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Change Detection between Landsat 8 images and Sentinel-2 images

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Abstract

The technology of change detection is a technique by which changes are verified in a certain time period. Remote sensing images are used to detect changes in agriculture land for the selected study area located south of Baghdad governorate in Agricultural Division of AL-Rasheed district because this method is very effective for assessing change compared to other traditional scanning techniques. In this research two remotely sensed images for the study area were taken by Landsat 8 and Sentinel-2, the difference between them is one month to monitor the change in the winter crops, especially the wheat crop, where the agriculture began for the wheat crop there in the Agricultural Division of AL-Rasheed district at 15/11/2018. The first preprocessing procedure was the extraction of the NDVI (Normalized Difference Vegetation Index) values for the two scenes of Landsat 8 and the two scenes of Sentinel-2B and then using the change detection between them to compare the changes in agriculture land. Also, change detection was implemented between NIR bands because they are most severely affected by biomass or the amount of available chlorophyll-containing in plant structures. The results of the change detection for Sentinel-2B were more accurate than for the Landsat 8 as demonstrated by field visits for the study area, where the changes in the distribution of vegetal cover (wheat and other winter crops) were clear and accurate in the image of Sentinel-2B, as opposed to Landsat's 8 image, where the variation in vegetation cover was not accurate, especially for the change detection between NIR bands.

Keywords: GIS techniques, NDVI, Change detection.

مقارنة تفضيلية بين كشف التغيرات لصور القمر الصناعي Landsat 8 مع صور Sentinel-2B

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الخلاصة

تقنية اكتشاف التغيير هي تقنية يتم من خلالها التحقق من التغييرات في فترة زمنية معينة. تم استخدام صور الاستشعار عن بعد للكشف عن التغيرات في الأراضي الزراعية لمنطقة الدراسة المختارة الواقعة جنوب محافظة بغداد في قسم الزراعة بمنطقة الرشيد لأن هذه الطريقة فعالة جدًا لتقييم التغير مقارنة بتقنيات المسح التقليدية الأخرى. في هذا البحث ، تم التقاط صورتين مستشعرتين عن بعد لمنطقة الدراسة بواسطة Landat 8 و2-Sentinel ، والفرق بينهما هو شهر واحد لمراقبة التغير في المحاصيل الشتوية ، وخاصة محصول القمح ، حيث بدأت الزراعة لمحصول القمح هناك في قسم الزراعة بمنطقة الرشيد في 2018/11/15. تتمثل

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الإجراءات الأولى للمعالجة المسبقة في استخراج قيم (NDVI مؤشر الغطاء النباتي الطبيعي) لمنظري Landat 8 ومنظري Sentinel−2B ثم استخدام كشف التغيير بينهما لاكتشاف التغييرات في الأراضي الزراعية. كما يمكن تنفيذ اكتشاف التغيير بين نطاقات NIR لأنها تتأثر بشدة بالكتلة الحيوية أو كمية التراكيب النباتية المحتوية على الكلوروفيل. كانت نتائج التغيير في اكتشاف Sentinel−2B أكثر دقة من Landat 8 كما يتضح من الزيارات الميدانية لمنطقة الدراسة ، حيث كانت التغييرات في توزيع الغطاء النباتي (القمح والمحاصيل الشتوية الأخرى) واضحة ودقيقة في صورة Sentinel−2B ، على عكس صورة Landsat 8 ، حيث كان التباين في الغطاء النباتي غير دقيق ، خاصة بالنسبة لاكتشاف التغيير بين نطاقات NIR .

1. Introduction

The change detection is the process of identifying differences in the characteristics of the Earth by observing them at different times. This process can be carried out manually or by remote sensing programs (S. Bazgeer, 2005) [1] . By analysis of atmospheric photographs, where the analysis is used to perform the equation between image and image and detect the change zones. (Wright, Lillesand, & Kiefer, 1980) [2] To detect the variable after analysis, two different dates are categorized independently. The area of change is then extracted by a direct comparison of the categorization results (Duro, 2012)[3]. One of the benefits of detecting post-categorization is that it transcends difficulties in detecting change associated with the analysis of acquired images at various times of the year or by various sensor (Richards, Jia, Richards, & Jia, 2013) [4] . The flaw of the post-categorization approach include more computational requirements and distinguish, high sensitivity to the precision of the individual categorization, as well as difficulties in accurately evaluating historical data sets. Because all optimization methods depend on processes or pixel scenes as well as pixel operations, accuracy in registering images and basic registering is more important to these methods compared to other methods (Clark, 2002) [5].

The changes detection have been done between the images of Landsat 8, and between the images of Sentinel-2B. The Landsat program is a large project to operate satellite images of the Earth. The satellite was launched on July 23, 1972, for land resources technology. The development of Landsat 8 was the result of communion between the US space agency (NASA) and the US Geological Survey (USGS)(Rachel, Paul, Rowland, & Ross, 2000)[6]. The selection of Landsat spectral bands is directed at different types and sizes of plants. One of the most important strengths of Landsat, in general, is that it re-inspect every spot on earth every 16 days, and has a long-term data archive so that the images captured by it can be compared from 1982, and also has relatively rich spectral information [7]. As for the satellite Sentinel-2B, It is an Earth-monitoring expedition from the (EU) Copernicus Program that obtains methodical optical imagery with high spatial resolution (10m to 60m) above the land and coastal waters. The launch of the first satellite, Sentinel-2A, occurred 23 June 2015 at 01:52 UTC on a Vega launch vehicle. Sentinel-2B was launched on 7 March 2017 at 01:49 UTC, also aboard a Vega rocket. Where this family of missions consists of two twin satellites (Sentinel-2A and Sentinel-2B). This task provides very wide services and applications such as agricultural monitoring, emergency administration, land cover classification or water quality [8].

2. The study area

The study area is selected for this research because it is famous for the cultivation of the wheat crop which is considered a strategic crop and is a major source of food security for the country. In addition, the ease of communication with the study area is important for the purpose of conducting field studies and identifying the features of agricultural land. The selected study area is located south of Baghdad governorate in Agricultural Division of AL-Rasheed district, where it showed in green as shown in Figure-1. The study area extends between the longitude (441150 - 442500) m north and the latitude (3665550 - 3667900) m east where it's an area is 220 km².

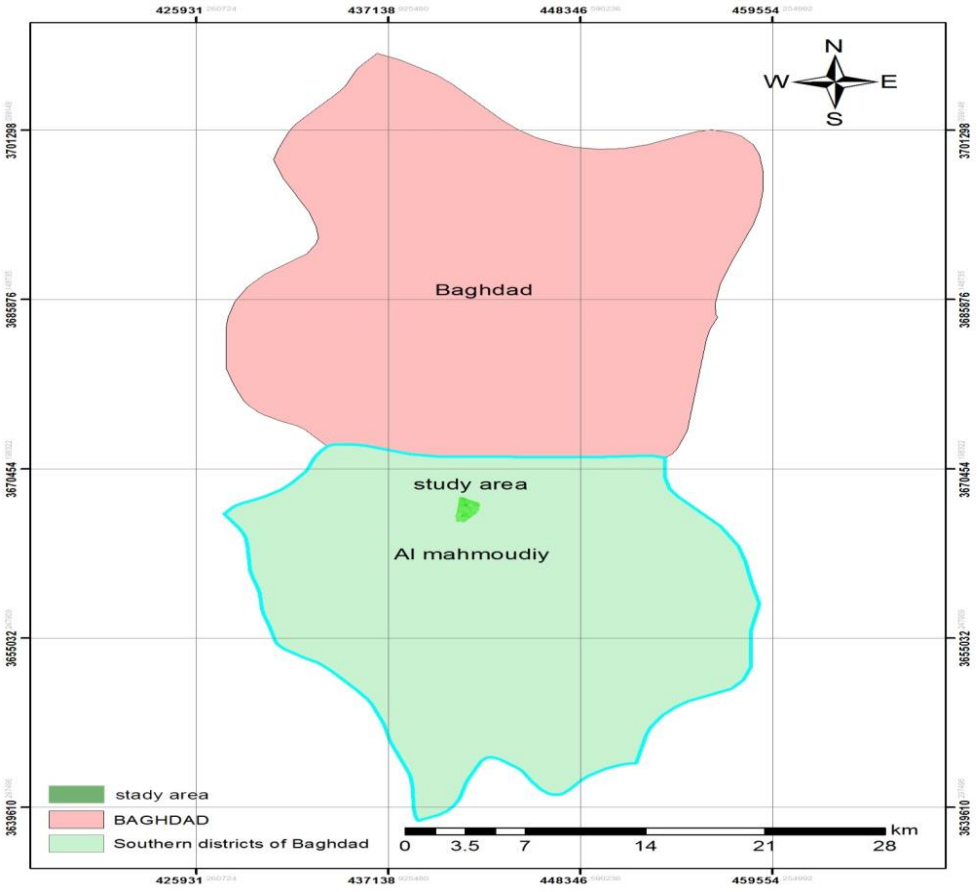

Figure 1-Showing the location of the study region.

3. Used Data

1. Satellite image (landsat8).
2. Satellite image (Sentinel-2).
3. GIS software.
4. Erdas program.

4. Methodology of Work

The entirety of this study was conducted using ArcGIS software specifically, and ERDAS program. Repeated imaging for the study area enables the estimation of changes in the type or condition of surface features. This is one of the most important of all analyses in remote sensing, typically called change detection. Many of these analyses use images acquired at two points in time, the primary focus of this research. The Change Detection, between NDVI imageries for the two of Landsat 8 scene on different dates, and also the Change detection, between NDVI imageries for the two of Sentinel-2B scene on different dates, was extracted. On the other side the Change detection, between the two of Landsat 8 scenes at the near-infrared region, and the Change detection, between the two of Sentinel-2B scenes at the near-infrared region, was extracted. For change difference for each band has been illustrated in the below equation (1) (Muhsin, 2016)[9],

$$Im_d{}^k(x,y) = Im_2{}^k(x,y) - Im_1{}^k(x,y) \quad (1)$$

Where:

$Im_d{}^k$ *(x,y):* The image subtractive for each band

$Im_1{}^k$*(x,y):* First images obtained from time1

$Im_2{}^k$*(x,y):* Second images obtained from time2

(x,y) : The coordinates of the pixels

K: band number

The NDVI (band ratio) is a structure from every input image, and the difference can be taken between the band ratios at different times. The change detection can be used on many other remote sensing methods. As in equation (2) (M. K. Alfarttoosi, 2016) [10]**.**

$$NDVI_d = NDVI_1 - NDVI_2 \quad (2)$$

Where:

$NDVI_d$ = change pixel value at NDVI

$NDVI_1$ = NDVI value on date 1

$NDVI_2$ = NDVI value on date 2.

5. Results and Discussion

5.1 Change Detection between NDVI imageries

After extracting the NDVI values of satellite images of the Landsat 8 satellite and Sentinel-2 satellite for the study area (in the Agricultural Division of AL-Rasheed district), Change detection of the NDVI imageries is obtained with different dates, where they included one scene for Landsat 8 and included one scene for Sentinel-2B.

a. NDVI scenes from Landsat 8 include Figure-2 and Figure-3

Figure-2, showing the NDVI value on the date 20-11-2018, where the value (0.030 - 0.090) represents areas were flooded with water, where some of these flooded areas were cultivated with wheat. The (0.090 - 0.161) value is showing the soil, the value (0.161 - 0.260) illustrated the summer crops close to the date of harvest, and the value (0.260 - 0. 468) is the winter crops such as lettuce and other winter crops as potato.

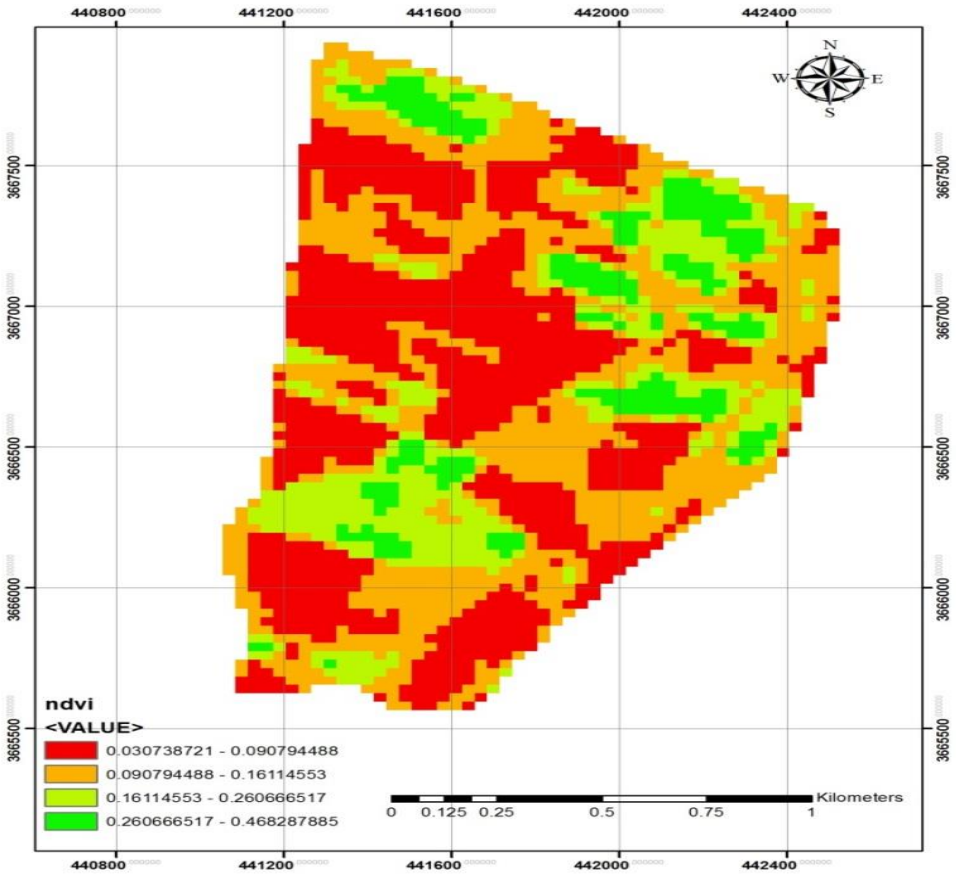

Figure 2-The NDVI scene on the date 20-11-2018, of Landsat 8

Figure-3 Showing the NDVI value on the date 22-12-2018, it can note the disappearance of summer crops and the beginning of winter crops. Where the values (0.263 - 0.403), and (0.167 - 0.263) represented the winter crops. The value (0.090 - 0.167) is contained the soil, and there is also an increase in the area which flooded with water represented by the value of (0.019 - 0.090) (some were planted with wheat).

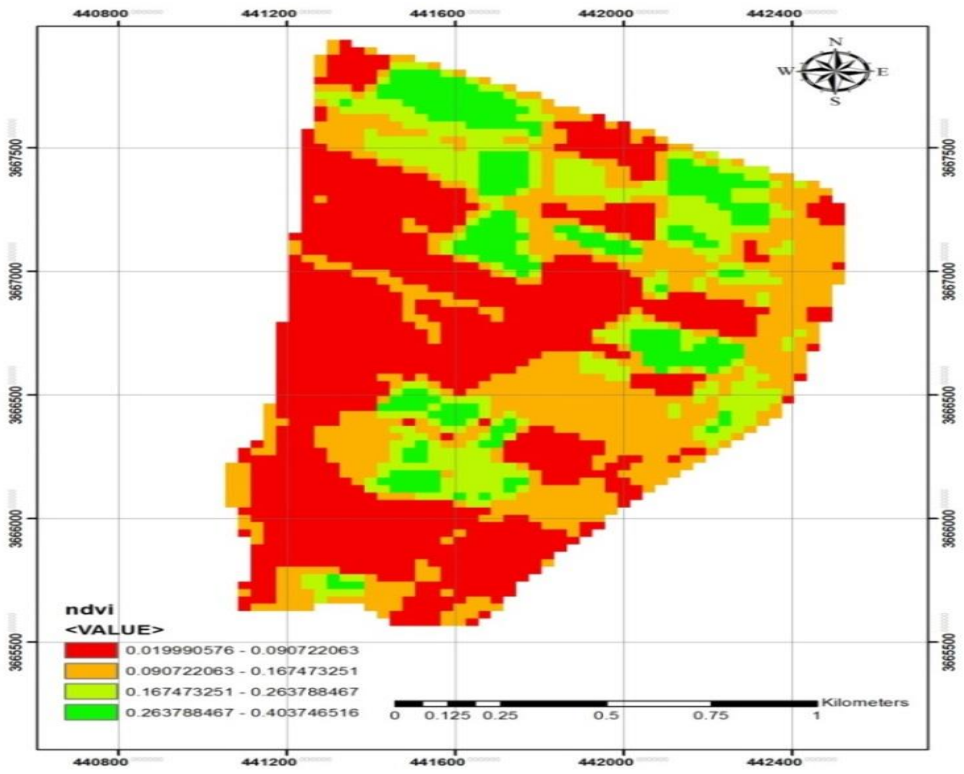

Figure 3-The NDVI scene on 22-12-2018, of Landsat 8

Change detection, between NDVI imageries for Landsat 8 scenes for the Agricultural Division of AL-Rasheed district, as shown in Figure-4. It can be observed that there is a significant increase in winter crops growth (wheat and other winter crops) and a decrease in uncultivated areas.

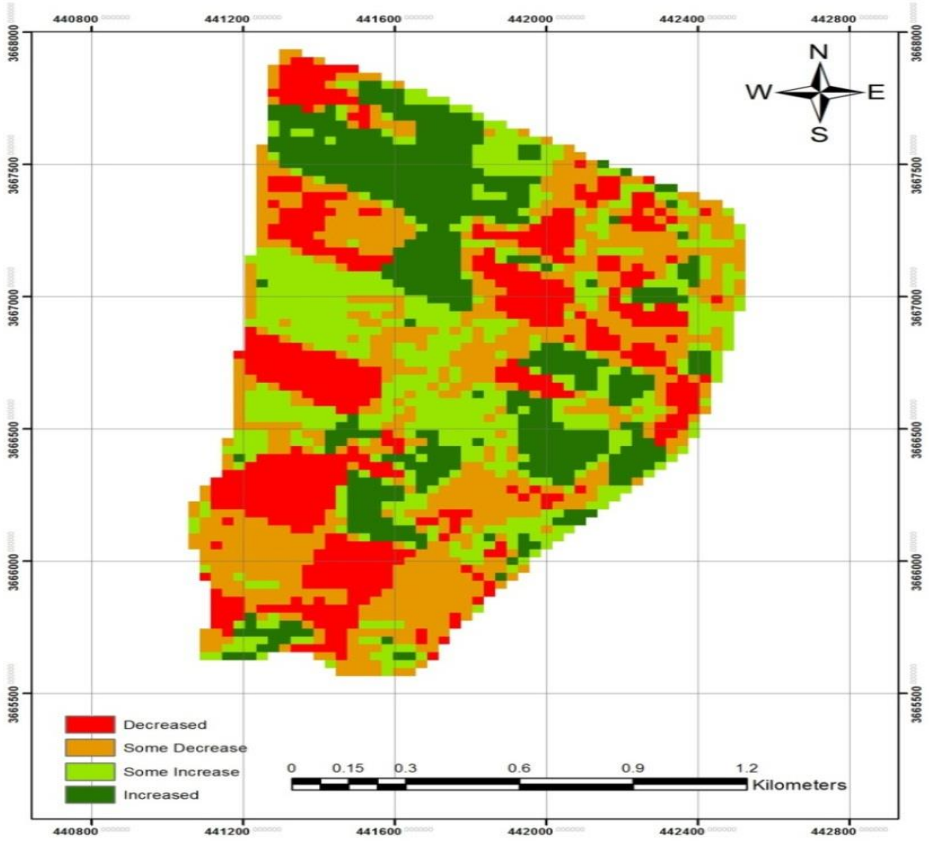

Figure 4-The Change detection, between NDVI imageries on 20/11/2018 and 22/12/2018.

b. NDVI scenes from Sentinel-2B include Figure-5 and Figure-6.

Figure-5, Showing the NDVI value on the date 20-11-2018, of Sentinel-2B Where the value (0.058 -0.145) represents the agricultural areas flooded with water. The (0.145 - 0.292) value is showing the soil, and the value (0.292 - 0.483) represent summer crops close to the date of harvest. While the (0.483 - 0. 778) the value contained the winter crops such as lettuce and other winter crops as potato.

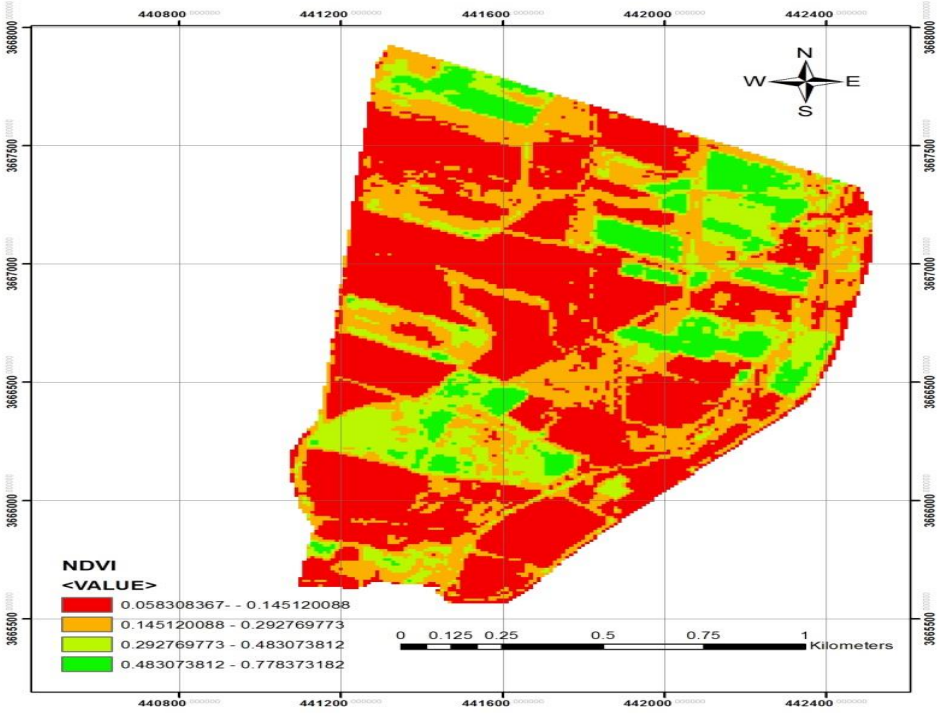

Figure 5-NDVI scene on 20-11-2018, of Sentinel-2B

Figure-6 Showing the NDVI value on the date 30/12/2018 It can be observed that the summer crops are disappeared and the winter crops are beginning, where the values (0.313 - 0.495) & (0.495 - 0.728) represented the winter crops.

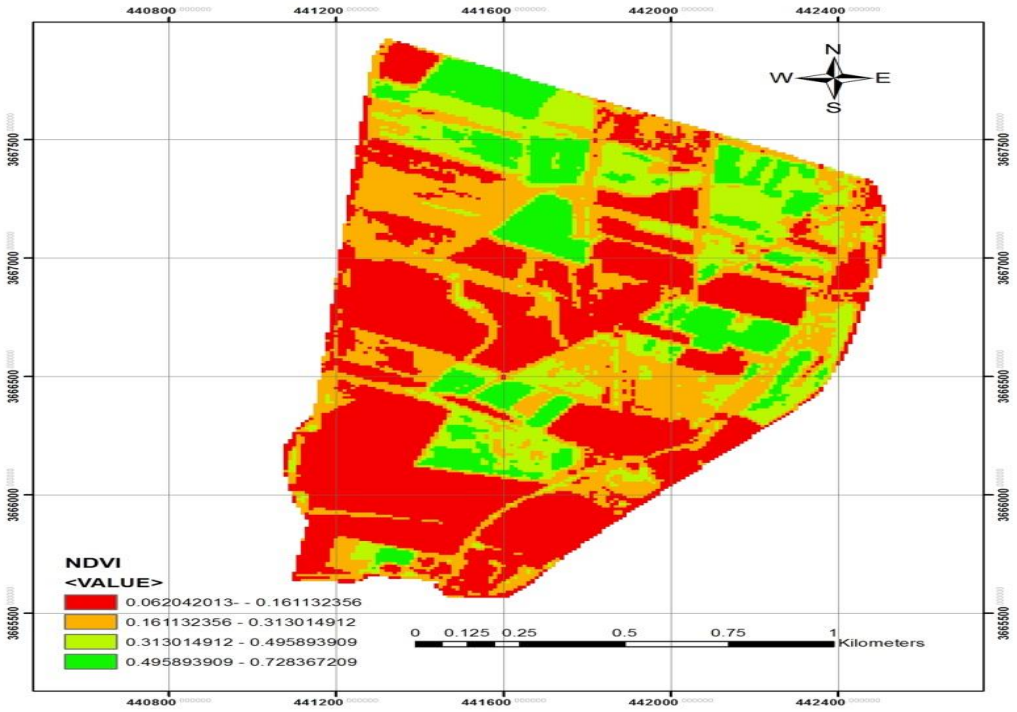

Figure 6-NDVI scene on 30/12/2018, of Sentinel-2B

Change detection, between NDVI imageries for Sentinel-2B scenes for the Agricultural Division of AL-Rasheed district, as shown in Figure -7. It can be observed that there is a significant increase in the growth of winter crops as shown in dark green and light green.

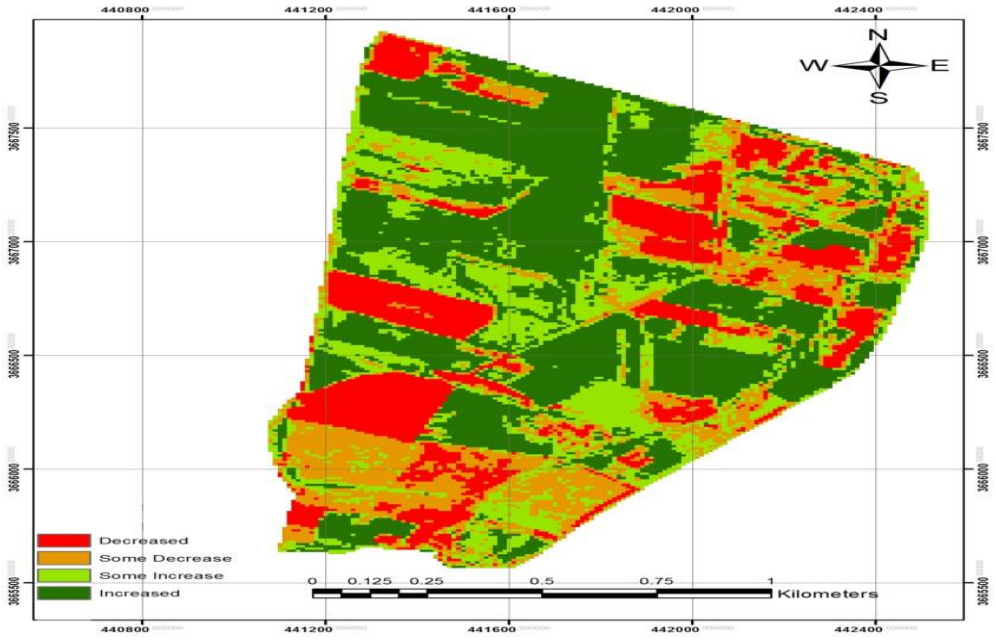

Figure 7-Change detection, between NDVI imageries on 20/11/2018 and 30/12/2018.

5.2 The Change detection, between NIR bands for satellites images

Change detection is obtained for the NIR (near-infrared region) bands for satellite images of Landsat 8 and Sentinel-2B where they included one Scene for Landsat 8 and for Sentinel-2B.

a. Change detection, between Landsat 8 scenes at near-infrared region (0.85–0.88 µm) in the Agricultural Division of AL-Rasheed district, as shown in the Figure-8. It shows the scene is inaccurate because of the low resolution for the Landsat 8 satellite and because of the reflectance in Landsat band 5 (the near infrared) is most severely affected by biomass or the amount of available chlorophyll-containing plant structures, so it can infer changes in vegetated cover only.

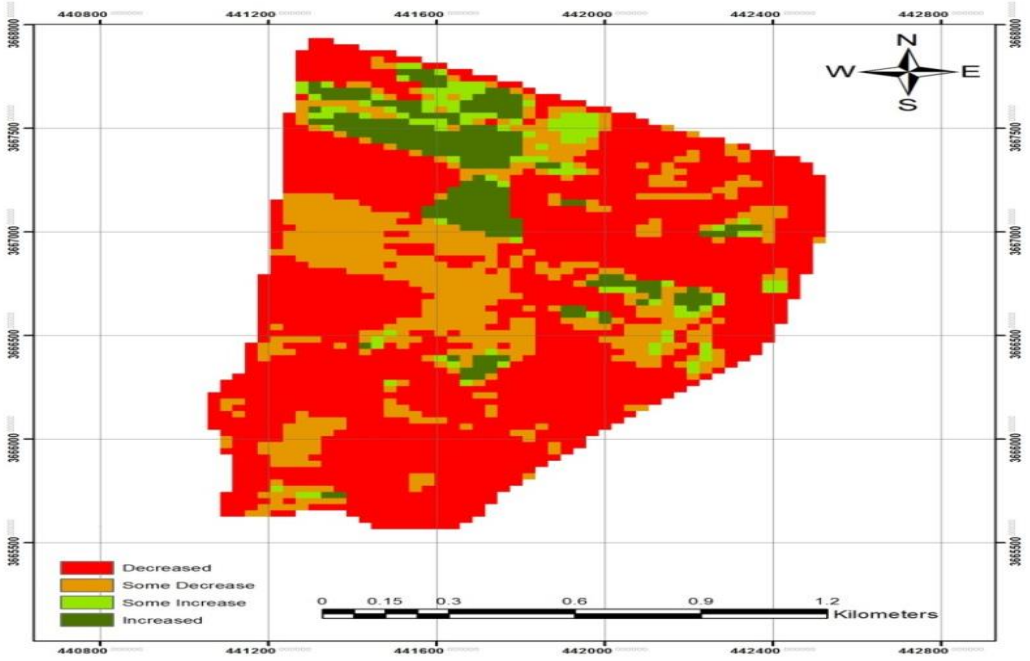

Figure 8-Change detection, between Landsat 8 images on 20/11/2018 and 22/12/2018 for band 5 NIR. There is an increase in the growth of winter crops.

b. The Change detection, between Sentinel-2B images at near-infrared region (0.842–0.957 µm) in the Agricultural Division of AL-Rasheed district, as shown in Figure-8. It produces a very accurate scene of the change detection in the study area. Where it illustrates an increase in the area of cultivated land (wheat and other winter crops) and the shrinking of uncultivated land. It also shows a scene similar to what it is in change detection, between NDVI imageries of Sentinel-2B.

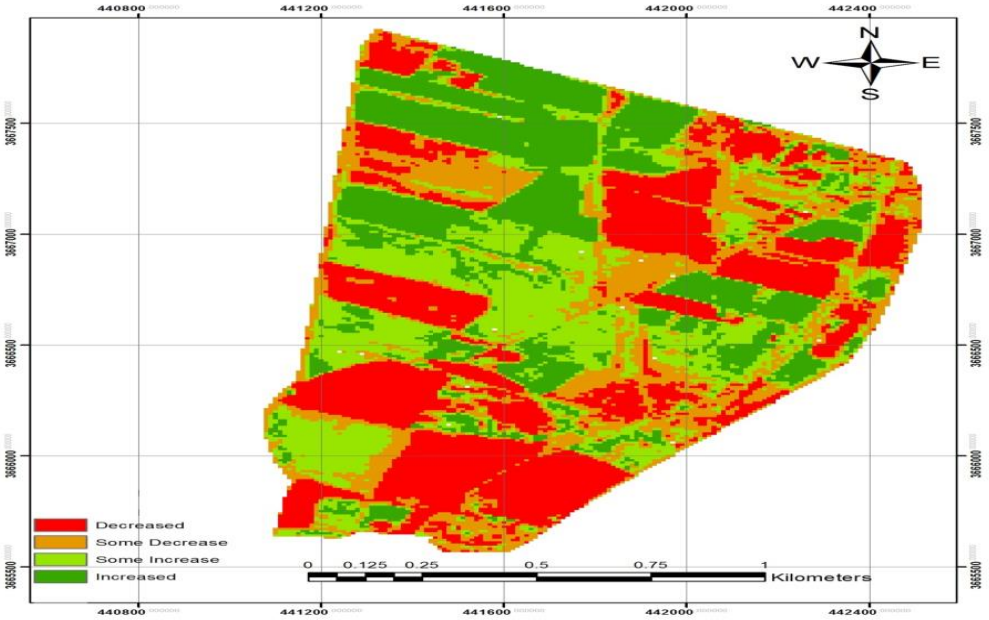

Figure 9-Change detection, between Sentinel-2B images on 20/11/2018 and 30/12/2018 for band 5 NIR.

6 Conclusion.

1. Landsat 8 imageries are inappropriate for small and mixed farms, and also for dispersed vegetative cover, as in the Agriculture of Division Al Rasheed district, because of the difficulty of ground discrimination.

2. Landsat 8 imageries are effective in observation of the health status of crops, the account of crop area, and crop productivity for regular farms and large areas.

3. Sentinel-2B imageries are very active in observation of the crop health status, the account of crop area, and crop productivity for the regular and irregular farms because of its high spatial resolution compared to Landsat 8

4. The results of the change detection for the study area showed four classifications, according to the increase and decrease in the vegetation cover.

A. A significant increase in winter crop growth such as Lettuce

B. Some increase in the growth of some winter crops such as wheat.

C. A significant decrease in summer crop growth due to harvest

D. Some decrease in the growth of weeds and jungles because it was treated by farmers.

5. Field visits proved that these results were more accurate for the image of Sentinel-2B compared to the results shown by the image of Landsat 8 in respect of the change detection between NDVI imageries.

6. The NIR band of the Sentinel-2B is influenced by the amount of available plant structures containing chlorophyll more than NIR band of Landsat 8, so the results of change detecting between NIR bands were inaccurate for the Landsat 8, as shown in Figure-8.

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