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Detection of Snow Cover using NDSI and False Color Methods

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Abstract

Snowfall is one of the most important natural phenomena that can be seen in the winter which is considered as a rare phenomenon in the Middle East. Snow is covering parts of mountains in northern Iraq and neighboring countries in the first months of the year. In this research, the snow cover can be detected and monitored using pseudo color method, and the Normalized Difference Snow INDECES (NDSI). Snow cover is difficult to detect in true color satellite images because the white color of snow cover is the same color with the cloud cover. Modis sensors that carried by Terra and Equa satellites images have been used in different bands and different resolution and the case studied in 4/2/2017, 5/2/2017.

Keywords: Snow cover, NDSI, False color methods.

الكشف عن الغطاء الثلجي بأستخدام طرق الاختلاف المعياري لمؤشر الجليد واللون الكاذب

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الخلاصة

تساقط الثلوج هو واحد من أهم الظواهر الطبيعية التي يمكن رؤيتها في فصل الشتاء والتي تعتبر ظاهرة نادرة في الشرق الأوسط، ان الثلوج تغطي أجزاء من الجبال في شمال العراق والدول المجاورة في الجزء الأول من السنة. في هذا البحث سيتم كشف ورصد الغطاء الثلجي باستخدام طريقة اللون الكاذب و كذلك طريقة الاختلاف المعياري لمؤشر الجليد . حيث أن الغطاء الثلجي يصعب الكشف عنه في صور الأقمار الصناعية الحقيقية اللون بسبب لونها الأبيض والذي هو نفس اللون للغطاء السحابي. صور الاقمار الصناعية Terraو Equa استخدمت بدقه واطوال موجية مختلفة ، تم البحث في 2017/2/4، 2017/2/5.

1. Introduction

Snowfall is an important aspect of winter in much of north of Iraq and the distribution of snow in space and time is an important parameter for a wide variety of reasons. Knowing the extent of the snow is valuable information in that it provides insight as to the amount of water to be expected from snowmelt available for runoff and water supply. In addition, the snow cover itself is a surface condition that affects radiation and water balance determinations that are inputs to hydrological cycle and climate studies, [1].The purpose of this study is intended to examine whether the snow cover estimates from the NASA Earth Observing System (EOS) Moderate Resolution Imaging.

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Spectroradiometer (MODIS) can be improved by using the variability in the Normalized Difference Snow Index (NDSI) spectral band ratio to estimate the snow cover being which observed in each MODIS pixel and false color method with different band outside the visual spectrum (infrared, ultraviolet , or X-ray).

2. Data used and study area:

(A). Terra MODISs True Color image with 250m Resolution in (4 and 5 /2/2017)**.**

(B). MODIS band 4 **(**0.545- 0.565 µm)**,** and band 6 (1.628-1.652 µm**)**

Study area: northern of Iraq (sulaymanihay), west Iran (kermanshah) and parts of turkey, see Table -1

Table 1-represent the longitude and latitude of the study area

Location	Longitude	Latitude
kermanshah	47°3'33.668"E	34°22'8.014"N
Center of turky	40°32'19.03"E	38°50'16.941"N
sulaymanihay	45°28'13.706"E	35°31'30.51"N

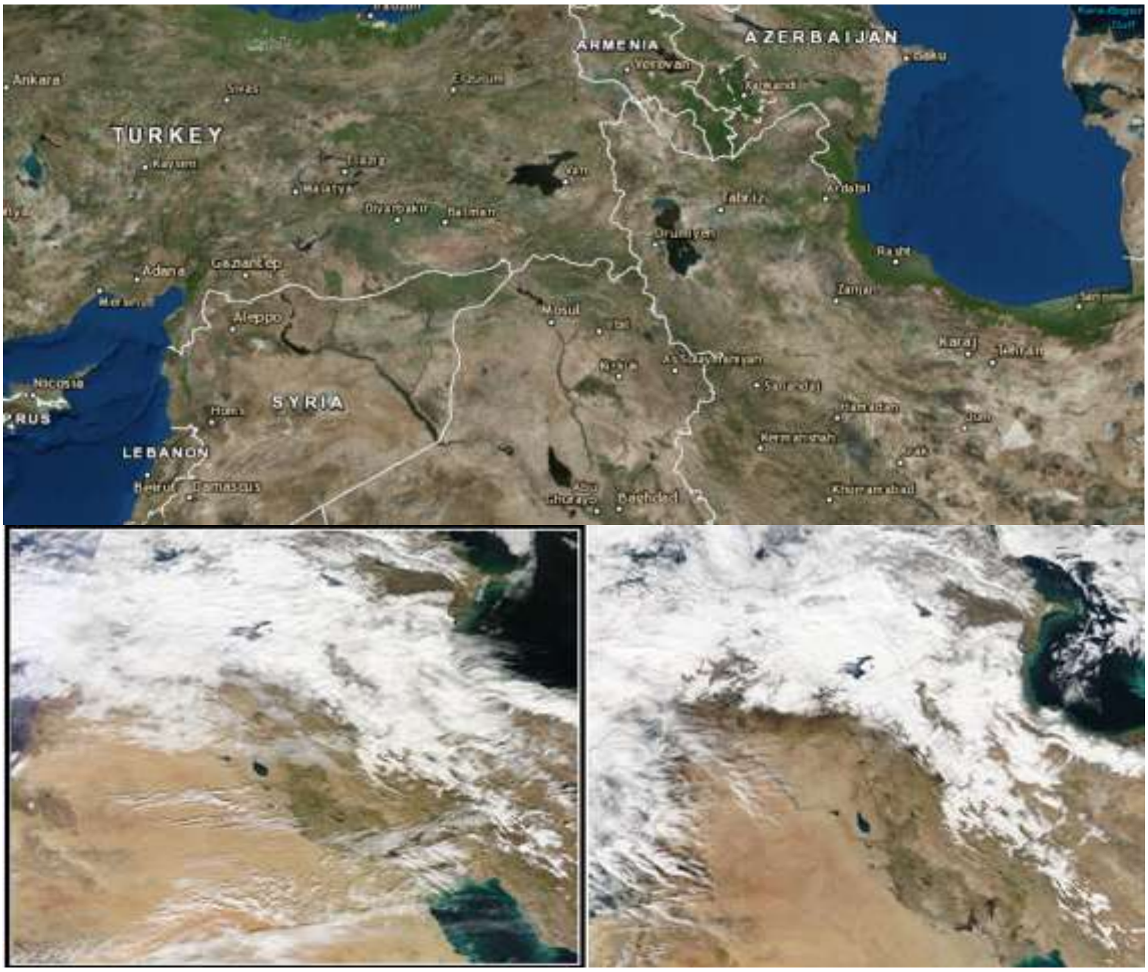

Figure-1- the study area taken by modis sensor that carried by terra and equa Satellite Images in 4, 5/2/2017.

3. Methodology of work:

3.1. False color technique

False color used to produce images in color that have been recorded in visible or non-visible parts of the electromagnetic spectrum and its display the objects in the images in color that differs from the true color images. The false color images doesn't use the natural color rendition in order to detect the features that are not readily discernible, for example the use of the infrared for detect the vegetation , basically all the data that false color use are outside the visual spectrum (infrared, ultraviolet , or X-ray). For the true color satellite images, the RGB channels are used (R red, G green, B blue) from the sensor of satellite are mapped to corresponding RGB channels of the image such as ,yielding a RGB→RGB mapping, in false color the simplest encoding is take an RGB

image but map it differently, like "RGG→NGB" where N being the near infrared band and false color is used for space and remote sensing satellite like MODIS and Landsat to monitor weather and to produce grayscales images from visible or infrared spectrum. The band combination used for distinguish clouds from snow and other features are MODIS bands (7-2-1) and (3-6-7), [2, 3].

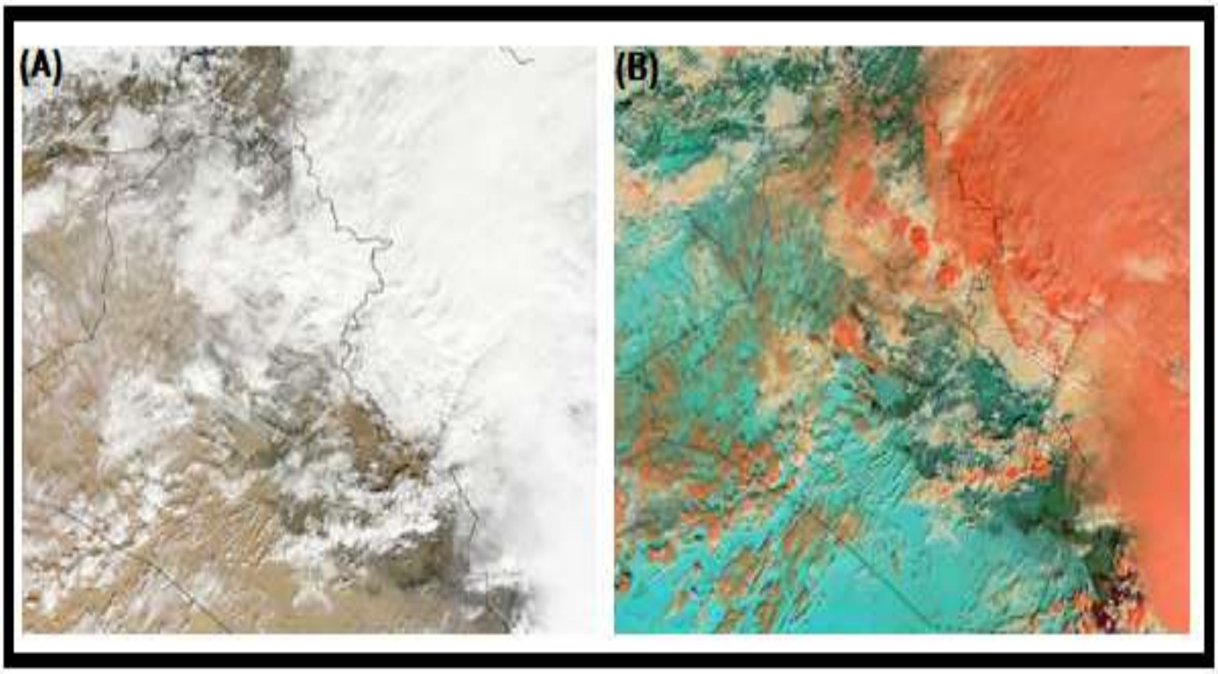

Figure 2- Represents False Color Image Bands (3-6-7).

3.2 Snow indices

Normalized-Difference Snow Index (NDSI) is a normalized difference of two bands (one in the visible and one in the near-infrared or short-wave infrared parts of the spectrum) is used to map snow. Snow is highly reflective in the visible part of the EM spectrum and highly absorptive in the near-infrared or short-wave infrared part of the spectrum. Whereas the reflectance of most clouds remains high in those same parts of the spectrum, allowing good separation of most clouds and snow, [4]. Normalized Difference Snow Index (NDSI) is a numerical indicator that highlights snow cover over land areas. The green and short wave infrared spectral bands are used map the extend of snow cover. Snow and clouds reflect most of the incident radiation in the visible band. However, snow absorbs most of the incident radiation in the short wave infrared, while clouds do not. This enables the NDSI to distinguish snow from clouds.

3.2.1 NDSI algorithm

At satellite reflectance in MODIS bands 4 (0.545- 0.565 µm) and 6 (1.628-1.652 µm) is used to calculate the normalized difference snow index (NDSI):

NDSI = (BAND 4 – BAND 6)/(BAND 4+ BAND 6) ……… ………(1)

As pixels will be mapped as snow if the NDSI is ≥ 0.4 and reflectance in MODIS band 2 (0.841- 0.876 µm) is >11%. However , if Modis band 4 reflectance is <10%, then pixel will not be mapped as snow even if the other criteria are met ,thus eliminating the water bodies that have NDSI > 0.4 µm, **[5]**.

4. Interpretation and Dissection results

4.1. False Color method

- **Band 7, 2, 1**

The MODIS Land Surface Reflectance product is most useful to distinguish burning scars from naturally low vegetation or bare soil and enhancing floods and clouds. Vegetation will appear green and burned areas appears reddish while clouds will appear in cyan color .The bands that have been used are Red = Band 7(SWIR=2105-2155 nm), Green = Band 2(NIR=841-876 nm), Blue = Band 1(VIS=620-670 nm).

The MODIS Land Surface Reflectance product is available from both the Terra (MOD09) and Aqua (MYD09) satellites; with the sensor resolution is 250 m. This technique will help to distinguish between the satellite image features, as Low clouds will appear white ,Vegetation's are green, Deserts are reddish brown ,Snow cover, while the high ice clouds are cyan ,Intense fire are orange or pink , Burn scars are orange or brown. False color technique changes the pixels values for the low clouds and ice clouds this helps to separate it from pixels of snow cover that take the shape of terrain, Figure-3.

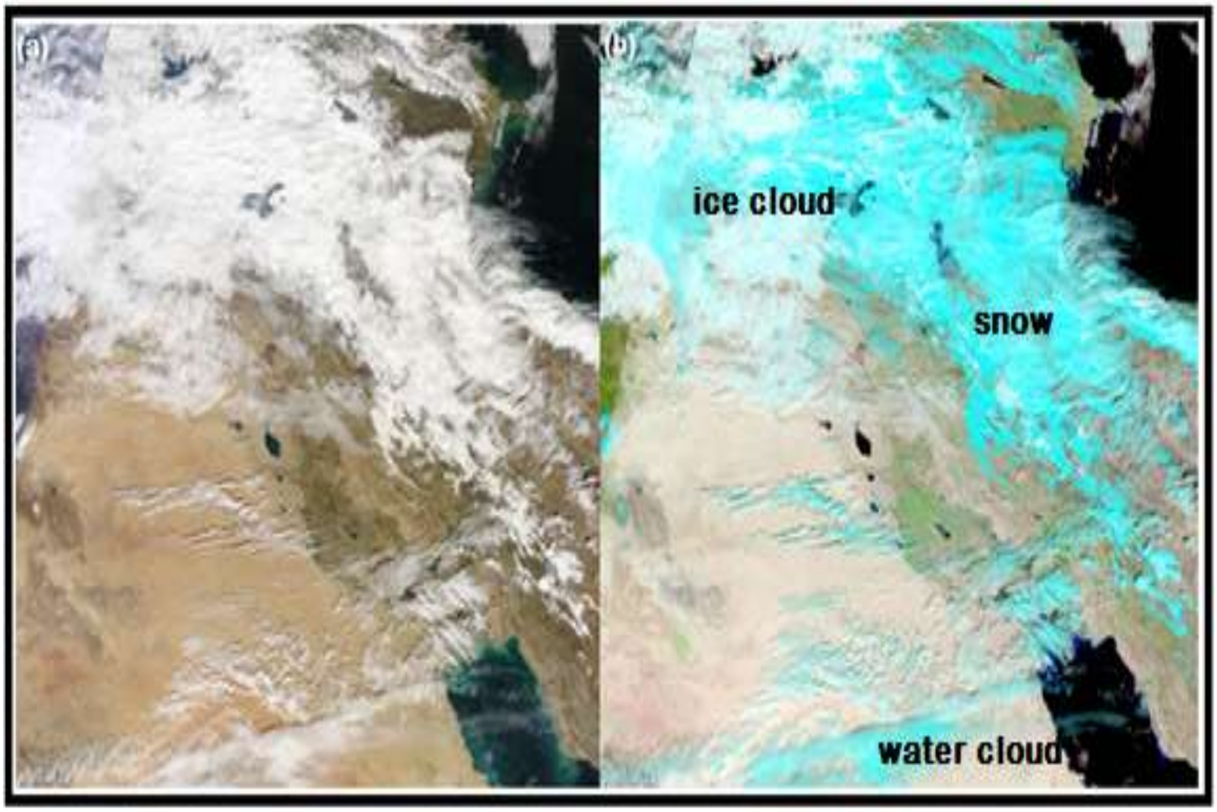

Figure 3-(a). Illustrates true color image band (1, 4, 3), (b). false color image band (7 ,2,1) shows snow cover the terrain in cyan color separating it from the clouds that have color range from white to cyan .

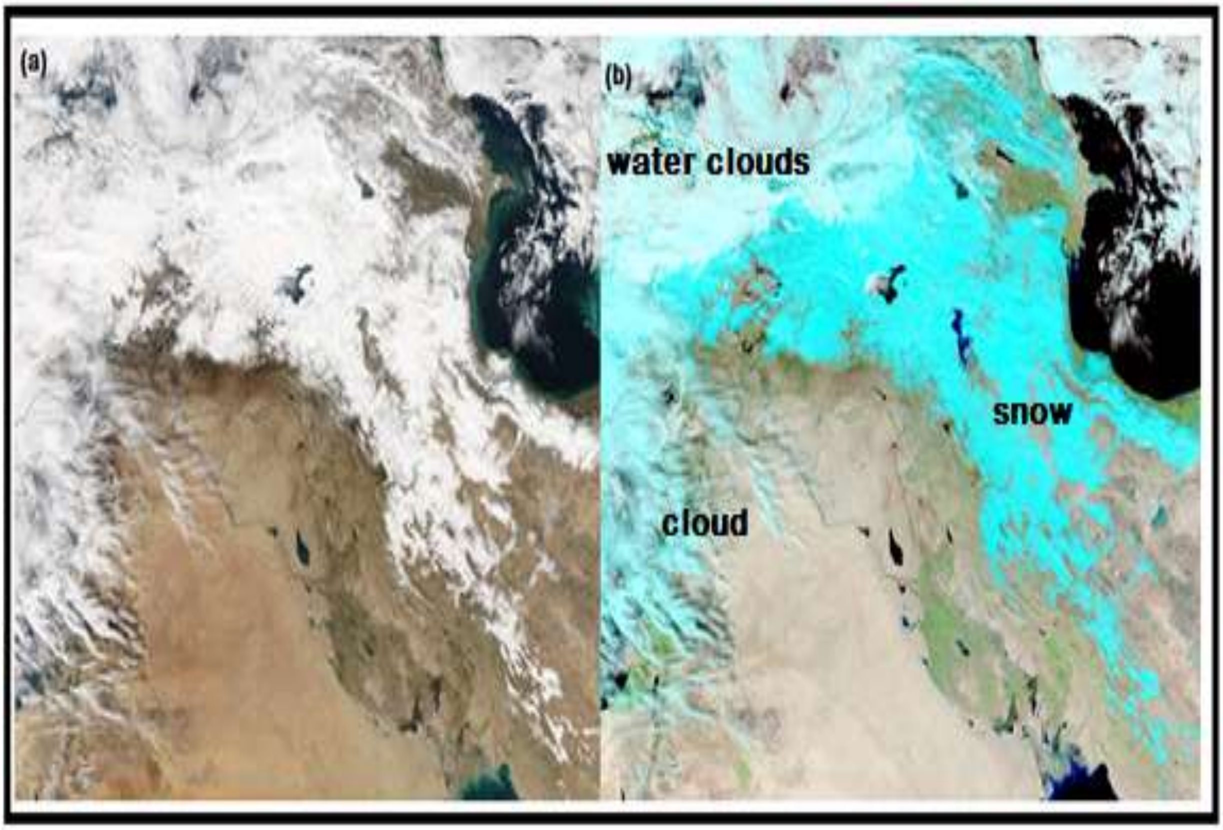

Figure 4- (a) representing true color image band (1, 4, 3), (b). false color image band (7, 2, 1).

- Bands 3, 6, 7

The MODIS Land Surface Reflectance product is most useful for distinguishing ice and water clouds from snow. Vegetation will appear green; clouds will appear in white or yellow white color, while snow appears in red color. The bands that have been used are red band 3 (359-379 nm), green band 6 (1628-1652 nm), blue band 7 (2105 – 2155 nm).

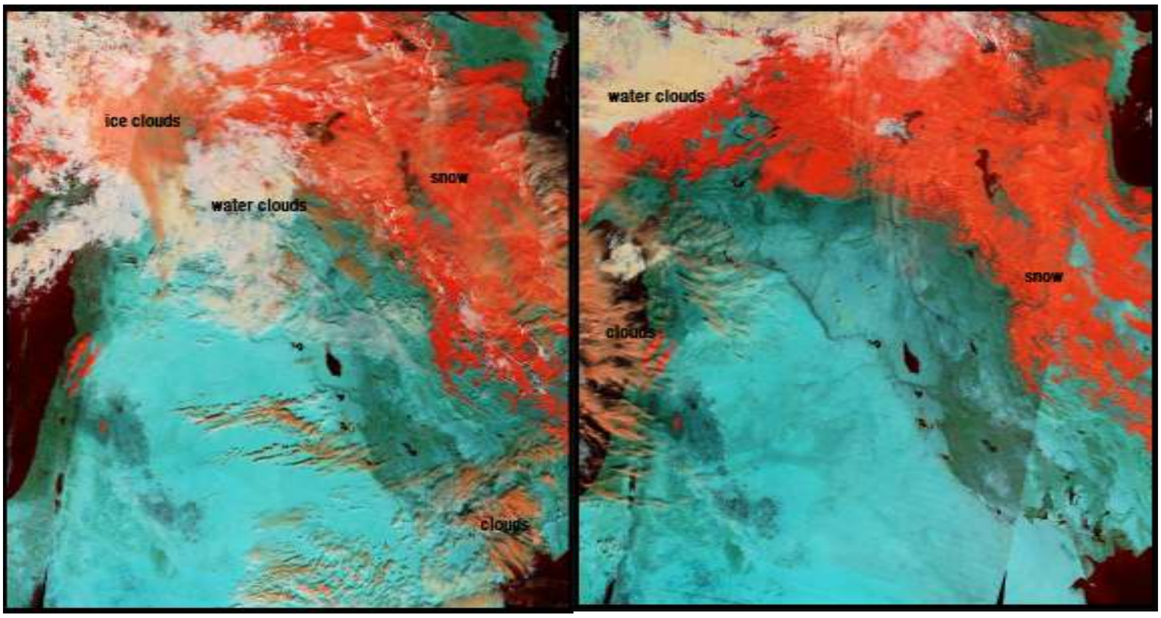

Figure 5- Producing false color image in band 3, 6, 7.

4.2. NDSI Normalized Difference Snow Index

At satellite reflectance in MODIS bands 4 (0.545- 0.565 µm) and 6 (1.628-1.652 µm) is used to calculate the normalized difference snow index (NDSI) as in equation one .The original satellite image was taken in 4-2-2017, which contains few clouds that abounds in the left side of the image, see Figure- (6.A). The results that can be obtained after applying the NDSI equation is such that dark color is the snow cover and the clouds are separated completely, as seen in Figure- (6.B). The Figures- (7.C&D) obtained when have been applied the false color method to make it easier for the human eye to distinguish between snow and clouds, which are difficult to separate them visually, and the blue and orange colors are a snowy cover.

While the original satellite image was taken in 5-2-2017, the clouds moved to cover most of the snow cover. When using the same equation, obtained the following: In the Figure- (7.B) that bright white represents the cloud cover while the dark white it represents the snow cover.

The Figures- (7.C & D) obtained by using false color method that leads the human eye to distinguish between them through the apparent colors, where blue and orange are snow cover while yellowish white is the cloud cover.

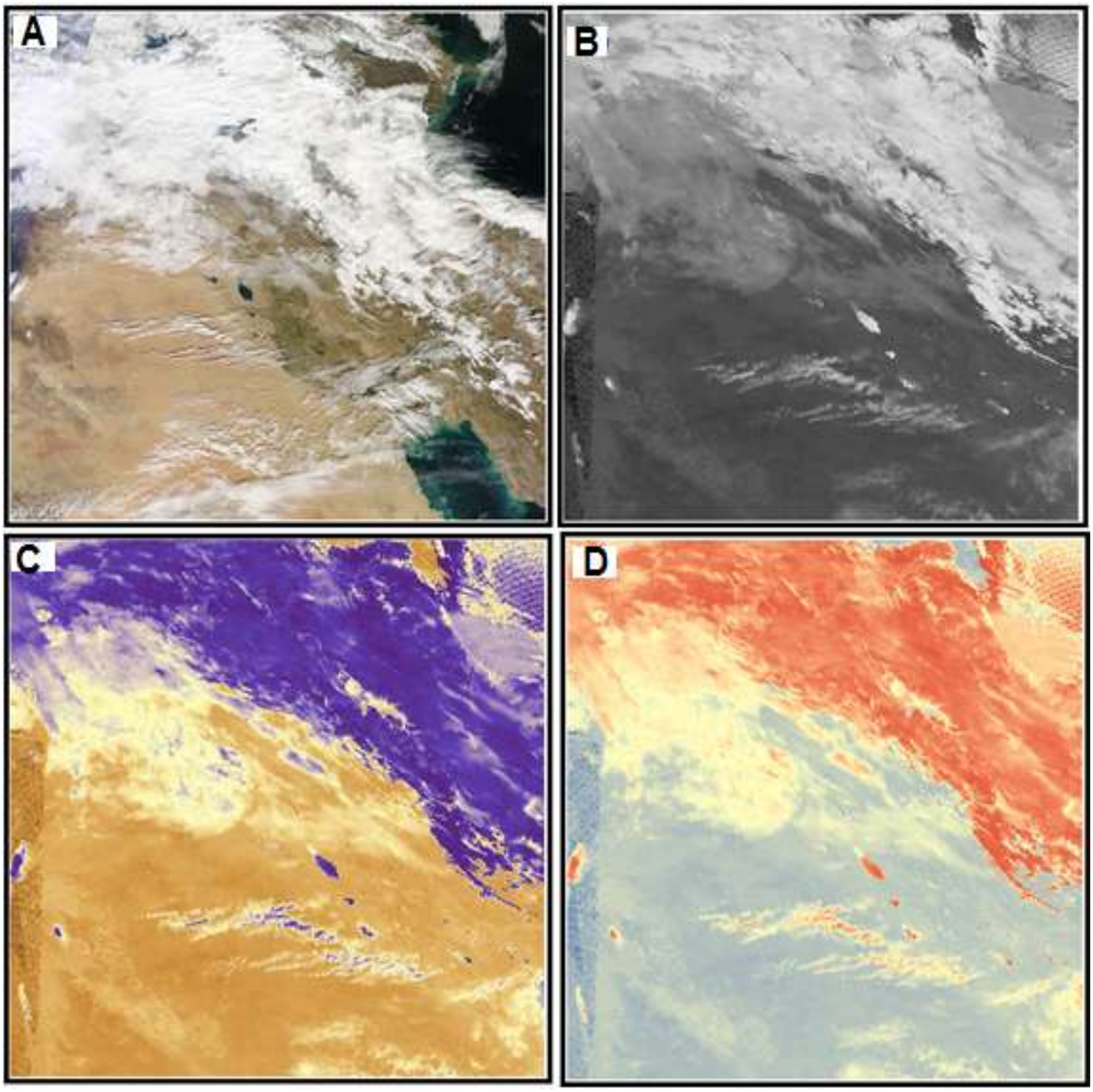

Figure 6- A. Show True Color Satellite Image. (B) Representing image after applying NDSI equation, (C, D) show NDSI in visible range of electromagnetic spectrum, in 5/2/2017.

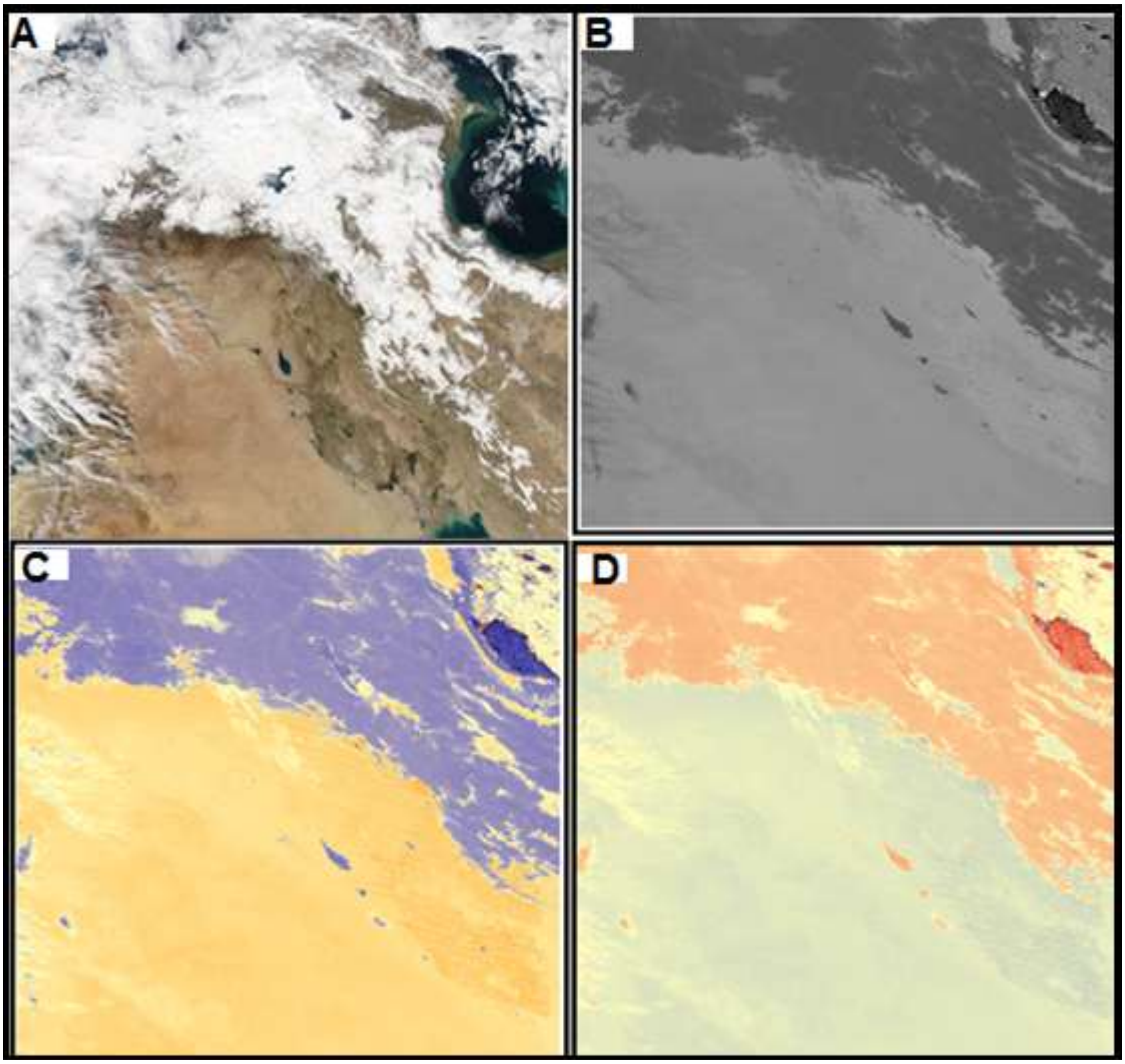

Figure 7- A. Show True Color Satellite Image. (B) Representing image after applying NDSI equation, (C, D) show NDSI in visible range of electromagnetic spectrum , in 4/2/2017.

4.3. Estimating fractional snow cover from MODIS using unsupervised classification

Once snow cover detected and separated from the cloud cover, also can be distinguished the snow cover that take the shape of terrain from other features using the unsupervised classification see Figure-8 The unsupervised classification technique is applicable to the images that result from the process NDIS [Figures (5.B & 6.B)], which can be obtained a variety classes of features, as illustrated in Figures (8.c & 8.d). In this method the snow cover is separated from the all other features. In Figure- (8.e), the orange color is representing the snow cover, while the Figure- (8.f) is showing the blue color as snow cover, and all other features represent as white color.

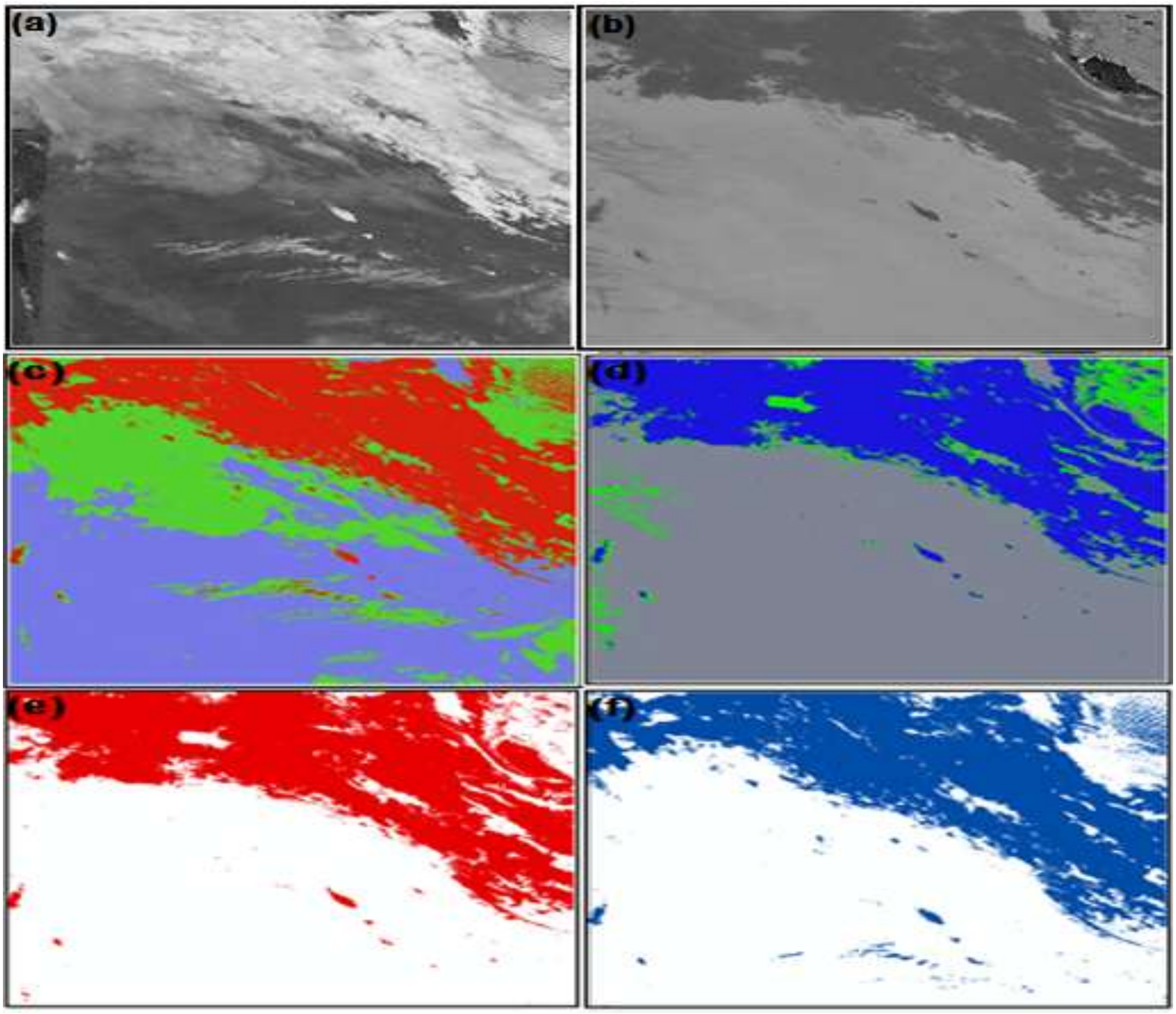

Figure 8-(a) NDSI Image 5/2/2017,(b) NDSI image 4/2/2017 (c ,d) unsupervised classification shows different classes including snow cover , while the (e,f) show the class of snow cover only.

Conclusion

1. False color method have given good result in separating snow cover from the clouds and other features , bands 7 , 2,1 and bands 3,6,7 , such as Figures-(3.a &4.b).
2. NDSI methods gave good results in separating snow cover from clouds and other features, as showing in Figures- (5.c&d)
3. Unsupervised classification methods used to get the snow feature only, as Figures- (7.e& f).

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