VEGETATION DETECTION USING REMOTE SENSING IMAGES AND NDVI INDEX: IN MARSHLANDS OF IRAQ

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ABSTRACT: Vegetation detection using remote sensing imagery has advanced greatly for managing natural resources and to gain a better understanding of processes related to agricultural variation over long time periods. In this study the visible red and near-infrared (NIR) bands of Moderate Resolution Imaging Spectra diameter (MODIS) are used to identify vegetation areas in the selected study area from Iraq over eleven successive years. The study area was subjected to a number of economic and political conditions that led to decline and growth in vegetation. The NVDI index is used to recognize pixels which most likely to contain significant vegetation. The results indicate that it is useful to use remote sensing images with NVDI index to study the effect and results of economic and political situation on changed vegetation.

Keywords: *Remote sensing, Vegetation detection, Marshlands of Iraq and NDVI Index.*

1. INTRODUCTION

Remote sensing images are digital images that show parts of the Earth's surface as seen from space without coming into physical contact with these parts. The sensor on the board of satellite reads amount of reflected energy transmitted from different portion of the Earth to the sensor [5,12]

These remote sensing images present features in the form of Spectral, Spatial and Temporal characteristics related to objects, area or phenomenon such as , vegetation, agriculture land and water resources[5]. The wealth of valuable information that generated from remote sensing data has tremendously benefitted and boosted many scientific researches and applications depending on the required studies such as, land surface mapping and monitoring, archaeological investigations, agriculture land and water resources monitoring [4][10].

Monitoring the locations, distributions and changes of land cover such as vegetation and water areas is important for creating links between policy decisions, regulatory actions and succeeding in land use [2]. Vegetation detection can be considered as vital task for managing the natural wealth resources and assessing the environment and ecosystem [13]. In the present time one of the main important issues facing the world is the detection of changes in vegetation from remote sensing images which were used for detecting the vegetative land cover changes over time that caused by some events and phenomena such as urbanization [6][8]. In 1989 the change detection has been described by Singh as a process that observing the changes or variations on Earth objects at different times [1]

Since different surface areas such as vegetation area has unique spectral features depending on their reflectivity across different spectral bands. As a result to chlorophyll rich vegetation having a high reflectance in NIR band compared to the visible band of the electromagnetic spectrum, most of studies generate the composite color image for vegetation detection by combing the near infrared band with both red and green bands [2,3,6].

Vegetation Indices can be calculated using the properties of these bands and the NDVI (Normalized Difference Vegetation Index) is the most common indices used in vegetation detection [1,13]

Numerous studies have been conducted for vegetation detection utilized NDVI index using remote sensing images acquired from different sensors. In 2009 [1] introduced a study about the Spatio-Temporal change of vegetation cover using Landsat TM and ETM+ images of 1986 and 2000, during the time period from 1986 to 2001 number of operations with NVDI index were implemented to detect the significant change of vegetation cover [1].

In supporting environment planning and land use practices in 2012 [2] presented an application for using the Landsat 7images and multi-spectral MODIS (Terra) EVI with NDVI index as a temporal land use change model for Punjab province of Pakistan to quantify the range and quality of variation and aid in future forecasting[2].

In 2014 [3] used the differences between the visible red and near-infrared (NIR) bands of a LANDSAT Thematic Mapper images with NVDI index to identify areas containing significant vegetation to study the effect of mangroves and other woody coastal vegetation as a protective measure against the 2004 Indian Ocean Tsunami [3] . In 2014 [11] presented a study to examine four different land cover changes such as dense tree cover, tree cover mosaic, wooded land and vegetation cover in West Africa occurred between 1975 and 1990 using Landsat Multispectral Scanner (MSS) for 1975 and Landsat Thematic Mapper (TM) for the 1990 period [11].

An enhanced change detection study has been presented in 2015 for analysis the TM satellite imagery using the NDVI index. In this study the NVDI was used to reveal the vegetation areas, land cover classification, thick and thin forest, water bodies, and other areas such as open, scrub, hilly and agricultural [5].

In this study, the detection of vegetation change using NDVI index for Moderate Resolution Imaging Spectroradiometer (MODIS) images from Iraq was investigated. In the following sections, the methodology and the experimental results are discussed.

2. METHODOLOGY OF VEGETATION DETECTION

In this section, the algorithm that has been used to detect the vegetation area in selected MODIS multispectral images is introduced. These vital steps are: image registration, image enhancement and vegetation detection using NDVI index. The description of each step has been presented in details.

2.1 Image Registration

Image registration can be defined as the procedure of aligning or overlaying two or more images taken for the same scene and acquired at different times, with various viewing angles, and/or from different sensors [7][15]. In this study numbers of scenes for the same Earth location are used in vegetation detection process related to the same area, ENVI package was used to perform image registration between all input image by using the first image that acquired in 2001 as a base image and the others as a warp image.

2.2 Enhanced the input images

Image enhancement is necessary for the colour separation of input images and for more effective visual display. A decorrelation stretching was used to enhance the colour differences found in a colored image by a method that includes the removal of the inter-channel correlation found in the input pixels.

The decorrelation-stretched process produces an overview that enhances spectral reflectance variations. In this study, analyzing the variations between NIR and red bands can be used to quantify the contrast in spectral content among the vegetation regions and another such as, bare soil or wet regions.

2.3 Create a NIR-Red spectral scatter plot

In the following process, the scatter was plotted to compare the NIR band with the visible red band. It has also been used to extract these two bands of original input images into their individual variables and display the two bands together as gray images, so the differences appears clearly.

2.4 Compute vegetation index using NDVI

Although there are various indices used in agricultural observing, the Normalized Difference Vegetation Index (NDVI) is utmost commonly utilized for grasping the structure, function of land cover and its related variation such as vegetation detection [9-14]. The NDVI can be calculated as a ratio of red and NIR bands using the following equation

NDVI= (near infrared band- red band)/ (near infrared band+ red band)………(1)

Generally, NDVI values range from -1 to 1. As a result, when the NDVI values between -1and 0 represents non-vegetation features such as barren rock, sand, built- up area and water areas, the NDVI values are greater than 0 represents the vegetation covers and high NDVI values (around 0.6 to 0.9) correspond to dense vegetation like that found in tropical forests or crops at their peak growth stage [9]. After calculating the NDVI, a suitable threshold is applied on resulted NVDI image, applying the suitable threshold will help to recognize pixels most likely to contain significant vegetation.

2.5 Link spectral and spatial content

Last but not least, for the second time the NIR-red scatter plot is drawn with the previously obtained threshold in a contrasting color (green) and thereafter re-drawn the NDVI image with new threshold using the same blue-green color scheme. As predictable the pixels having an NDVI value above the threshold appears with the green color in NIR-red composite image.

3. Experimental Results and Discussion

This section describes how NDVI technique was used to study the effect of changes on vegetation areas using remote sensing images by performing the steps of section 2.

The selected area demonstrates a diverse wetlands and rich agricultural areas located in Mesopotamia in Iraq, where the Tigris flows south from top center and the Euphrates flowing in from the left center. However, historically in spring this area has been speckled with ponds, verdant with reeds and other wetland plants. Also this area includes the largest remnant marsh, Al Hawizeh, located at the Iran-Iraq border just east of the Tigris River (top right) but this area was exposed to many changes because of the wars and political factors such as drying up these areas for political reasons. Eleven scenes from 2000 to 2010 were selected for the same area in order to create a comprehensive vision about the effect of political and wars on the change in agricultural areas and a series of images from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite were used for this purpose.

1- After applying the image registration between all used images, the steps of the introduced algorithms were implemented on selected areas from 2000 to 2010. Four examples of the years 2001, 2004, 2008 and 2010 are selected to present the changes in vegetation area using the introduced algorithm, where in each year there were changes in the selected area. Figs. 1, 2, 3 and 4 showed the steps of the algorithm on the selected area on 2001, 2004, 2008 and 2010 respectively as follow:

2- Figs.1, 2, 3 and 4 (a) shows the color input image. It is evident in Fig.1 (a) which presents the area in 2001 that the area included a few small green patches and bare soil as a result to drained a large areas by Saddam Hussein to punish the tribes living there consequence for participating in anti-government rebellions, while Fig.2 (a) presents the area in 2004 following the Second Gulf War and the end of Saddam Hussein's regime in 2003, where a large area has been re-flooded after Iraqis began destroyed the dikes and canals that had drained the marshes which led to the emergence of green areas and growth of plants and algae. Figs.3 and 4 (a) presents the same area in 2008 and 2010 respectively, where the area appeared reddish brown, rather than the lush green color which usually appears in vegetation areas in 2008. Whereas in 2010 the irrigated agricultural areas in the center of the image appeared more extensive and greener than they have been in the previous years.

3- Figs 1, 2, 3 and 4 (b) presents the enhanced image using decorrelation stretching. The decorrelation stretching is used to distinguish between the vegetation areas and other areas such as bare area which appear in brown, marsh and Tigris and Euphrates Rivers. It is clearly that the selected area is characterized with small and sporadic green areas.

4- Chlorophyll is the main factor in reflectivity of vegetation which absorbed robustly in red band and appears in visible observation in green. Also, chlorophyll reflects most strongly in near-infrared band. Therefore, Figs.1, 2, 3 and 4 (c and d) presents the visible red and NIR infrared bands respectively.

5- Figs. 1, 2, 3, and 4 (e) presents the scatter plotter that extracts the NIR band and green band from the composed color image.

6- The NDVI equation is performed to observe the difference between the NIR and red bands by applying suitable threshold. Figs. 1, 2, 3 and 4 (f and g) demonstrate the NDVI result and NDVI with suitable threshold respectively. It is clear that the green areas are shown more luminous for the years 2004 and 2010 and less clear in 2001, where the green areas appear in white dots.

7- Finally, Figs.1 and 2 (h) revealed the scatter plot after NDVI with suitable threshold. It is obvious that the green areas are located at the same location in all cases but with more clarity in 2008 and 2010.

Fig.5 shows a graph between the years used in the study and the calculated NDVI value. It is clarified that the greater value is in 2004 because of the recovery of the region after the war and then the values begin to fluctuate between the rise and fall and according to the economic and political situation in the region.

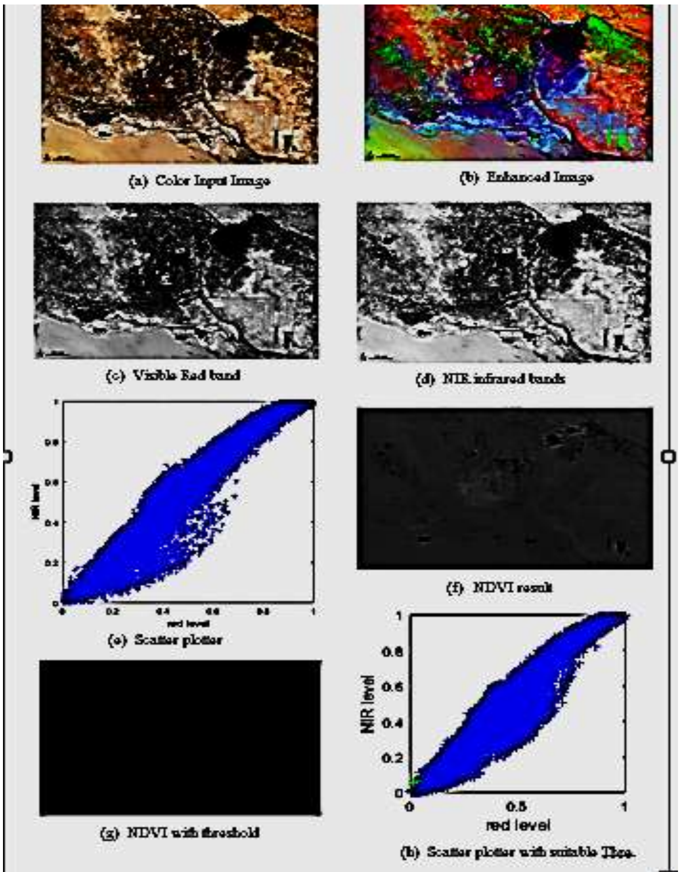

Figure (1) the results of the proposed method in 2001

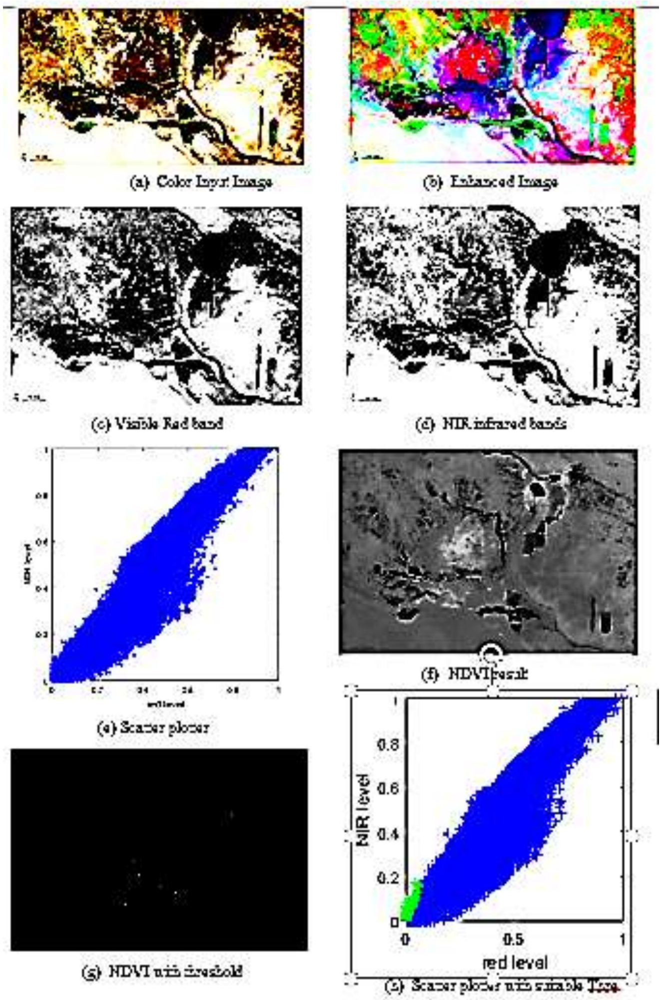

Figure (2) the results of the proposed method in 2004

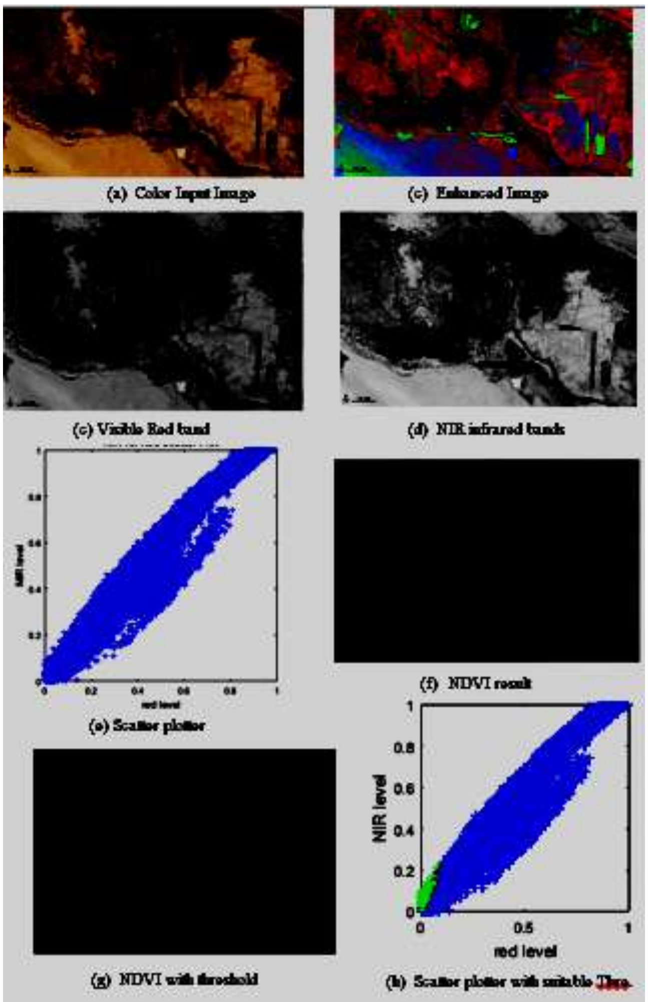

Figure (3) the results of the proposed method in 2008

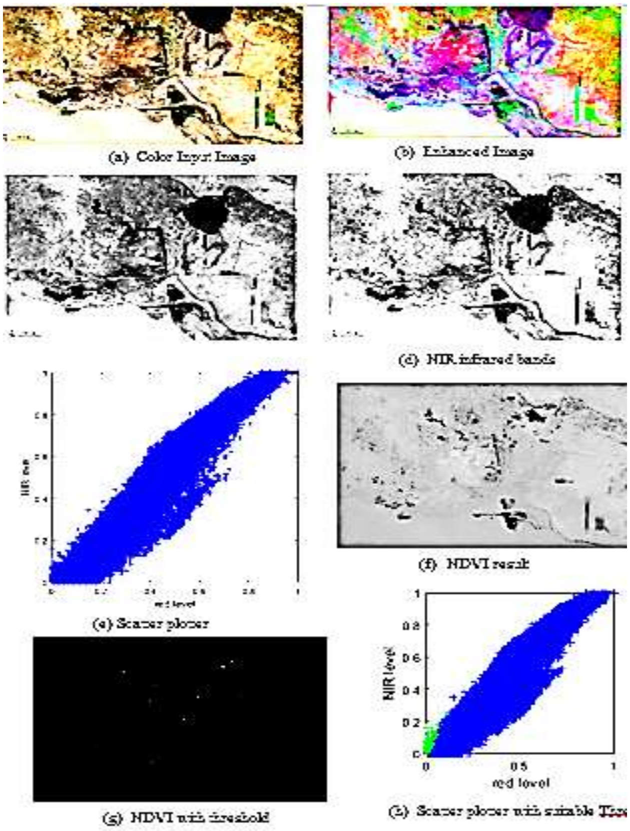

Figure (4) the results of the proposed method at 2010

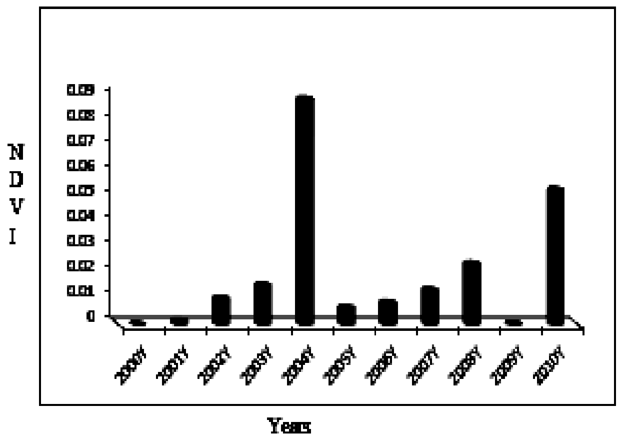

Figure (5) the graph between the years used in the study and the calculated NDVI

4- CONCLUSION

The algorithm introduced impressive results for vegetation detection in areas characterized with small and sporadic green areas using multispectral remote sensing images. The vegetation cover can be detected by performing the NDVI index with suitable threshold. This research is developed to study the effect of the economic and political situation on the south of Iraq. Also there are some limitation in this study where the difficulties to gain images for the current years is due to the situation in Iraq and the political determinants of photography, despite this we got some photos from the NASA site to improve and implement this study, which showed great results in this area. The progress continues to gain images for the current years to be most useful search idea for specialists in this field. As a future work, the presented algorithm can be used worldwide for detecting the water as well as vegetation on the areas that consists of water and vegetation.

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