The processes in the proposed model are:

1. The first step is the collection of data from BHUVAN.
2. The second step is the preprocessing of the data using QGIS to classify images into water and other.
3. The third step is the converting of RGB images to gray scale images.
4. The fourth step is to resize the images manually and calculate the surface area of water.
5. The fifth step is to plot water level vs. time graph.

DATA COLLECTION

For gathering data, we used a tool called Bhuvan to extract LIS III images. The steps followed to extract data using Bhuvan are:

1. Open Bhuvan portal (https://bhuvan.nrsc.gov.in/bhuvan_links.php).
2. Create an account.
3. Open data archive.
4. Select subcategory as LIS III and under select area select tiles.
5. Now select the area (76.25E9.5N-76.5E9.75N).

Five sets of images are formed .They are:

- Set I is formed by grouping 3 images (December 2011, February 2012, February 2013) with a time gap of approximately 1 year.
- Set II is formed by grouping 2 images (December 2011, February 2013) with a time gap of approximately 2 years.
- Set III is formed by grouping 2 images (January 2008, December 2011) with a time gap of approximately 3 years.

- Set IV is formed by grouping 2 images (January 2008, February 2012) with a time gap of approximately 4 years.
- Set V is formed by grouping 2 images (January 2008,february 2013) with a time gap of approximately 5 years

The images obtained from Bhuvan portal are of LIS III and are grey scale.

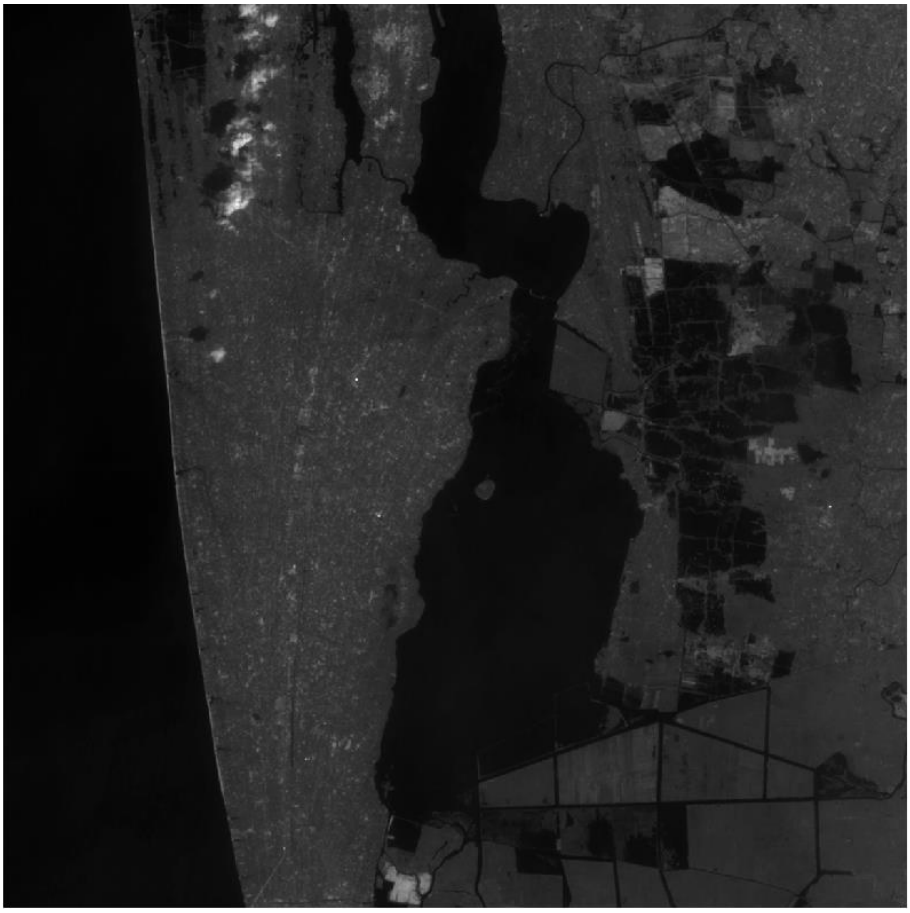

Fig 4.2: LIS III image of the region 76.25E9.5N-76.5E9.75N, Date: JAN 2008

CLASSIFICATION OF IMAGES

After the collection of data which is in LIS III format, collected data need to be pre-

processed and classified in a supervised form. For that purpose we use QGIS. A plugin inbuilt in QGIS called “semi-automatic plugin” was installed for the purpose of classification. Using the semi-automatic plugin, a band set is created and the band is processed. After this a training set is created and band processing is done. The training set is used to train the different band set images. While training, areas of water and others are selected manually to colour them in white and black respectively. Once training is completed, classifies images are obtained. The images are classified into areas of water and others.

The steps used to classify images into water and others using QGIS are:

1. Install semiautomatic plugin.

   To install semi-automatic plugin, Open QGIS. Under plugins, search for semi-automatic plugin and click install.

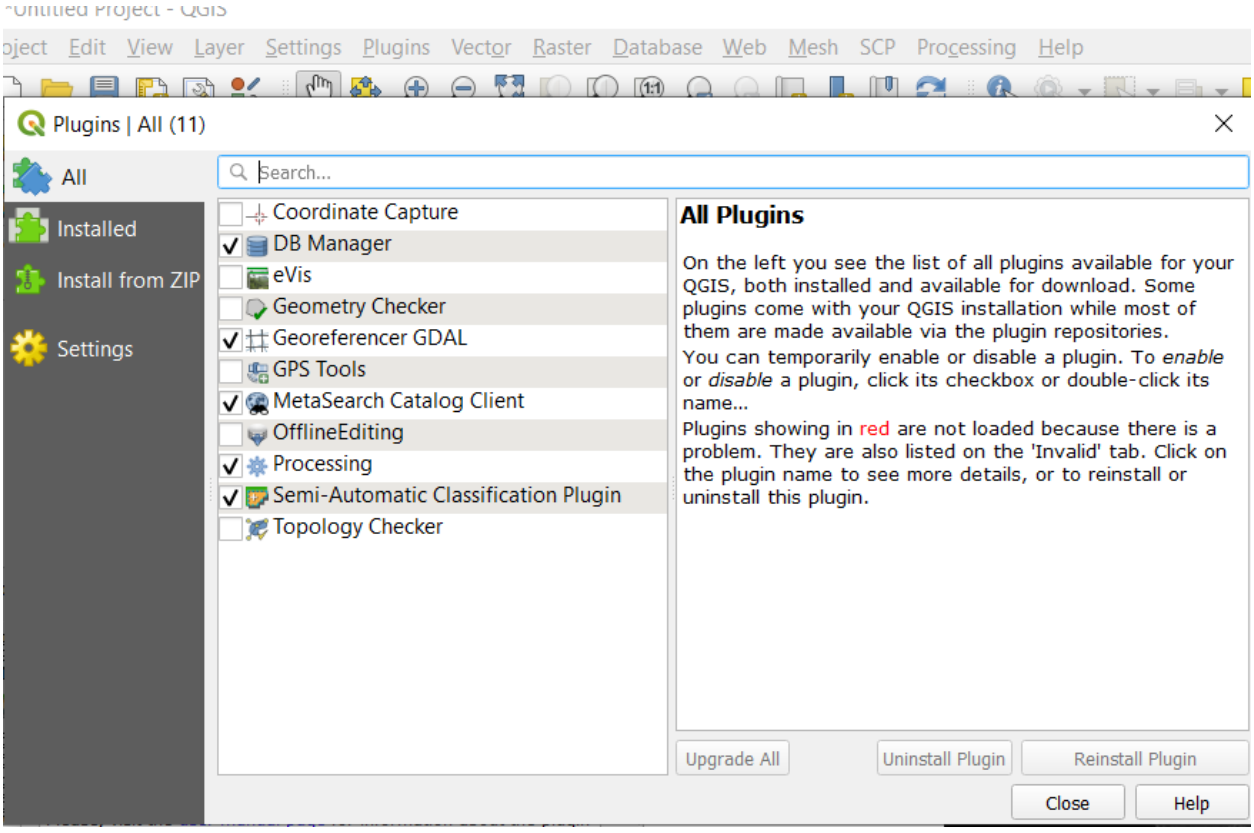

Fig 4.3: Semi-automatic plugin installed

2. To add image to QGIS, click layer and under it select add layer. Then click add

raster layer.

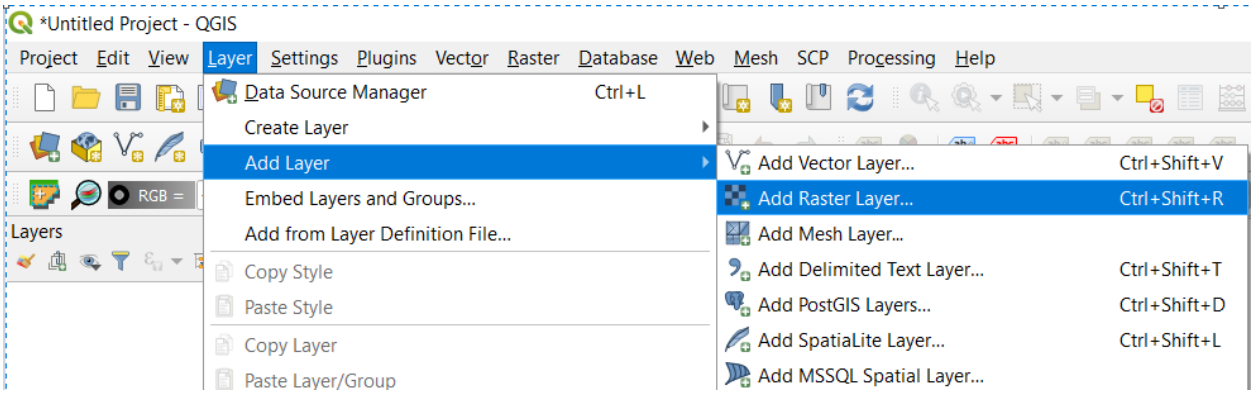

Fig 4.4: Adding Raster layer

A window will be opened where you can browse and select the image. Image will be in the form of 4 bands. Select them and then click Add.

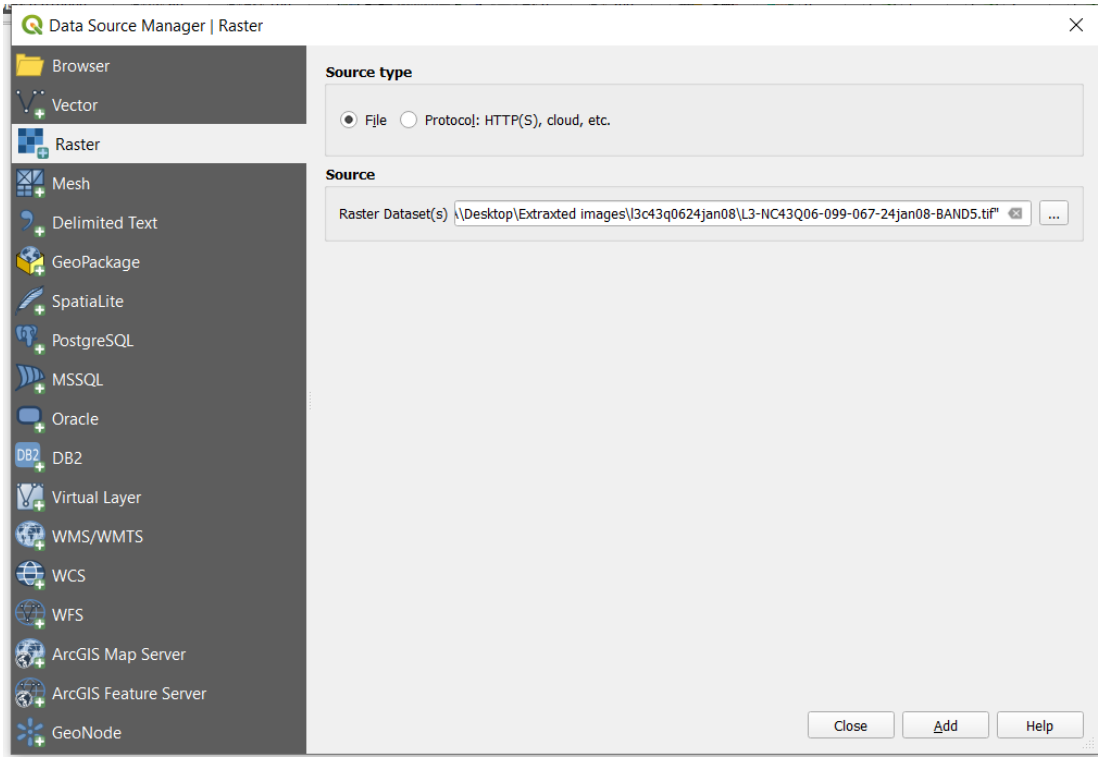

Fig 4.5**:** Adding image to QGIS

3. Now select semi-automatic plugin and under band set create band set.

   To create band set select band set. Refresh it then. Add all bands to form band set

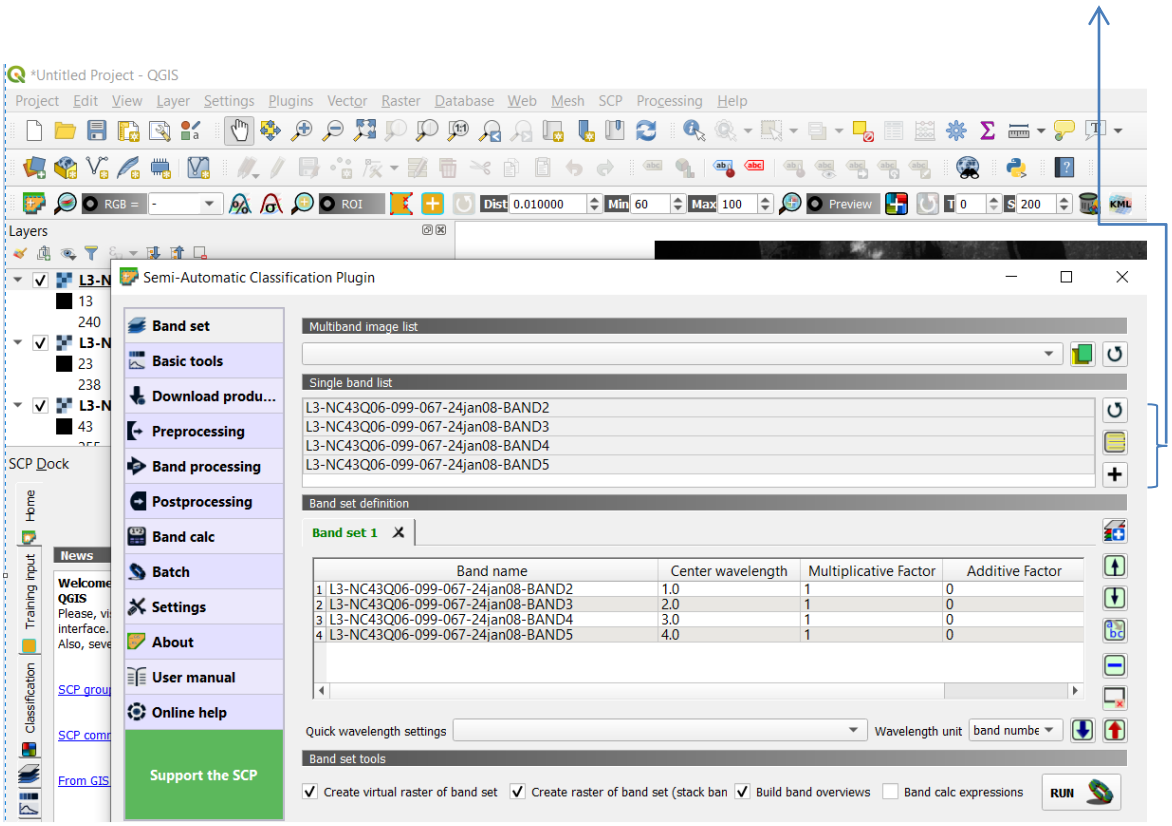

Fig 4.6: Adding band set

Tick the boxes as shown in fig 4.5. That is tick the boxes Create virtual raster of band set, Create raster of band set and Build band overviews.

Once added select Run. A new window will pop from which you can select folder. Once selected click select folder.

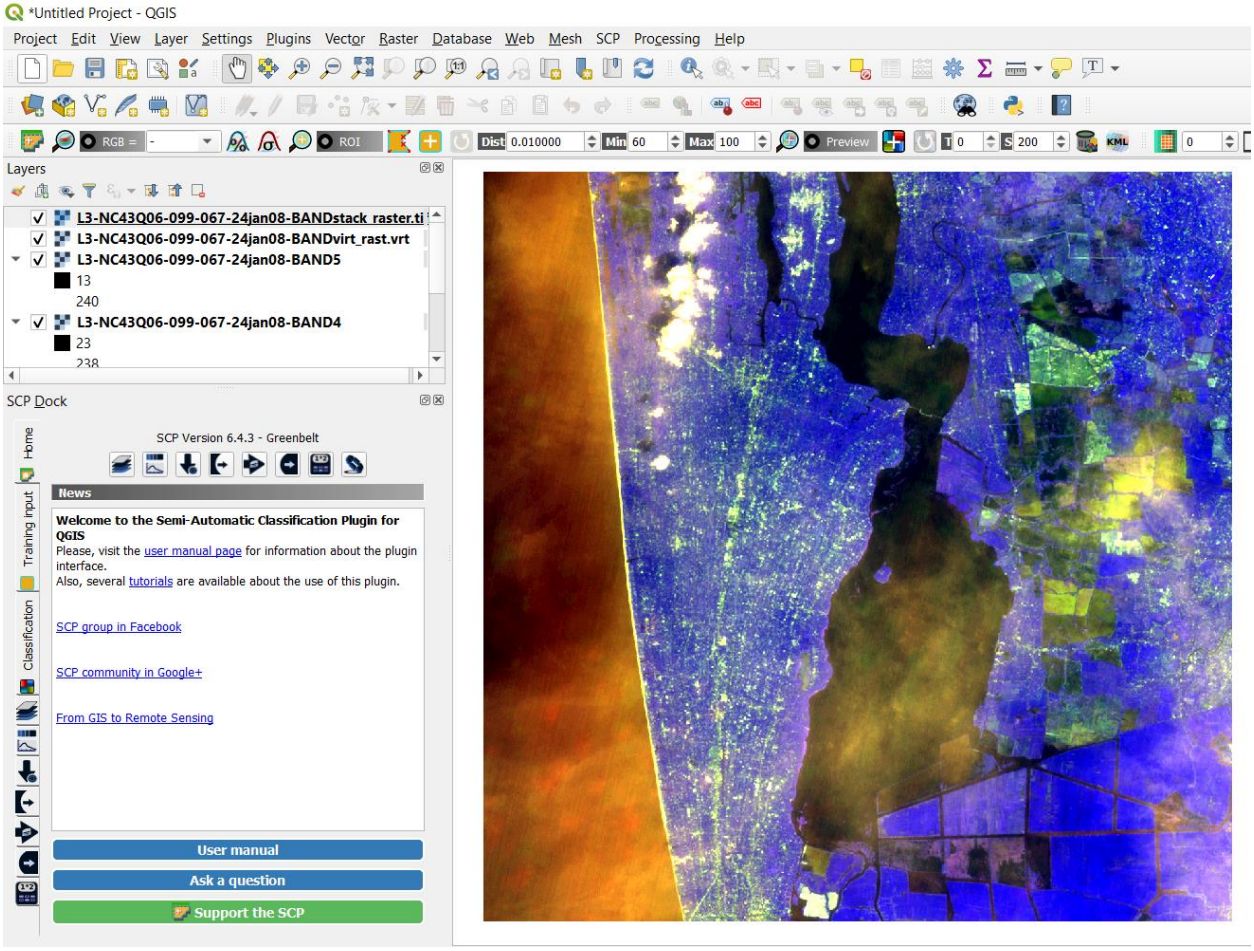

Fig 4.7: After adding band set

4. Band Processing

   Band processing is done by first select the semi-automatic plugin. Once selected choose band processing. Under it select PCA and select number of components as 2.

   Once selected, Click Run button.

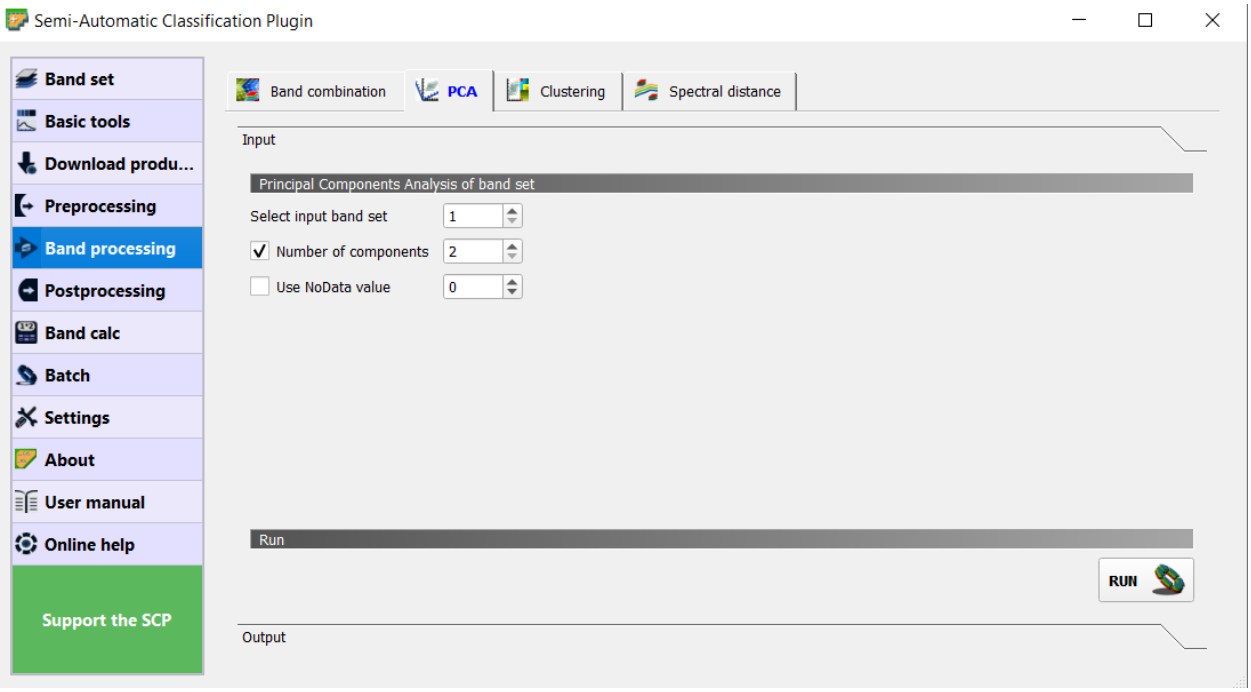

Fig 4.8: Band processing

5. Remove unwanted band.

   Compare PCA band2.tif with PCA band1.tif and select appropriate one. For selecting appropriate one check which one is more accurate in demonstrating water correctly.

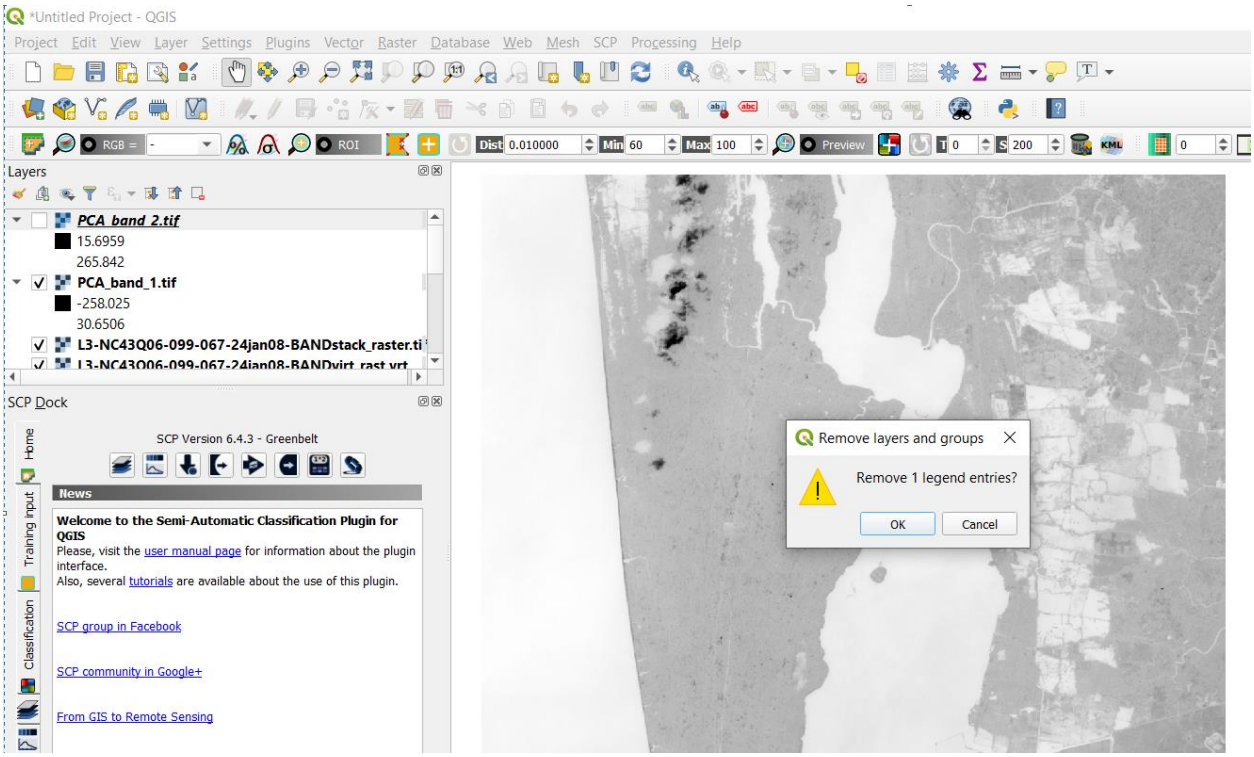

Fig 4.9: Removing unwanted band

6. Create a training set.

   Select new training and create a name and save it.

   Create new training

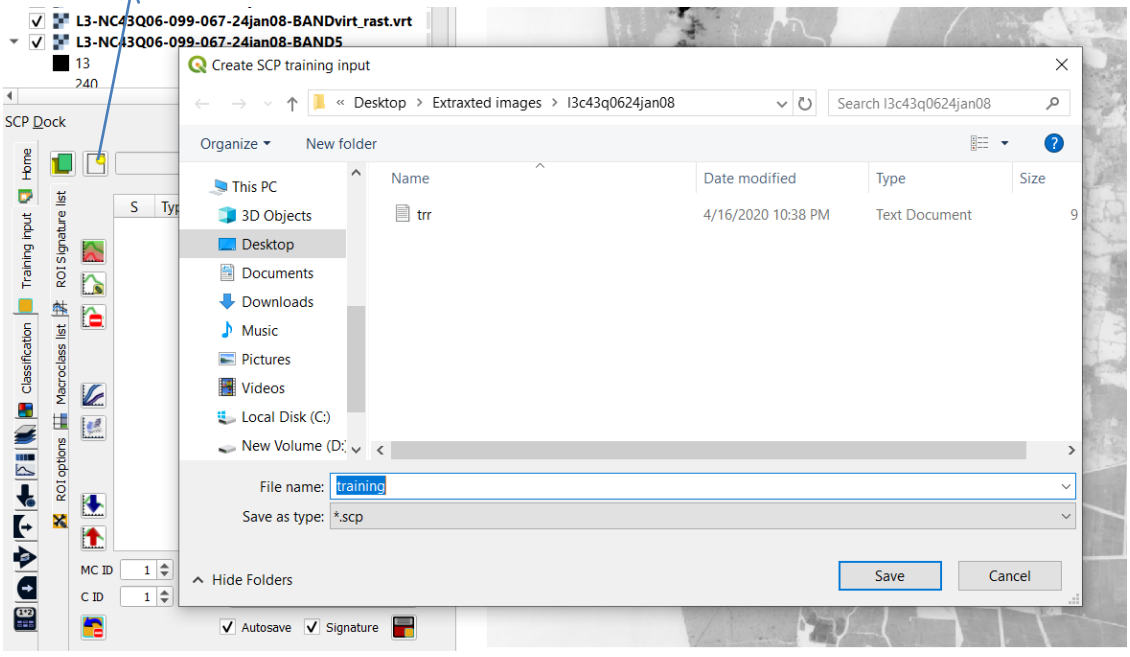

Fig 4.10: Create a training input

7. Train the model by activating pointer and then selecting the region using the same.

   Change info as other and select save temporary ROI

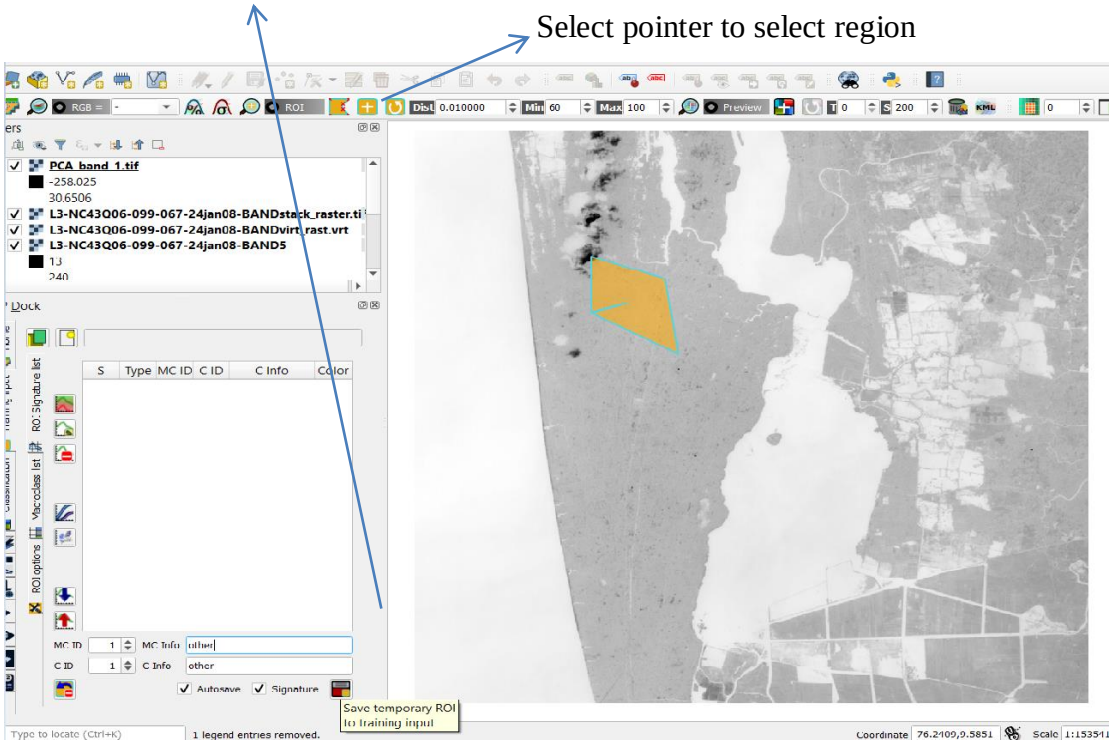

Fig 4.11: Train the model

Repeat the same for water. While doing, change id to 2.

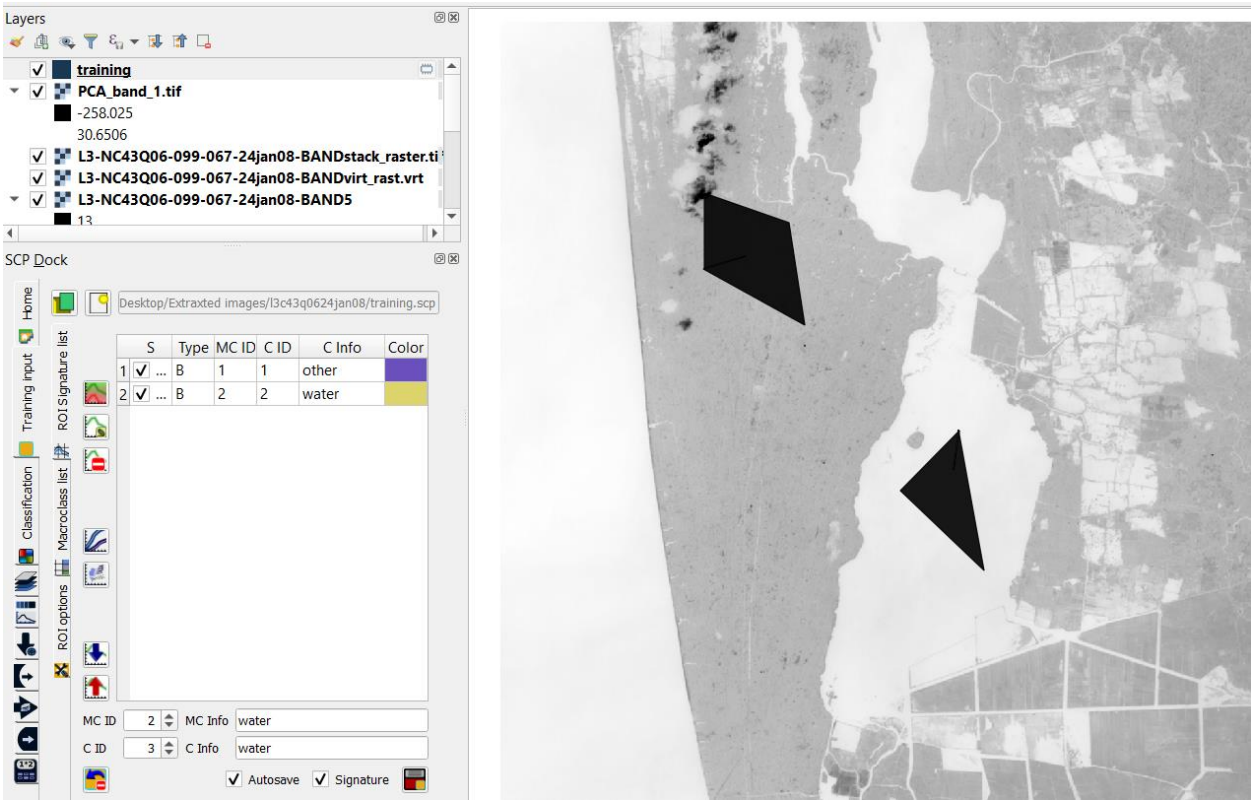

Fig 4.12: After Training the model

8. Change colours

   Set colours of other as black and water as white.

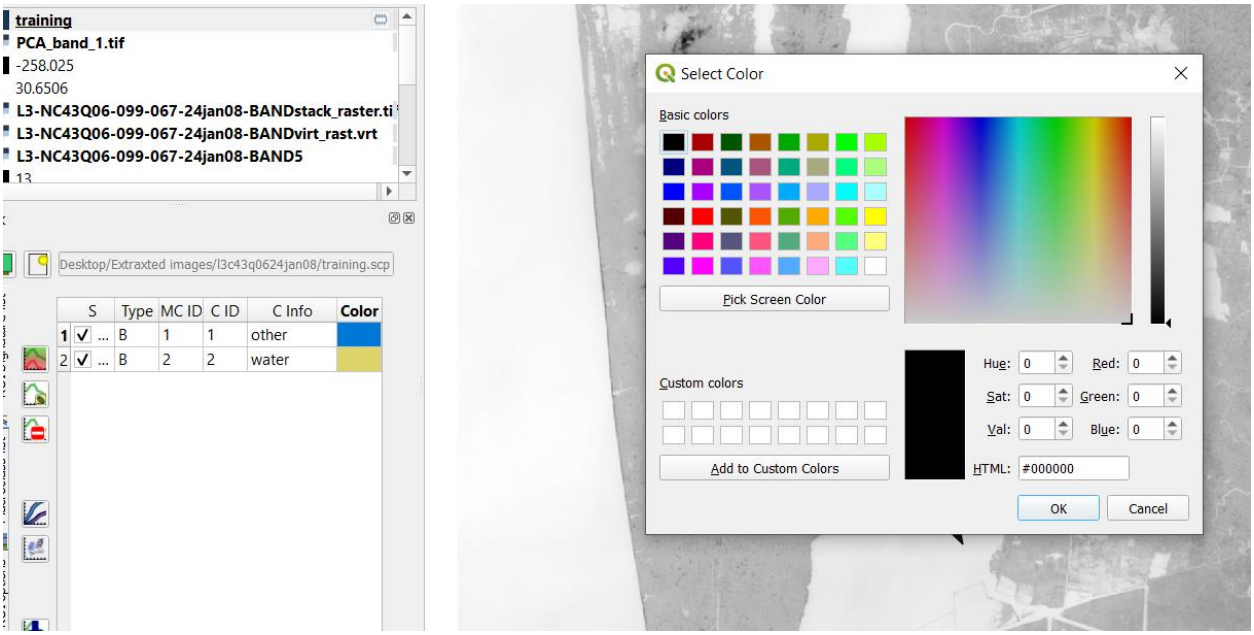

Fig 4.13: Set colors

Repeat the same by changing colour of water to white.

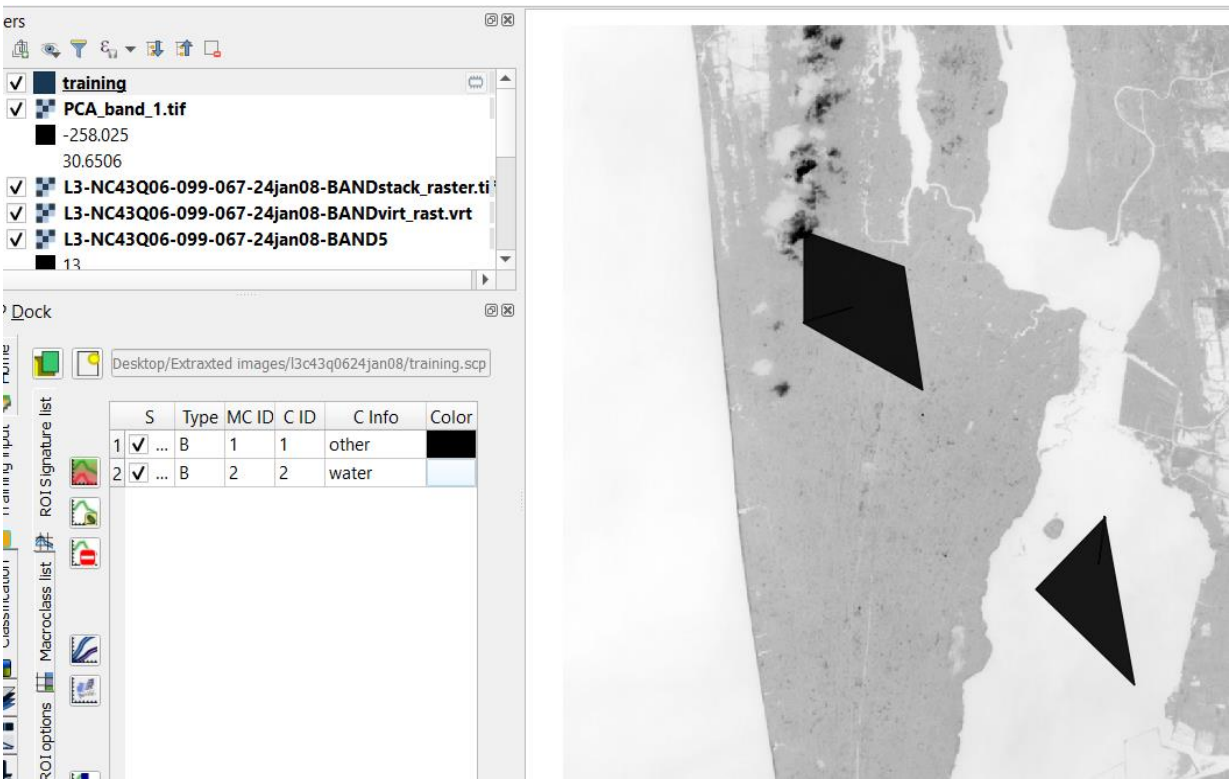

Fig 4.14: After setting colors

Under training input select Macro class list and then reassure changing of colours by changing it once again as in fig 4.13 and fig 4.14

.

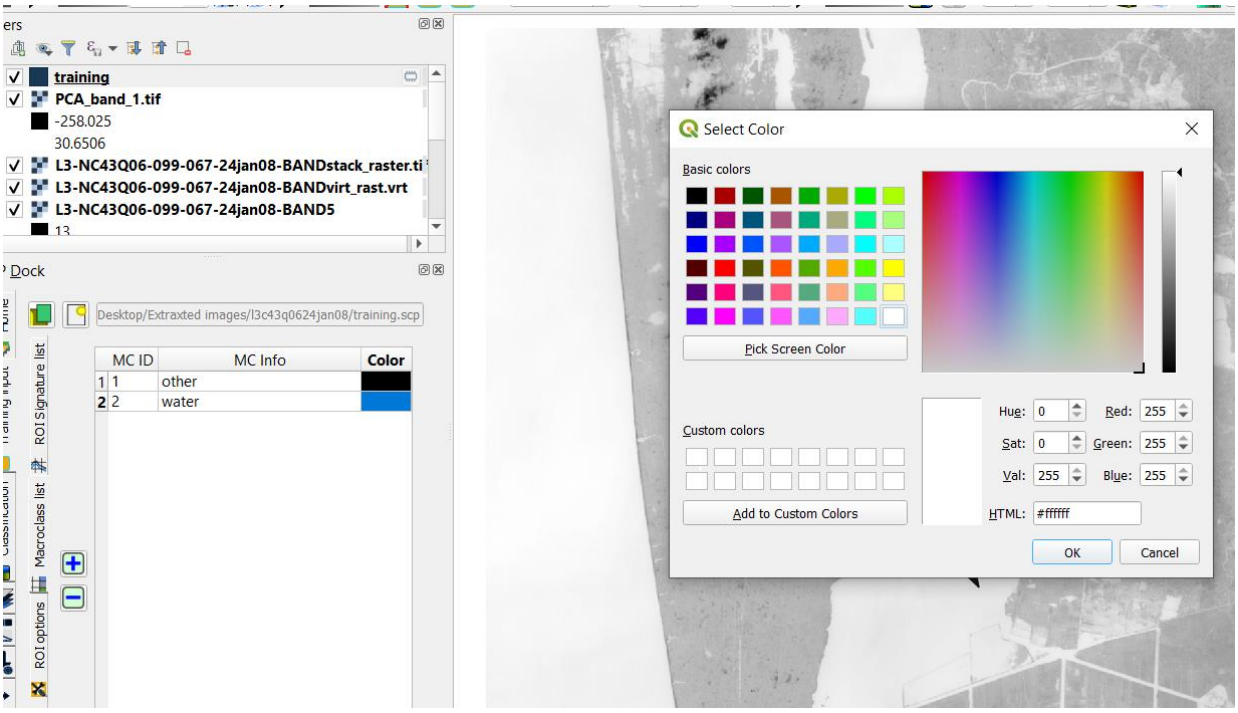

Fig 4.15: Set colors using macro class list

9. Classify

   To classify the image using the training set created, select classification and tick MC ID and run the algorithm.

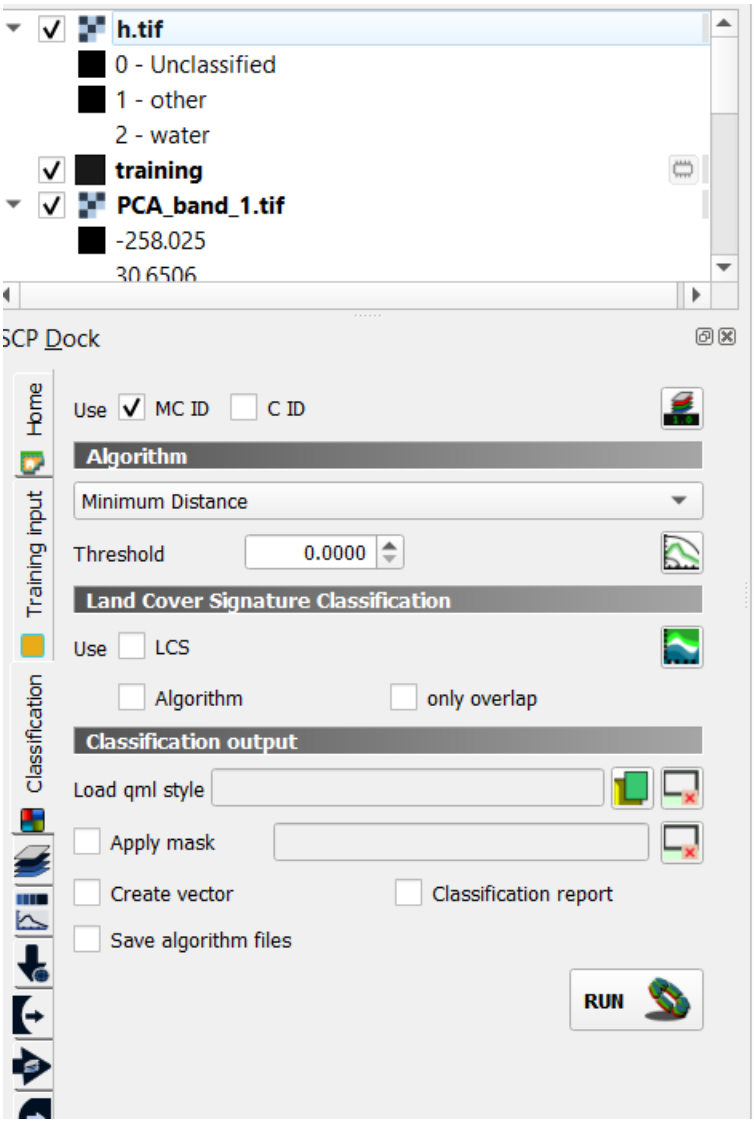

Fig 4.16: Classify

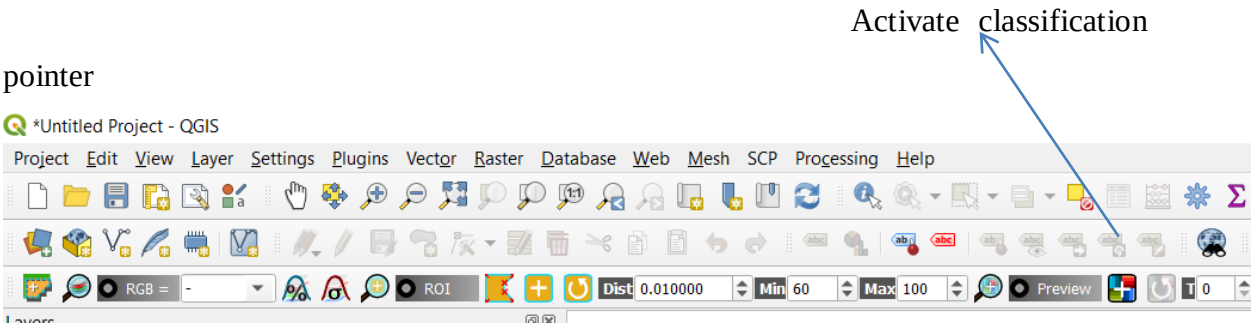

Fig 4.17: Activating classification pointer

The output of this yield classified images with water represented as white pixels and

other areas as black pixels [7].

Fig 4.18: Classified image of the region 76.25E9.5N-76.5E9.75N, Date: JAN 2008

Fig 4.19: Classified image of the region 76.25E9.5N-76.5E9.75N, Date: DEC 2011

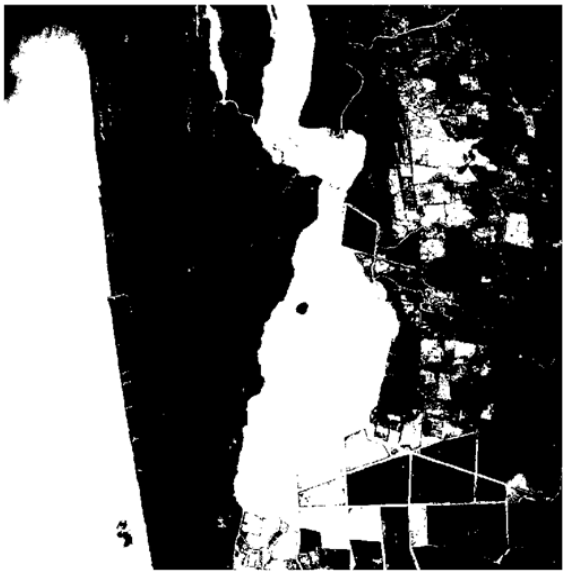

Fig 4.20: Classified image of the region 76.25E9.5N-76.5E9.75N, Date: FEB 2012

Fig 4.21: Classified image of the region 76.25E9.5N-76.5E9.75N, DATE: FEB 2013

Fig 4.22: Classified image of the region 69.5E22.5N-69.75E22.75N, DATE: OCT 2008

MATLAB CODE TO FIND THE AREA

MATLAB provides many inbuilt functions. Imread() function in MATLAB helps in reading the image file. Imshow() helps in showing the image file. The output of the previous section, that is, classified black and white images are read into MATLAB and are processed. In MATLAB, we convert the rgb image to gray scale image using the function rgb2gray().A function called bwarea() helps in calculating the surface area of white pixels in the image. Bwarea () estimates the area of all of the on pixels in an image by summing the areas of each pixel in the image. In bwarea(),the area of an individual pixel is determined by viewing at its 2-by-2 neighbourhood[6]. There are six different patterns, each representing a different area:

- Patterns with zero on pixels (area = 0)
- Patterns with one on pixel (area = 1/4)
- Patterns with two adjacent on pixels (area = 1/2)
- Patterns with two diagonal on pixels (area = 3/4)
- Patterns with three on pixels (area = 7/8)
- Patterns with all four on pixels (area = 1)

MATLAB CODE

The below code displays and calculates the surface water area of the grayscale classified image Of January 2008.

```
BW = imread('C:\Users\GAHANA\Desktop\Classifies images\jan2008ori.png');
Aw=rgb2gray(BW);
imshow(Aw);
bwarea (Aw);
```

The functions used in this code include imread(),rgb2gray(),imshow() and bwarea().

The same code is used with a change in file name in the imread() is used to calculate the surface area of water of that image. Using this feature we can calculate surface water area of all captured images.