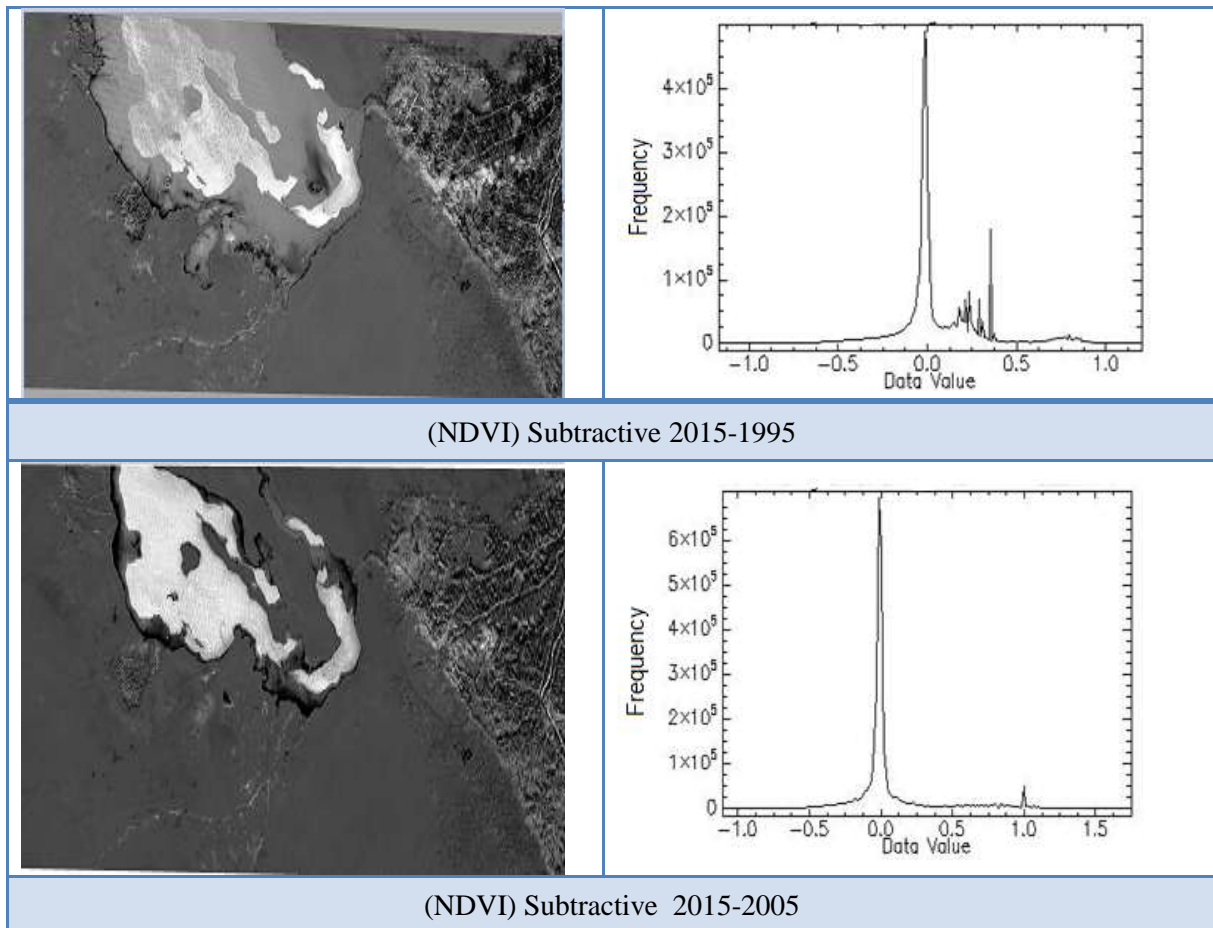


Figure 6-Normalized Difference Vegetation Index (NDVI) for Time 1(2015) and Tim2 (1995, 2005).

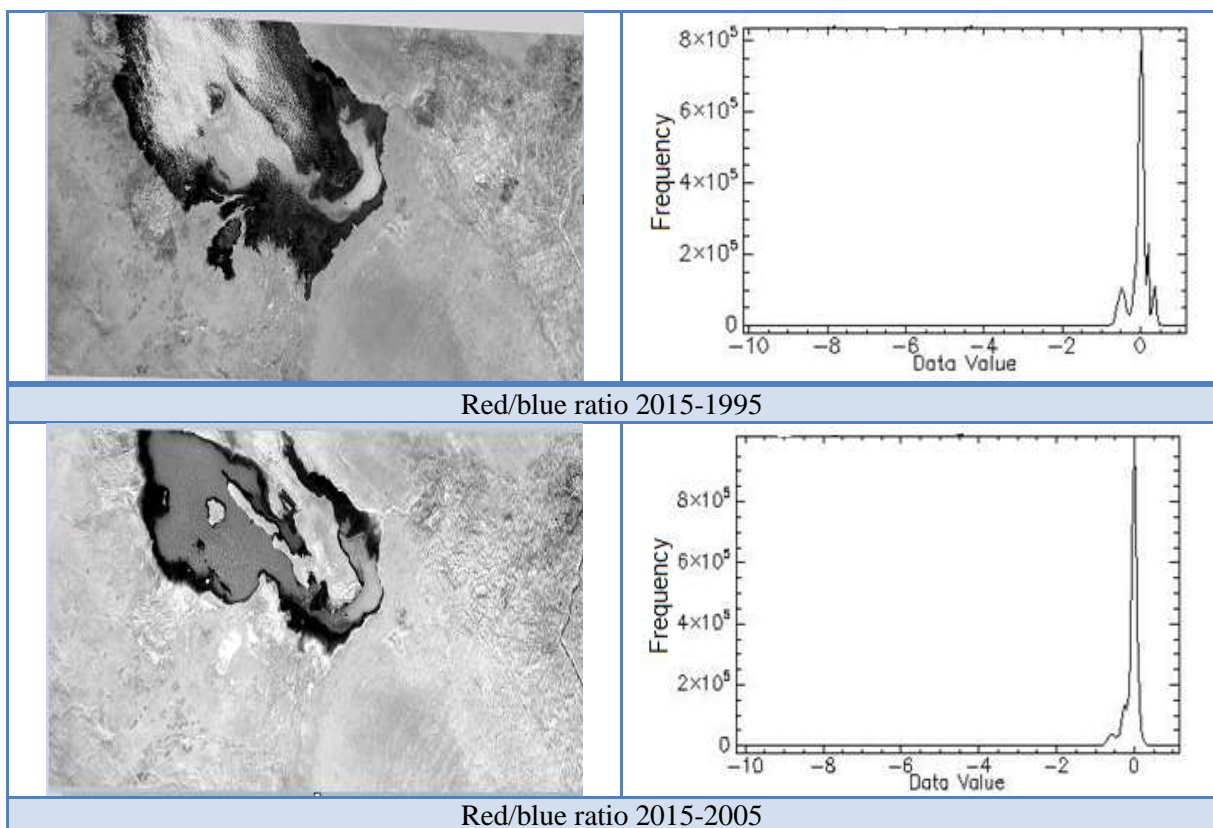


Figure 7-Red/Blue ratio for Time1 (2015) and Time2 (1995, 2005).

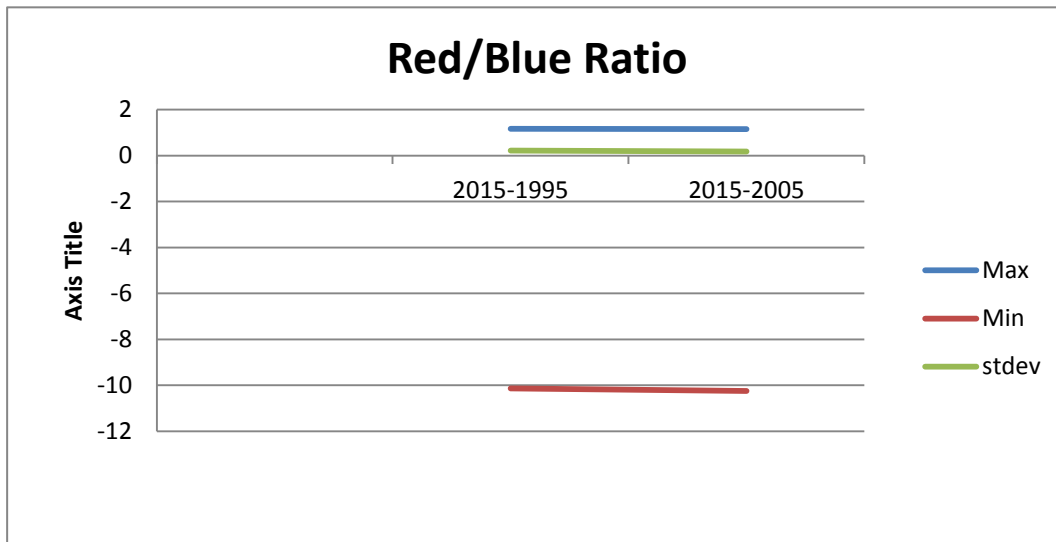


Figure 8- The statistical Red/Blue ratio for Time1 (2015) and Time2 (1995, 2005).

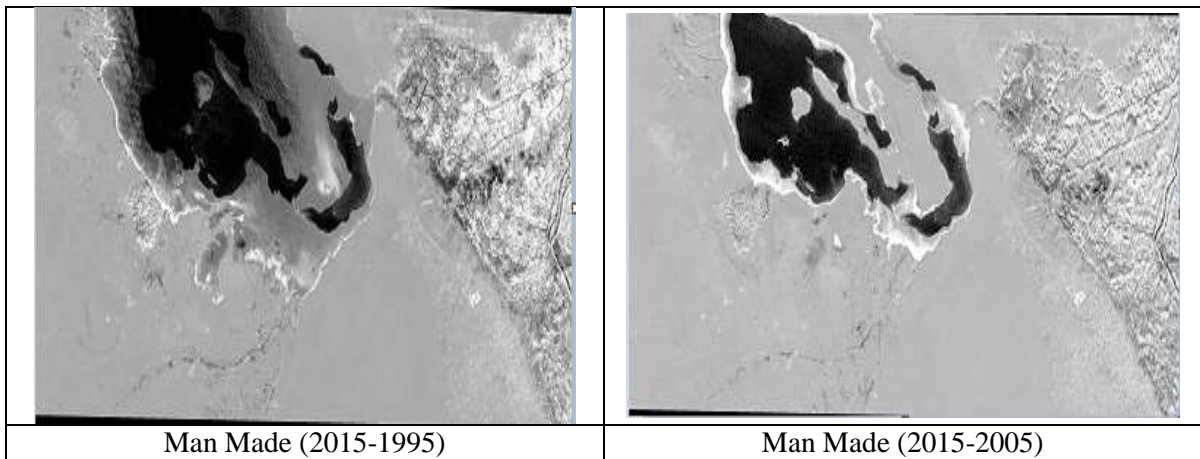


Figure 9- Shows the Man Made ratio for Time1(2015) and Time2(1995, 2005).

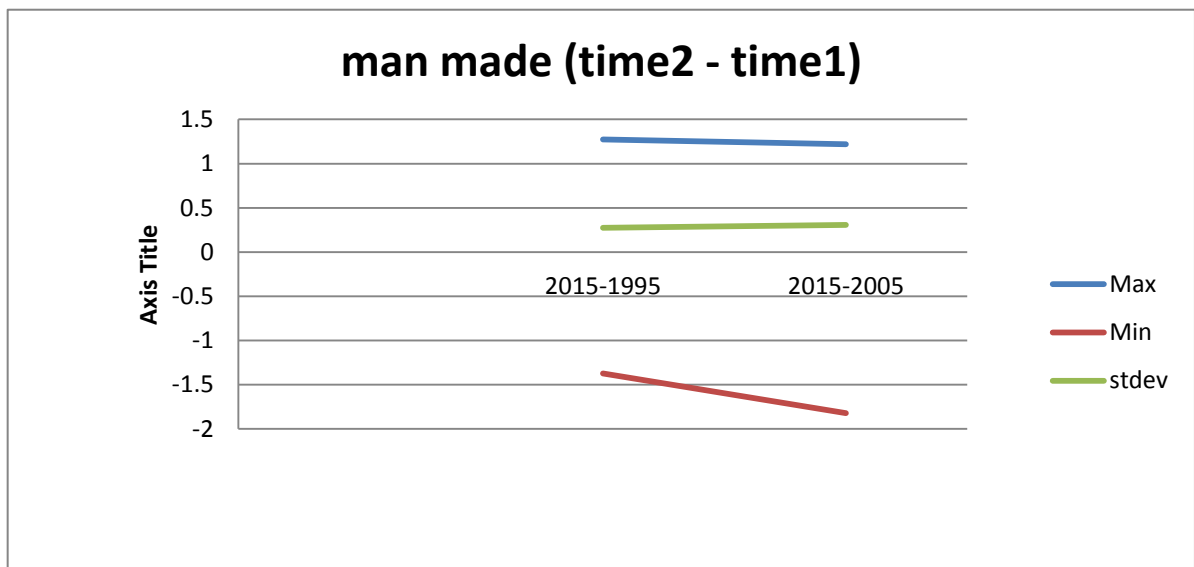


Figure10- Shows the statistical Man Made ratio for Time1 (2015) and Time2 (1995, 2005).

7. Discussion

Change detection is a technology ascertaining the changes of land use and land cover features within a certain time interval. It provides the spatial distribution and information of features changes. This research interested with detects the vegetal cover of Karbala province using different remote sensing methods. The pre-processing includes radiometric, atmospheric corrections; geometrical rectification and image registration, all these correction have been applied on the gathered images, as well as gap restoration was applied on the defected image in 2005.

Many monitoring techniques were employed to detect the vegetal cover of studied area, supervised classification has been applied and the results show increase of the vegetation region in 2015 compared with the past years (1995, 2005) and the expanding of vegetal cover have been done gradually from 1995 to 2015 period. This increase is indicating to interest of people in the cultivation of arid lands and increases the water share of the province.

Target detection is consider to be very important stage of this research and give very reliability results to find and detect the vegetal region and the results of these techniques were coincide with the results of supervised classification about the increase of vegetation region from 1995 to 2015 and the statistical distribution of this region can be shown in Figures- (3, 4) respectively.

Also this research include change detection using subtractive methods, where these techniques depend on compute the NDVI of the two compared image and find the difference between them and the results can be seen in Figures- 6 the results show that more change has been happened between 2015 and 1995 period as be shown in histogram of Figure-6. Red band and blue band ratio has been computed for the two compared images and compute the difference between them, the results give a little changes as be illustrated in Figures - (7 ,8) respectively. Finally manmade subtractive have been applied on the two compared image and the results agree with the fact that Minimum values indicate low human activity as shown in Figures- (9, 10) respectively.

References

1. Setiawan, Y. and Yoshino, K. **2012**. change detection in land-use and land-cover dynamics at a regional scale from modis time-Series Imagery. *ISPRS Ann. Photogramm. Remote Sens. Spat. Inf. Sci.*, **1**(7): 243–248,.
2. Jabalpur, M. **2004**. Vegetation detection in multispectral remote sensing images : protective role-analysis of vegetation in 2004 Indian Ocean. *PDPM Indian Inst. Inf. Technol. Des. Manuf. Jabalpur*, pp. 3–7,.
3. Taylor, P. and Singh, A. **1989**. Review Article Digital change detection techniques using remotely-sensed data. *Int. J. Remote Sens.*, **10**(6): 989–1003.
4. Storey, J., Scaramuzza, P., Schmidt, G. and Barsi, J. **2005**. Landsat 7 Scan Line Corrector-Off [G]ap-Filled Product Gap-Filled Product Development. *Pecora 16 "Global Priorities L. Remote Senspoks.*, **16**: 23–27.
5. Huang, L. S. D. C. **2014**. An assessment of support vector machines for land cover classification. *Int. J. Remote Sens.* **23**(4): 725–749.
6. Canty, M. J. **2009**. *Image Analysis, Classification, And Change Detection In Remote Sensing. With Algorithms for ENVI/IDL*. 2^{ed}, by CRC Press, pp: 204–219.
7. Mather, P. and Tso, B. **2009**. *Classification Methods For Remotely Sensed Data*. 2^{ed}, CRC Press pp: 54–60.
8. Richards, J. A. and Jia, X. **2006**. *Remote Sensing Digital Image Analysis*. Springer Berlin Heidelberg New York , pp. 78–196.
9. Buganim, S. and Rotman, S. R. **2006**. Matched filters for multispectral point target detection. *Proc. SPIE*, **6302**: 1–8,.
10. West, J. E., Messinger, D. W., Ientilucci, E. J., Kerekes, J. P. and Schott, J. R. **2005**. Matched filter stochastic background characterization for hyperspectral target detection. *Proc. SPIE*, **5806**, p. 2.
11. Yacouba, D., Guangdao, H. and Xingping, W. **2010**. Assessment Of Land Use Cover Changes Using Ndvi And Dem In Puer And Simao Counties , Yunnan Province , China. *Rep. Opin.*, **2**(9): 3