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GLACIER AND SNOW ANALYSIS USING MATLAB

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ABSTRACT

Climate change is one of the significant issues emerging worldwide. Even it is observed that polar region is much more vulnerable to climate change than other places. Its result could be easily visible on snow and glacier. This paper is dedicated to analyzing snow and glaciers through various factors like detection of snow, intensity and other factors by comparing with data available through MATLAB (MATrix LABoratory) toolbox. Matlab aids in easy computation, visualization in familiar mathematical notation. Moreover, data analysis is being done for previous 5 years with different season for better clarification. In this paper, data of LANDSAT-8 satellite is being used with image processing tools of matlab.

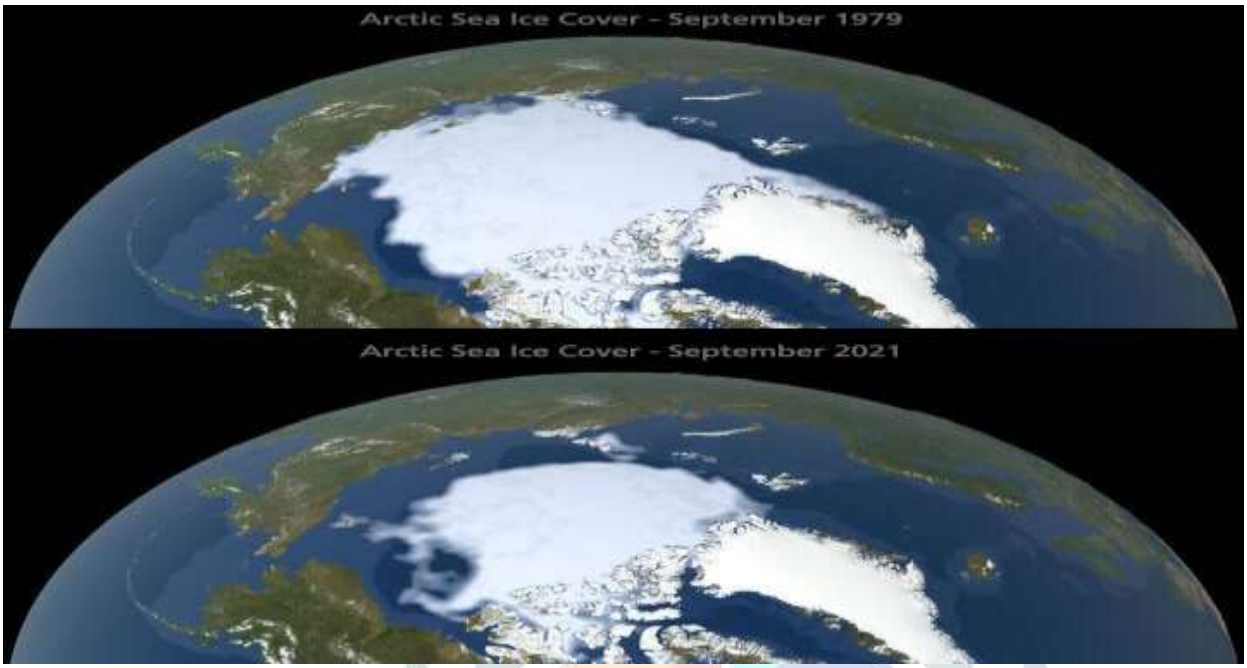
KEYWORD: MATLAB, Image Processing, Analysis

INTRODUCTION:

Approximately ninety percent of solar radiation reflected back when it hits the snow. According to UCAR in the arctic and Antarctic region average temperature rose by 3.1 and 3 degree Celsius [1]. Climate system are affected by climate change leads to decrement of glacier mass volume and swelling glacial lakes [2]. Snow and glacier analysis is very crucial while studying climate changes. Landsat data is widely accepted for snow cover mapping. Melting of snow or ice in Himalayan region is of utmost concern because due to climate changes many issues in terms of livelihood, agriculture would arise and in mountainous region most of these activities are depend upon glacier water [3].

As increment in greenhouse gases leads to trap more heat by absorbing long waves coming from earth. Increasing in sea level, melting of ice and snow, heatwaves, hurricanes and many more can be seen as significant result of it.

Fig1: Arctic region snow covered area from 1979 to 2021



Due to very fast changes in climate system, the glacial region of Hindukush–Karakoram–Himalaya (HKH) is usually referred as the 'water tower of Asia and stores large amount of water. It supplies approximately 80% flows to the Indus River during summer season and hence study around this area is being done [4].

Landsat 8 satellite Orbits the Earth in a sun-synchronous orbit which is near-polar orbit with inclination of 98.2 degree. The data captured by it is in visible, near infrared, and shortwave infrared portion portions of the electromagnetic spectrum and offers 15 meter panchromatic, and 30 meter multi-spectral spatial resolution. Landsat 8 carries two sensors, first is the Operational Land Imager sensor and the second is thermal Infrared Sensor [5].

The Thermal Infrared Sensor (TIRS) was provided to the Landsat-8 payload to continue thermal imaging that give support emerging applications such as evapotranspiration rate measurements for water management [6]. The Operational Land Imager (OLI) provides two brand new spectral bands in respect to the Landsat-7 ETM+ instrument in which one tailored especially for detecting cirrus clouds (band 9, new Near Infra-Red (NIR) band) and the other one for coastal zone observations (band 1, new deep blue visible channel). Comparisons of the resulting snow cover which is estimated from high spatial-resolution Landsat data for the Mount Everest region for different seasons in last decades using image processing toolbox [7].

Image process tool case provides a comprehensive set of reference-standard algorithms and advancement apps for image process, analysis, visual image, and algorithmic program

development. It helps to perform image segmentation, image improvement, noise reduction, geometric transformations, and image registration victimisation deep learning and type of ancient techniques of image process. The tool case supports process of second, 3D, and even a randomly massive pictures [8].

METHODOLOGY:

The basic of MATLAB code is the array of an real and complex element. These values are naturally represents the images values, intensity values and ordered set of colors. In MATLAB most of the data are saved as two dimensional in case of image in which each element represents the matrix corresponds to single pixel in the displayed image. Images sizes are displayed as 700*900 in which 700 are rows and 900 are column.

The images which downloaded here from LANDSAT-8 are RGB in nature that is the three dimensional array where the first plane represents the red pixel intensities, second plane represents the green plane intensity and the third plane represent the blue color intensity. For better understanding this rgb format of image is converted into gray form for better classification. Arithmetic tools of image processing is also used to get broader perspective regarding this. With this kind of availability of tools MATLAB becomes best for image processing system.

Imread and imshow command are used to read and show the image. The images are firstly compared on year basis and then on seasonal basis.

```
I = imread('C:\Users\adipa\Desktop\28_09_2020.jpg');
imshow(I);
J = imrotate(I,10,'bilinear');
figure, imshow(J);
[K,rect] = imcrop(J);
figure, imshow(K);
```

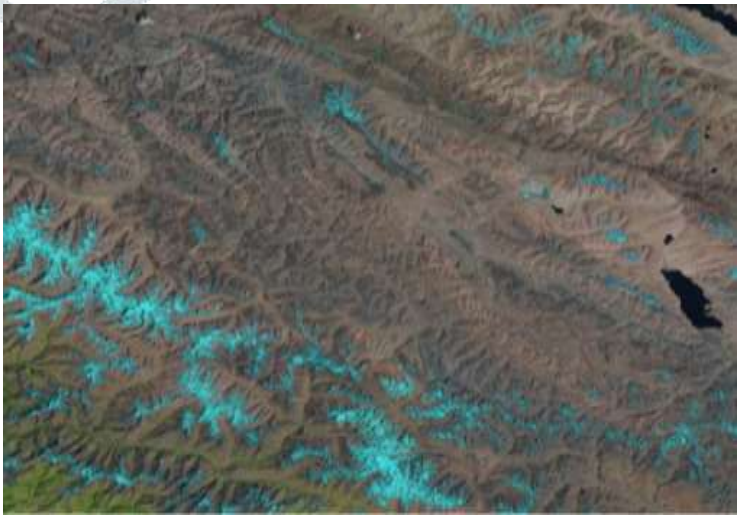


Fig2: Image dated on 28-09-2020

```
I=imread('C:\Users\adipa\Desktop\5_06_2013.jpg');
imshow(I);
J = imrotate(I,10,'bilinear');
figure, imshow(J);
[K,rect] = imcrop(J);
figure, imshow(K);
```

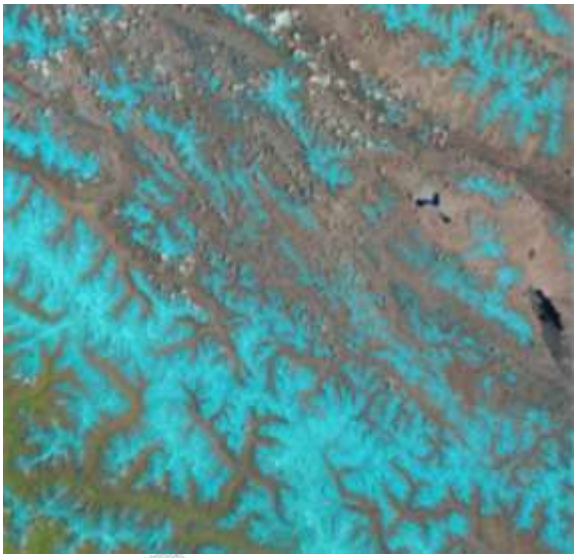


Fig3: Image dated on 5-06-2013

For better analysis of intensity and distribution this RGB images are converted into gray scale images and the output is of the same class as the input. Both the images are contrasted so than while contouring the difference between their intensity could be visible.

```
L = rgb2gray(J);
Figure
imshow(L);
```

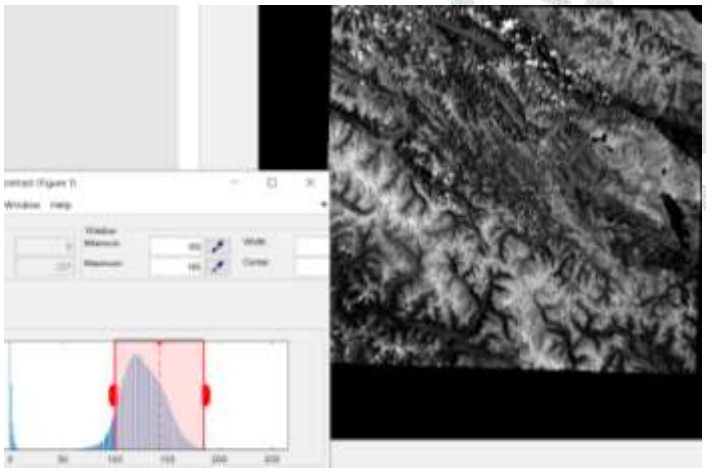


Fig 4 : 28-09-2020

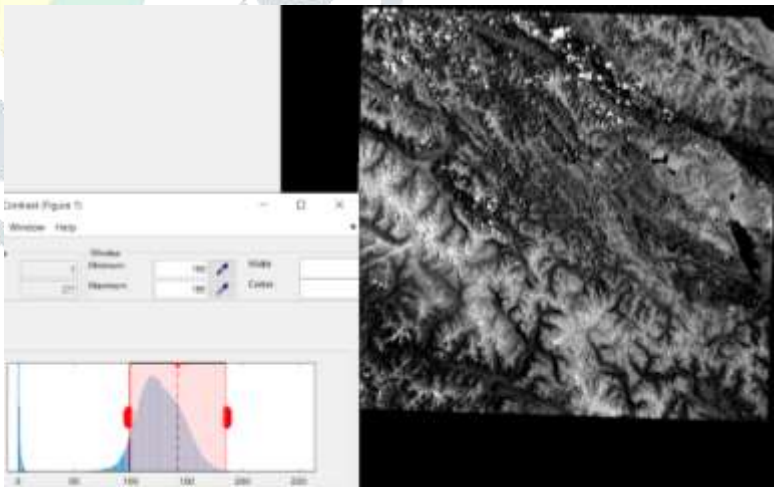


Fig5: 05-06-2013

The contour of each of those pictures are finished with the colorbar command.

```
M = imcontour(L);
```

Colorbar

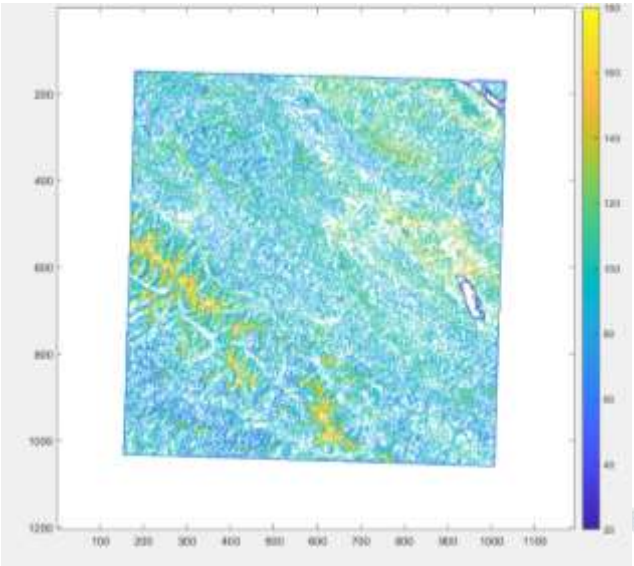


Fig6: 28-09-2020

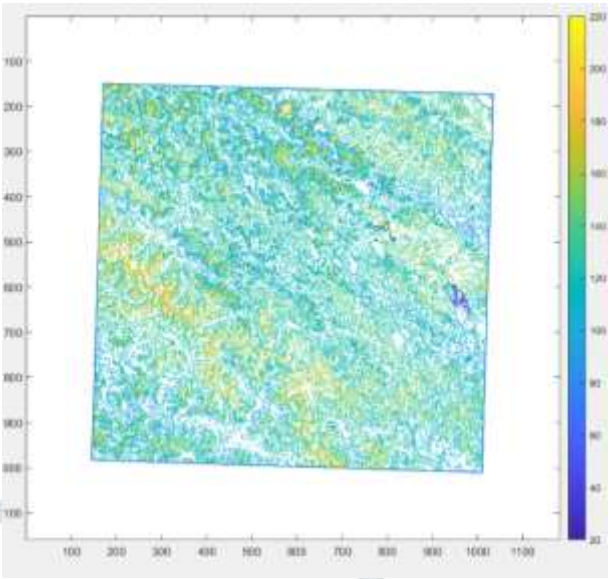


Fig7: 5-06-2013

imcontour(I) draws a contour plot of the grayscale image I and difference between the images taken on two different years could be easily seen.

Colorbar function is used to give the scale of the specific range of the object in the form of colors.

Airthmatic operations like mean, correlation and standard deviation also helps in anlysing the images.

For image dated on 28-09-2020

meanval = mean2(M);

= 5.602407387782016e+02

val = std2(M);

= 2.792793910662186e+02

O = medfilt2(M);

R = corr2(M,O)

R = 0.5581

For image dated on 5-06-2013

meanval = mean2(M);

= 535.149229100863

val = std2(M);

= 2.703233904394093e+02

O = medfilt2(M);

R = corr2(M,O)

R= 0.5640

Create boundaries of snow by using im2bw converts the grayscale image I to binary image BW, by replacing all pixels in the input image with luminance greater than level with the value 1 (white) and replacing all other pixels with the value 0 (black).

```
BW = im2bw(L);
imshow(BW)
```

Fig 8: 28-09-2020

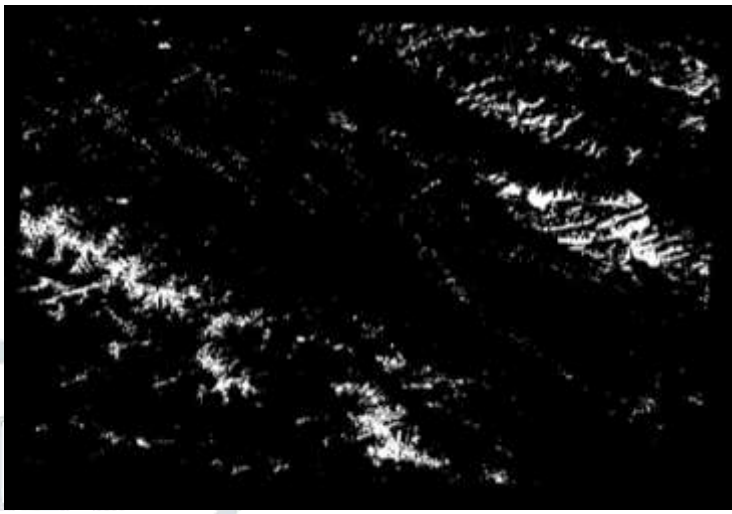


Fig 9: 5-06-2013

Finding the edges in images also help in such a way that this function returns a binary image BW1 containing 1s where the function finds edges in the grayscale or binary image I and 0s elsewhere.

```
BW1 = edge(BW,'Canny');

 imshow(BW1);
```

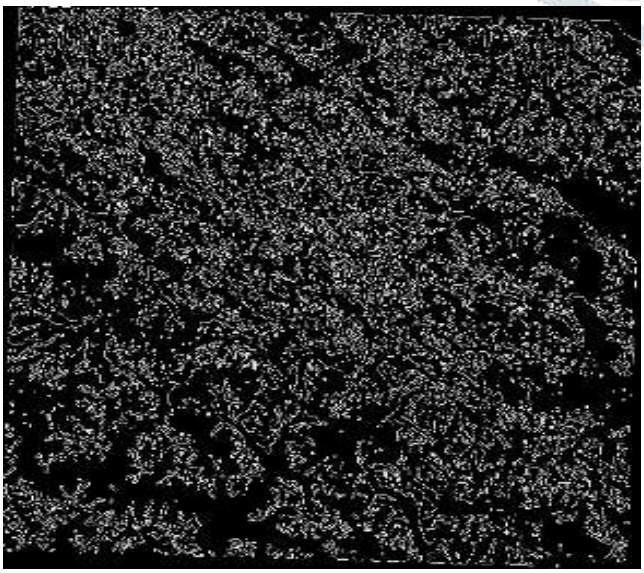


Fig 10: 5-06-2013

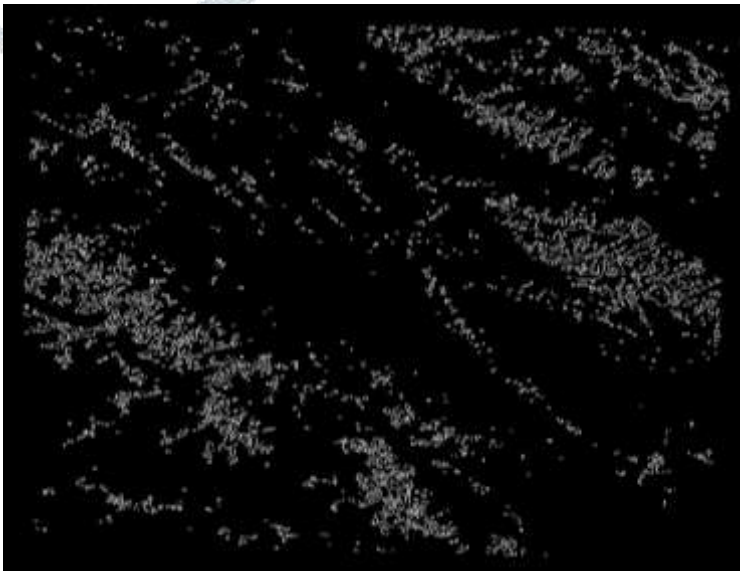


Fig 11: 28-09-2020

RESULT AND DISCUSSION:

The image processing toolbox used successfully in completion of analyzing the snow and glacier near Himalayan region in Asia. Season based comparison could also be done in same way but the only difference are that it won't show great difference in intensity with image processing. For such deep analysis deep learning could become very handy as the proper clusters of data and daily basis analysis would become more clear. The maximum and minimum temperature near Himalayan region and polar region are increasing day by day and tend me increase more in future if proper precaution would not be taken.

It is very much important to built snow monitoring system and high altitude weather stations so that proper analysis od data could be done. Not only Himalayan regions are getting affected with this but Antarctic region is also very much affected results in disturbing the Antarctic organism and hence ecosystem[9].

Expansion mechanism due to climate change are creating a lot of hazards. Like in Tibetan region mechanism of debris contact proglacial lake facilitates threat of flood, agricultural loss and may more [10]. Hence, it is very much crucial to take proper steps regarding the climate change and save the ecosystem.

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