PRACTICAL EXERCISE (OPTIONAL)

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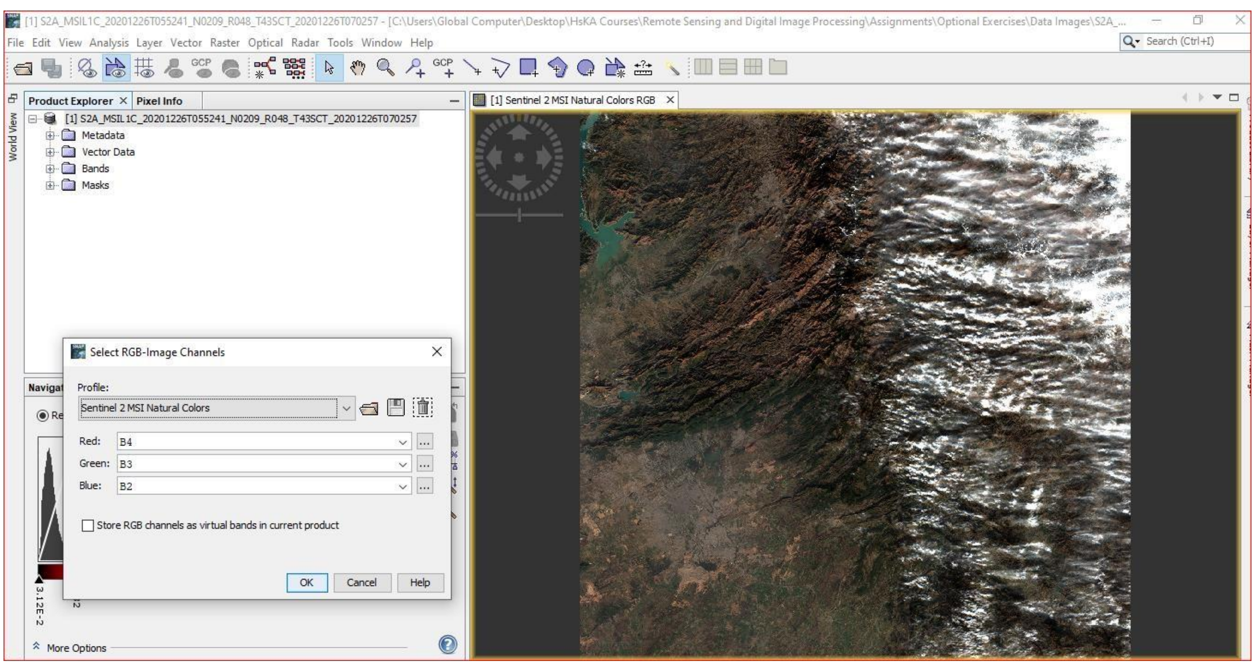
Exercise 1

BASIC SENTINEL-2 DATA EXPLORATION

Sentinel-2 records thirteen different intervals of the electromagnetic spectrum, from a minimum of about 440 nm to a maximum of about 2190 nm, and with spatial resolutions of 10, 20, and 60 m (Drusch et al., 2012). The three bands B2, B3, and B4 which roughly correspond to blue, green, and red light, respectively, are typically used to generate “true color” products by directly mapping these band reflectance to pixel RGB values. However, combining these three bands directly results in images with overly saturated colors (green vegetation is the typical case) and sometimes unrealistic colors.

DATA ACQUISITION AND PROCESSING

The Sentinel II imagery was acquired with by using Sentinel Hub website. The study area District Abbottabad for which the image was acquired lies in Northern West province of Pakistan. The acquisition date of image is June 07, 2020 and it was chosen because it has a very low cloud cover and also June is best month in regard to maximum green cover on the land.

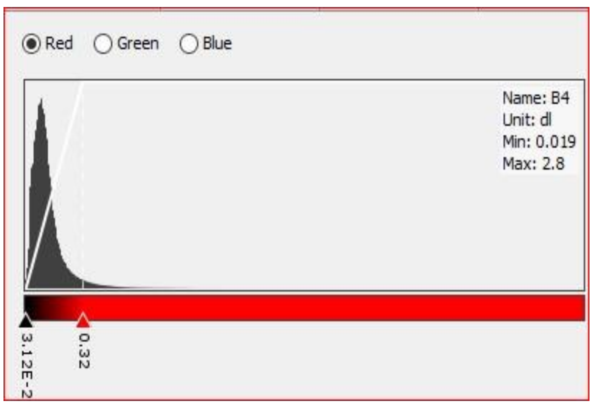


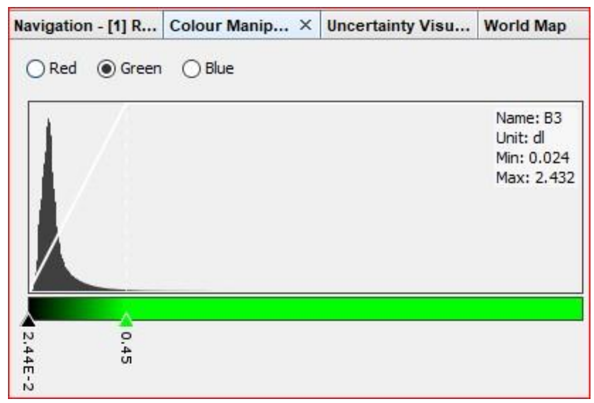
Computing Statistics of RGB Natural Composite

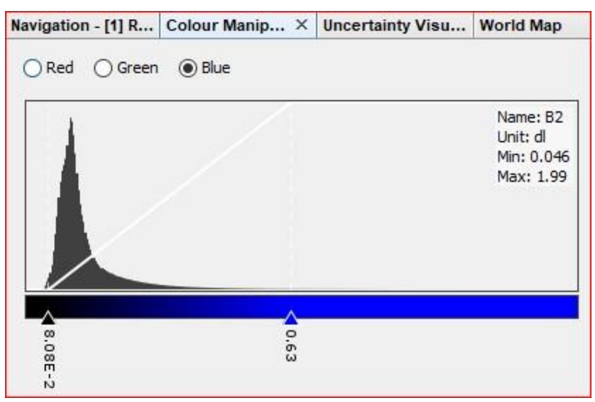
In order to compute statistics and look into the maximum and minimum reflectance values for each band we can click on Rough Statistics which gives the boundaries

The RGB image in SNAP is built using the red, green and blue bands of Sentinel-2 MSI: respectively bands 4, 3, 2 (as you can see on the snap shot, those bands are selected by default). The "Profiles" in this case are predefined color composites to visualize.

The Color Manipulation tool window is used to modify the colors used in the image. Depending on the type of the source data used for the images







Exercise 2

COMPUTE NDVI AND CREATE CROP/VEGETATION MASK

WHAT IS NDVI?

Normalized Difference Vegetation Index (NDVI) quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs).

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

NDVI ranges from -1 to +1. But there isn't a distinct boundary for each type of land cover. For example, when you have negative values, it's highly likely that it's water. On the other hand, if you have an NDVI value close to +1, there's a high possibility that its dense green leaves. But when NDVI is close to zero, there aren't green leaves and it could even be an urbanized area.

NDVI CALCULATION IN SNAP SOFTWARE:

DATA COLLECTION

For the calculation of NDVI the Sentinel II imagery was acquired with by using Sentinel Hub website. The study area District Abbottabad for which the image was acquired lies in Northern West province of Pakistan. The accusation date of image is June 07, 2020 and it was chosen because it has a very low cloud cover and also June is best month in regard to maximum green cover on the land.

METHODOLOGY

The downloaded was then imported into SNAP software. There are basically two methods to calculate NDVI in SNAP, these are;

1. By *Band Math* adding the bands manually by subtracting and adding NIR and Red Bands. It allows us to calculate underline pixel values in each band.

2.The second one is by using Optical Tool bar and then going into Thematic Land Processing and then to NDVI.

Using the Band Math, Band 8 which is the Near Infrared Band was subtracted with Band 4 which is Red Band and similarly they were added in the de nominator in order to get a ratio between these two bands.

$$\text{NDVI} = \frac{NIR-R}{NIR+R}$$

$$\text{NDVI} = \frac{(\text{B8}-\text{B4})}{(\text{B8}+\text{B4})}$$

As a result, the NDVI was successfully computed by using the above equation.

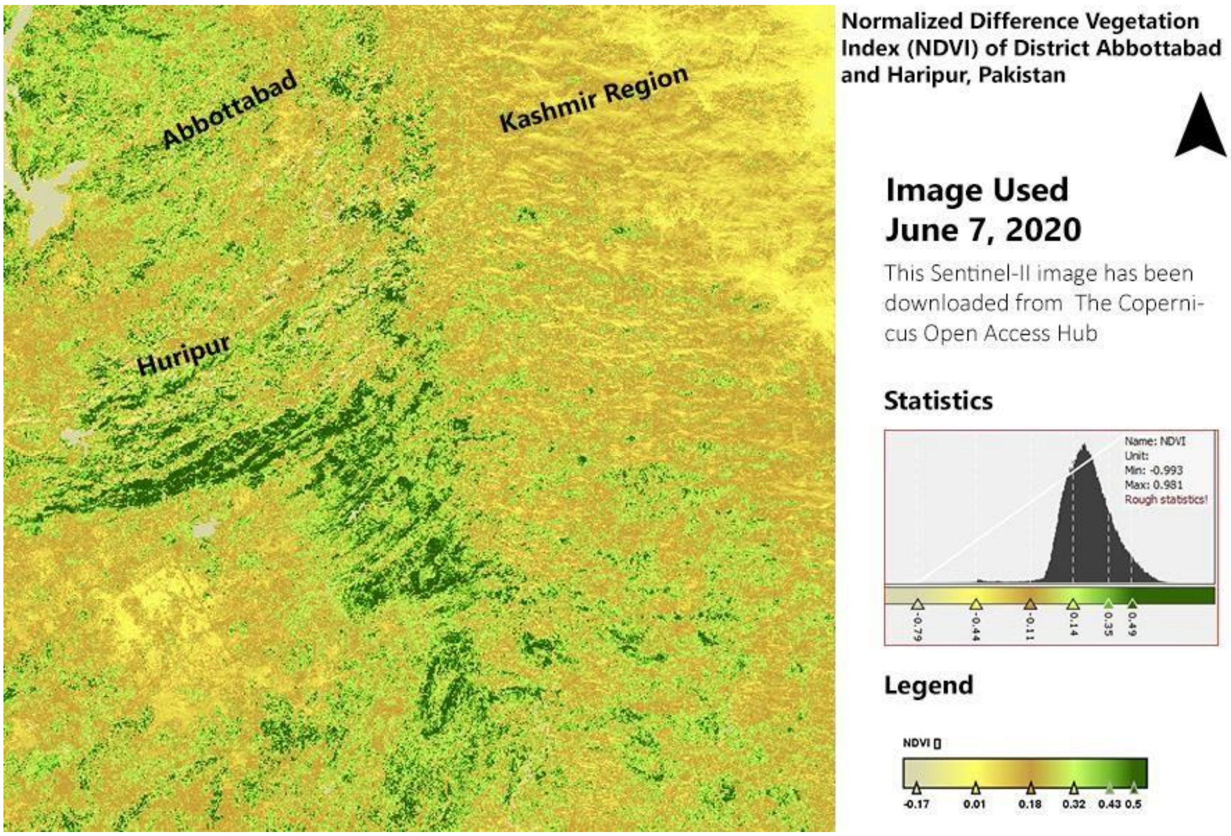


Figure 1: Computed NDVI

Explanation

The maximum value is 0.5 which shows the dense and healthy vegetation as these are particular agricultural areas and forest cover and are in dark green color. While the minimum value is -0.17 which shows the low and in healthy vegetation. Some areas have a yellowish color and has the value 0.32 which is showing that vegetation is neither too healthy nor too weak.

Exercise 3

Flood mapping using Sentinel-1 Output: Flood map

In August 2020, due to heavy rainfall in Northern part of Pakistan it resulted in floods. Swat region was one of the worst to hit by the heavy rainfall due to its topography. For this exercise Swat was selected as as a study area to carry out flood mapping using Sentinel I images in SNAP software. For the flood mapping it is important to have to set of images i.e.

1. Archive images or Pre flood images
2. Crises images or Post flood images

The Archive image was downloaded of 29th July 2020 and crises image was download on September 03, 2020. After the images were downloaded they were imported in SNAP as a zip file and first compared so in order to develop a proper concept that which areas are flooded and which are not.

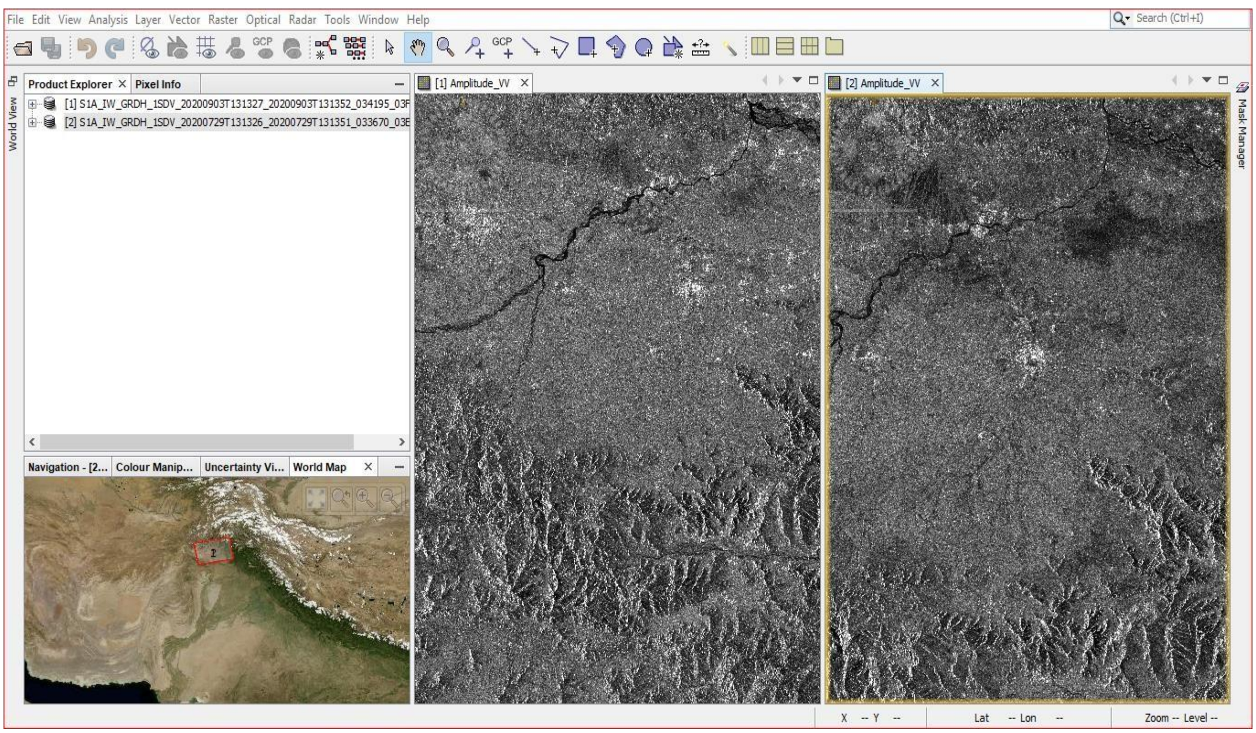


Figure 2: Crises and Archive images

After the comparison the **Subset** of both images was created in order to focus on specific area rather than the complete tile. The subset must be saved in the folder with the corresponding names like before and after flood images in order to run the process smoothly later on.

MULTILINKING OF IMAGE

In order to reduce the image, the multilinking task is performed by going into Radar menu and Submenu SAR utilities then to Multilinking. It helps to reduce the speckle and to maintain the good resolution the number of range looks and Azimuth looks were put as 3. This process was repeated for both the imageries and in this way a smooth and good resolution was created.

CALIBRATION

By going into the Radar menu and then to sub menu Radiometric the calibration is performed. It basically provides a good comparison of the images that are multilinked in the previous step.

After the calibration the pixels were converted from linear scale to nonlinear scale also known as a logarithmic scale. By clicking right on the images created it is converted into Linear to/ from dB. It is done because it separates land features from the water bodies.

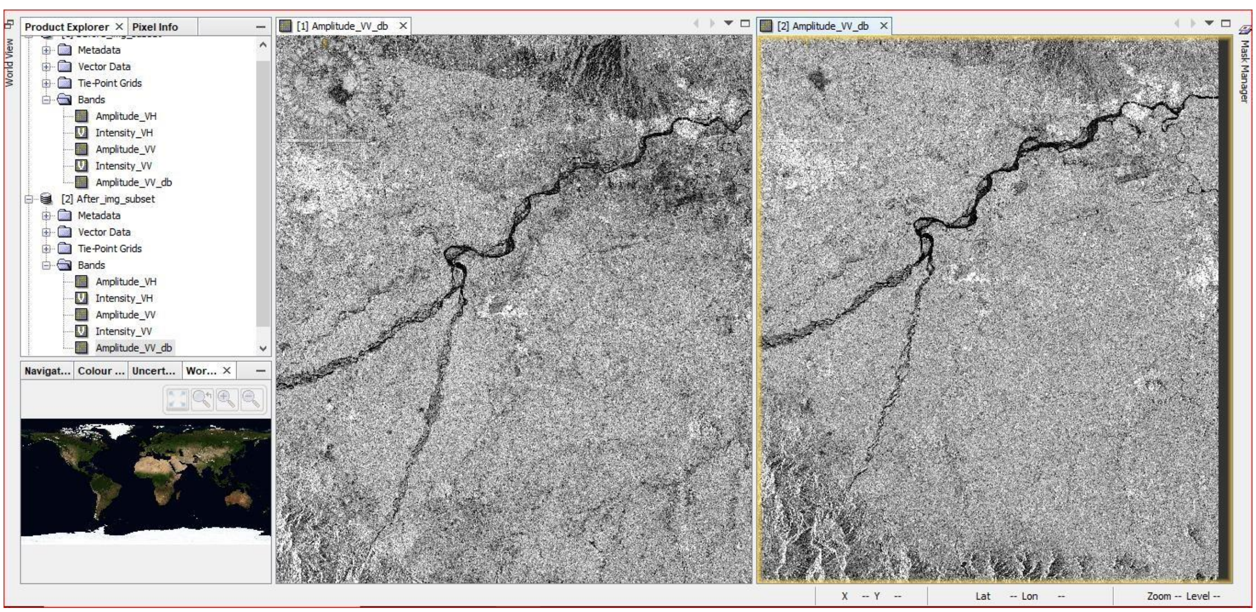


Figure 3 Calibration the pixels

After it in order to avoid any distortions on the area smooth the pixels the next step was to run Range Doppler Terrain Correction. Once it was obtained the resultant images were again changed to Liner to/from Db then it was further converted into the band and saved for further operations.

After it the images are needed to be stacked together using product geolocation for the output extent. The steps are Raster →Co registration → Stack Tools →Create Stack.

After this the bands from each of the images put together into one image file with a new file automatically created. Compare the decibel images and apply a contrast stretch. For overlaying of these two images and create the RGB composite: Layer Manager → + icon → Image of Band/ and overlay the crises image. Select the 03 September 2020 Image (in decibel). These images are compared by selecting and deselecting the checkbox next to the layer that overlays. Also these can be compared using the transparency slider.

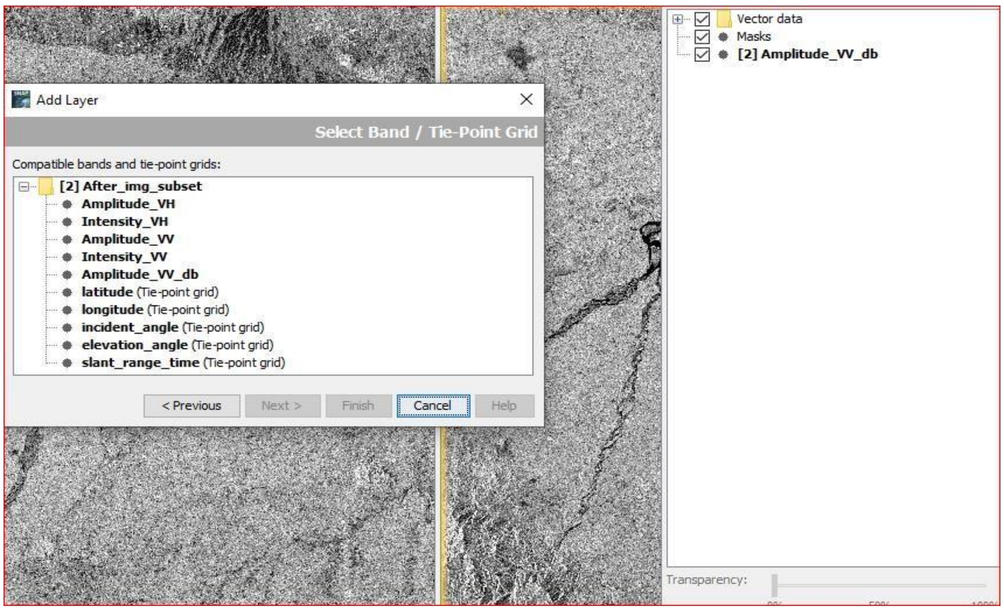


Figure 4: Creating Stack

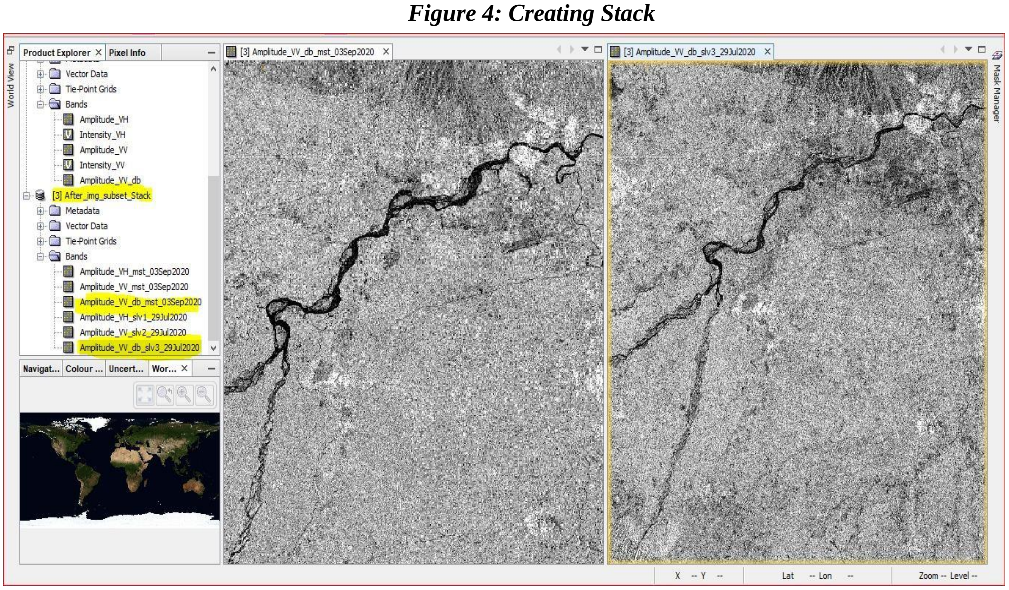


Figure 5: Corrected Archive and Crises imageries

FINAL FLOOD RGB COMPOSITE MAP

Finally, and RGB composite needed to be created in order to make a difference between permanent water bodies and the actual flooded areas. Right Click on the stacked image and then create open RGB image window. The before flood image of 29th July was put into the red band channel and other two bands green and blue were filled with crises image of 03 September, 2020. It is done so because radar has a high response in the red band. In the former image we do not expect to see flooded areas. Therefore, we will have a high backscatter return. However, over the flooded areas will have a low backscatter return in the crisis image. So where there is flooded areas, these areas should appear in red as will have a high response in the red channel but a low response in the green and blue channels.

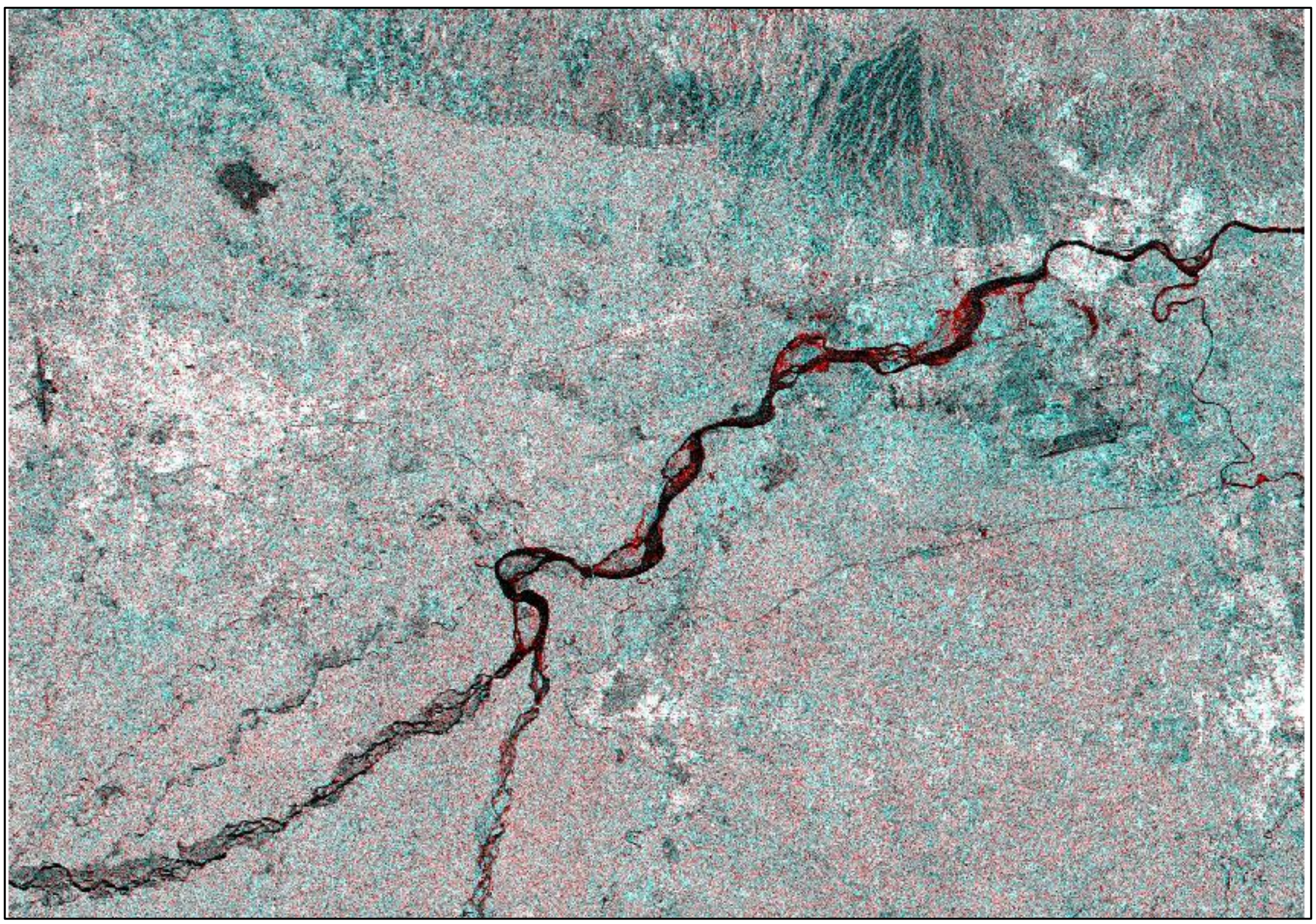


Figure 6: Final Map showing the extent of flooded areas