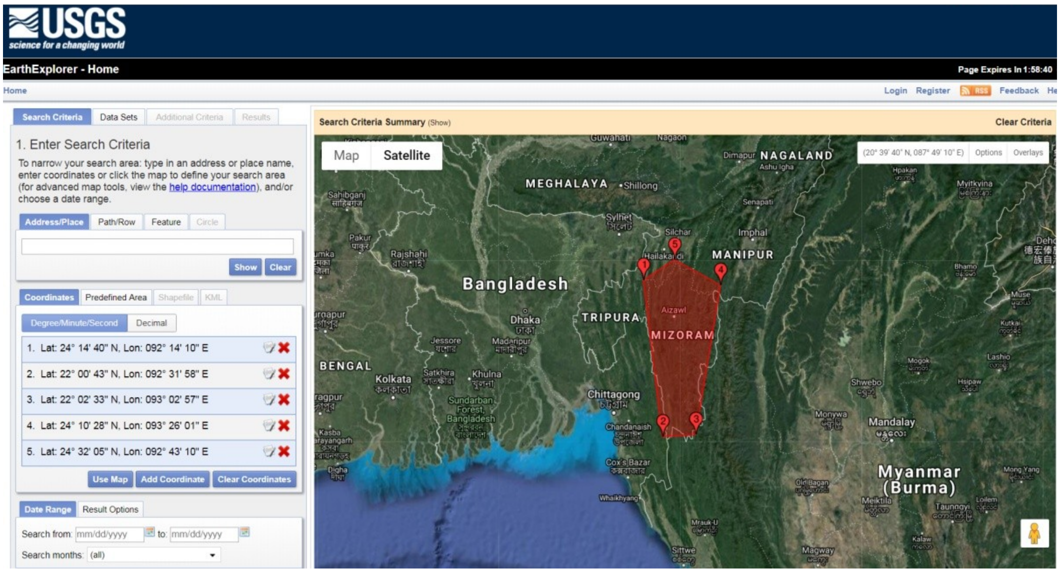
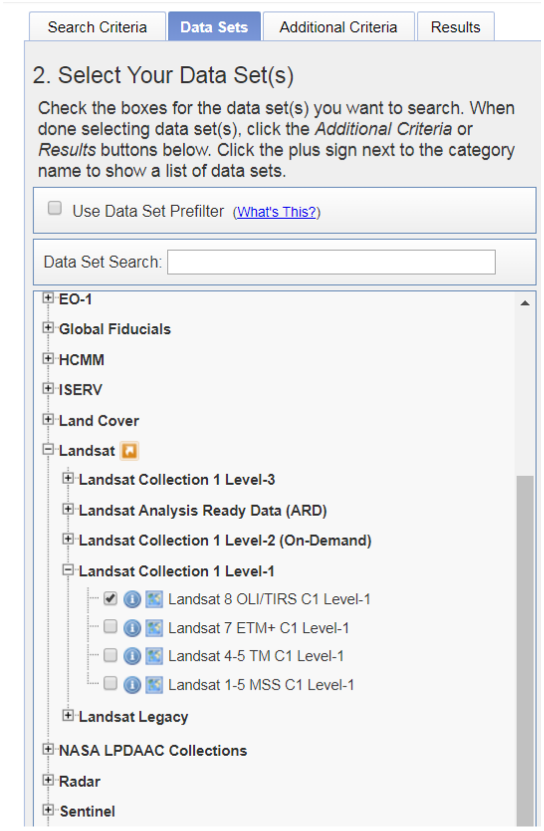
Handout on Satellite Data Visualization and Basic Raster Operations

Satellite data is available at many different resolutions, spectral regions and revisits. Depending upon our application, we need to select the optimal sensors. For eg: surveillance activity will require constant monitoring. This will need a camera of high repetivity, precision agriculture will require revisits in the range of a few days to weeks but will require very high resolution imagery covering the wavelengths that the crops are responsive to etc. Some of the Indian satellite data can be downloaded from Bhuvan website hosted by the National Remote Sensing Centre, ISRO, Hyderabad. Foreign satellite data is available at the respective space organization web pages and data portals. Landsat series of satellites is a commonly used dataset and we will be using the same for our exercise. The data can be downloaded by creating an account on the Earth Explorer portal of USGS and the freely available data may be downloaded through the same. The link for data download is as follows: https://earthexplorer.usgs.gov/

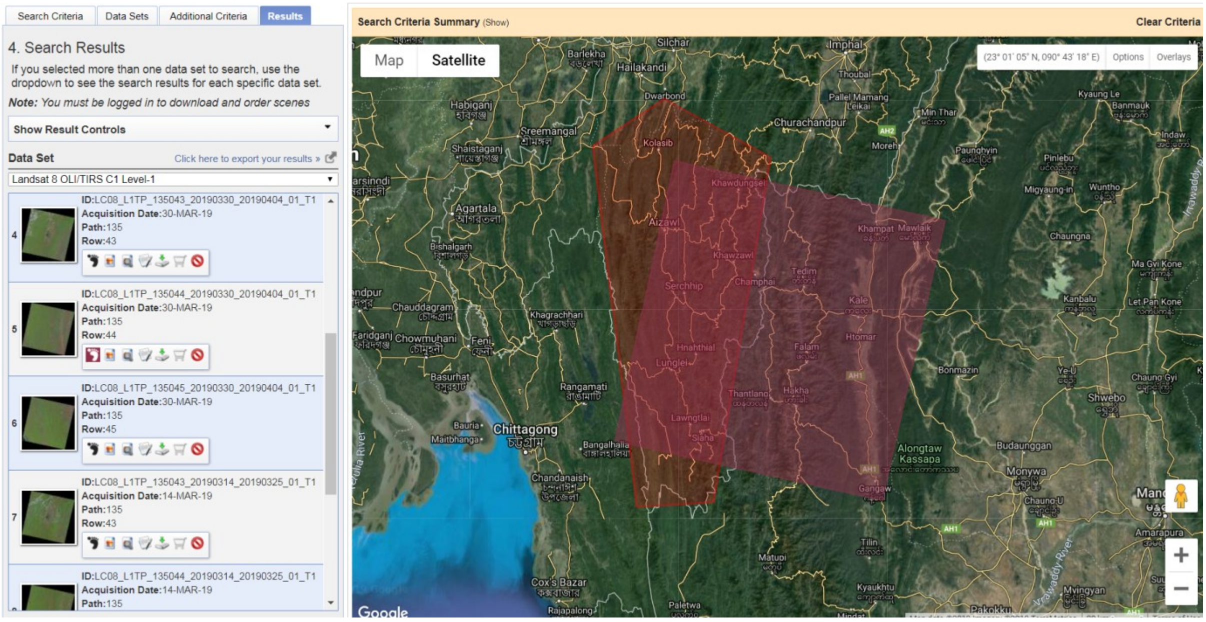
The study locations can be selected by clicking on the map. Additional filtering based on date can be set as required:



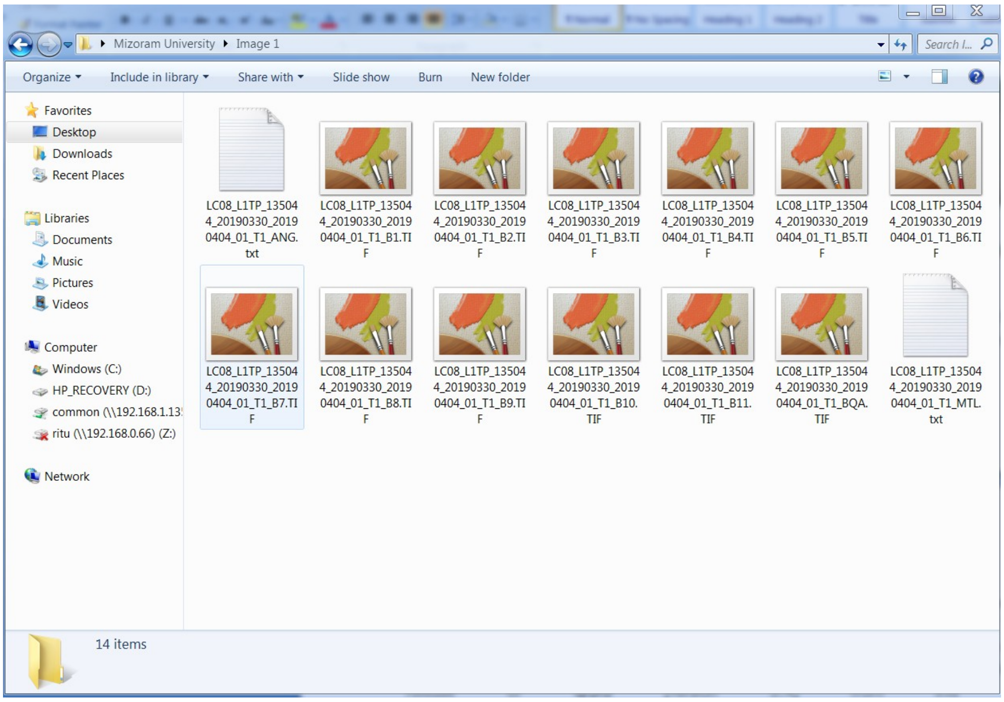
The datasets of interest can be selected. In our case, we will download the Landsat 8 Level 1C dataset available for free download upon login.



Additional criteria such as imaging conditions, cloud cover etc can be set under the additional criteria tab. Next, the results are observed.

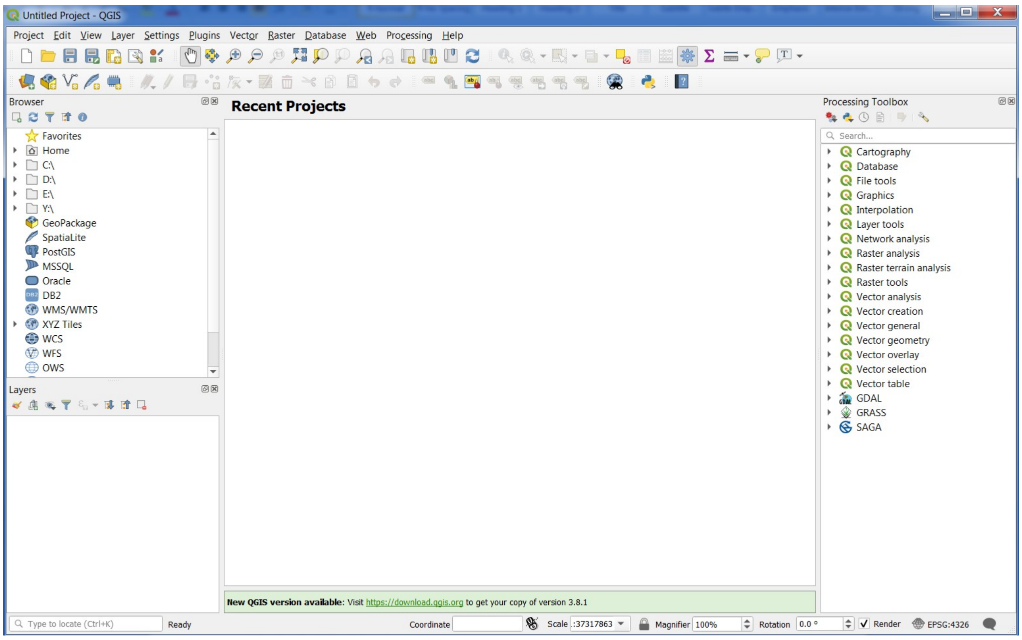


The level 1 Geotiff products are to be downloaded. The image will be in a .tar.gz format. These are to be unzipped to obtain the images as seen in the folder below:

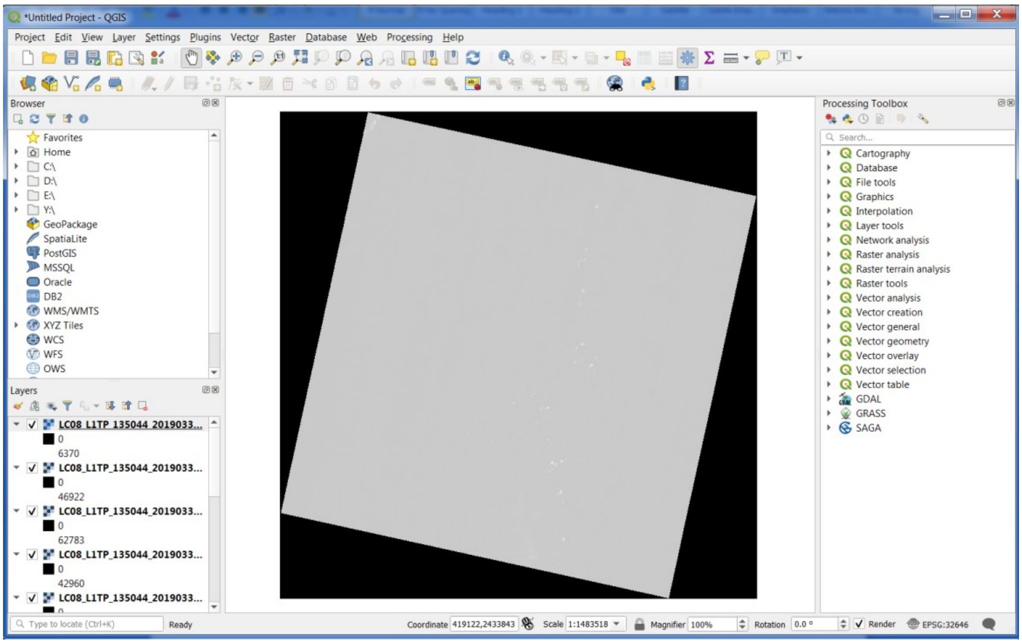


You will notice there are a number of images (5 VNIR: B1-B5, 2 SWIR: B6 and B7, 1 15m/px panchromatic: B8, 1 cirrus: B9 and 2 TIR: B10 and B11) within the folder. Each of these images are images of the study region corresponding to a particular wavelength (band). The standard viewers of your computers might not be able to visualize these images. They are visualized using remote sensing and GIS software. We are using the open source software QGIS for all our studies in this workshop. You may download and install the long term release of QGIS (version 3.4) from this website: https://qgis.org/en/site/forusers/download.html

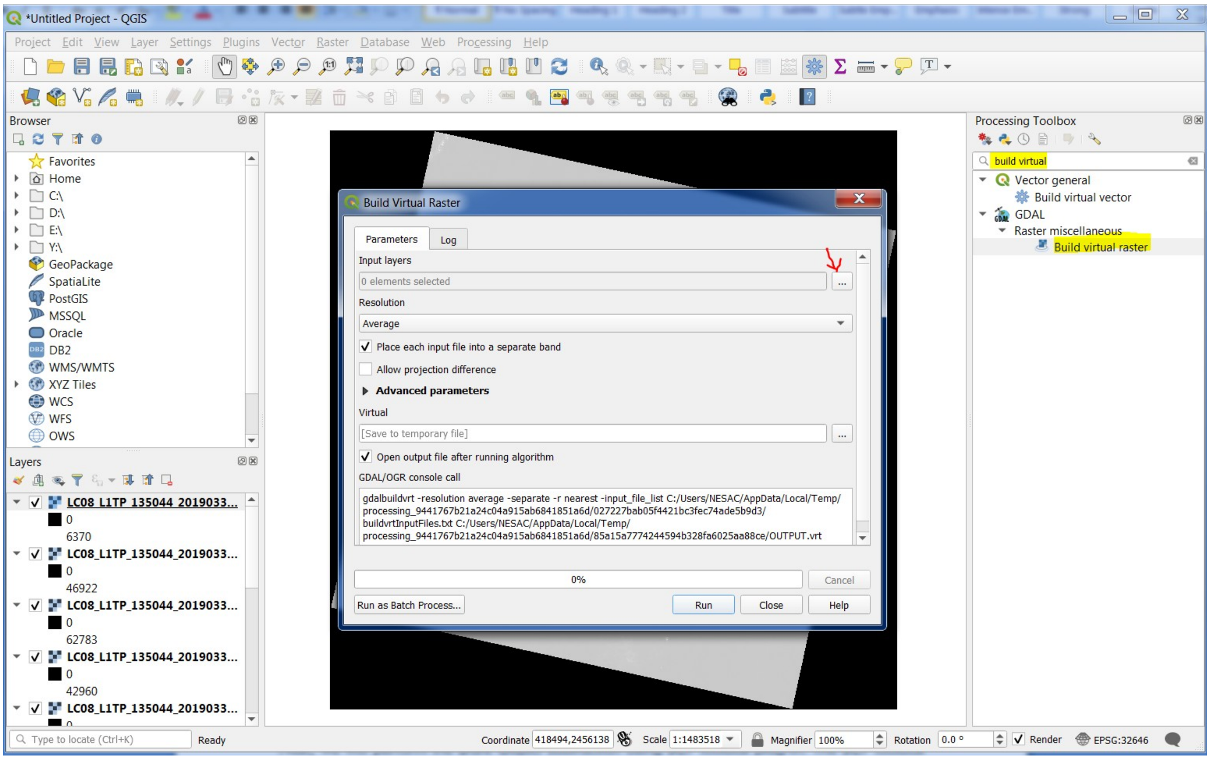
Launch the QGIS software.



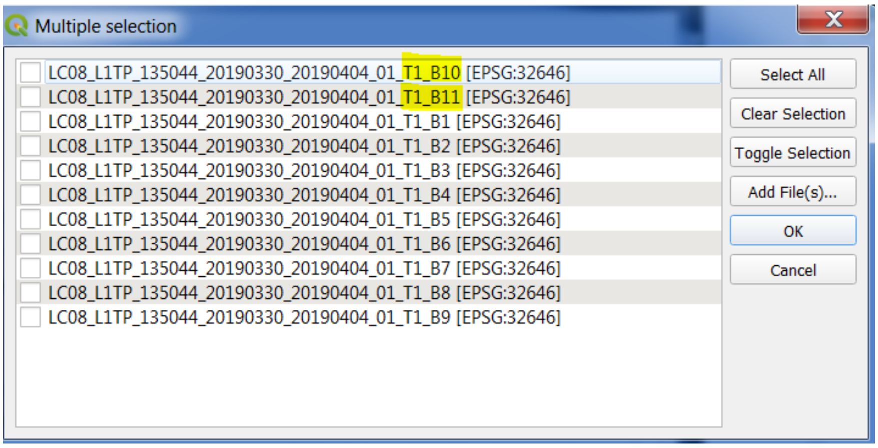
Click and drag the images to view it.

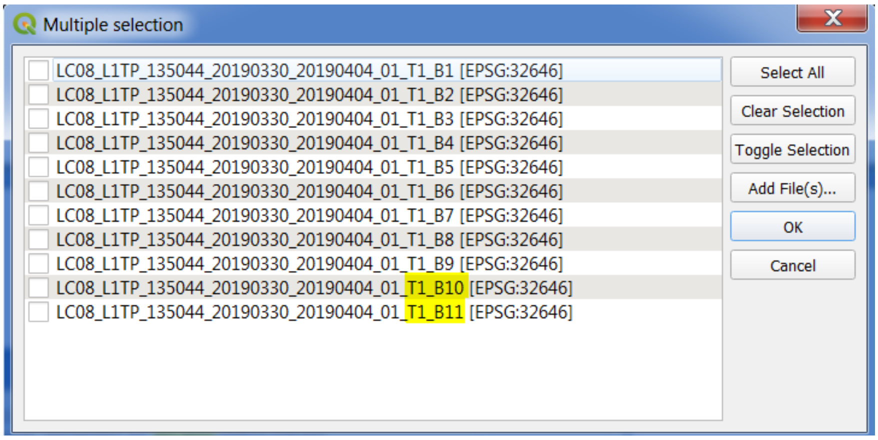


These individual bands need to be stacked into one image. This is achieved in QGIS through a process called Virtual Raster Creation. In the processing toolbox on the left of the QGIS window, type Build Virtual Raster and select the tool. If the processing toolbox is not visible, click the processing tab and select the processing toolbox.

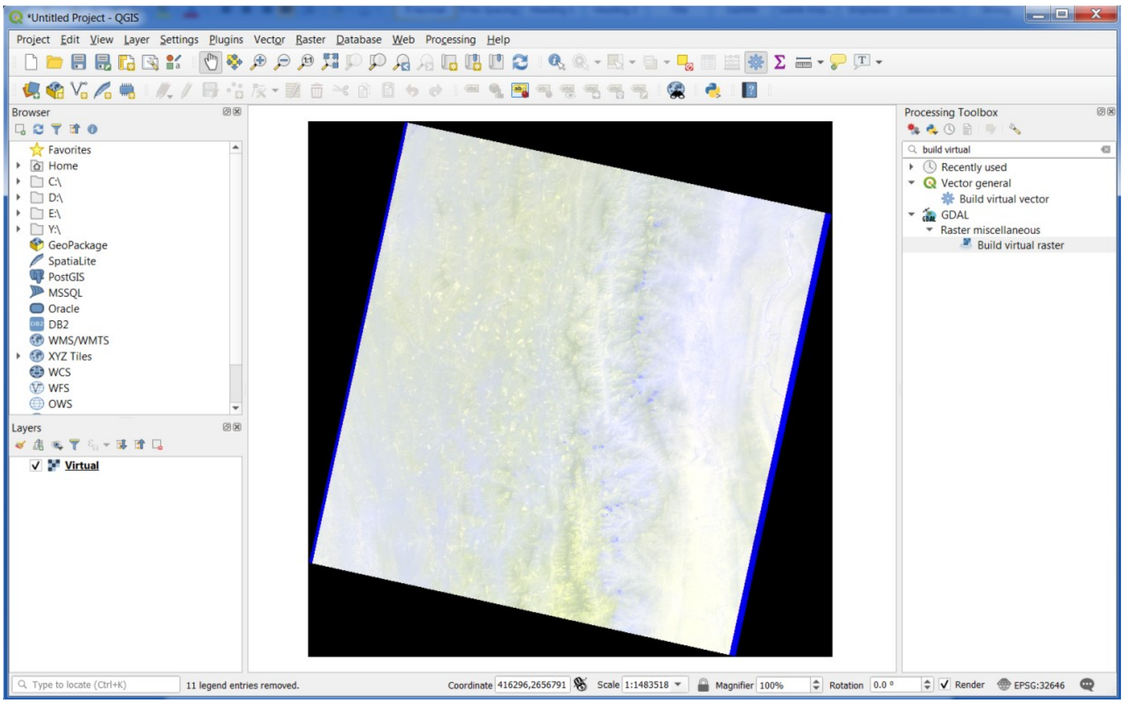


Click on the ... button next to Input layers to select the layers you would like to generate a virtual raster with. In the window that pops up, ensure that the order of bands is the order you wish to use them. In the below image, B10 and B11 are wrongly placed. Click and drag them to the bottom of the band list. Click Select All, click OK and run the tool.

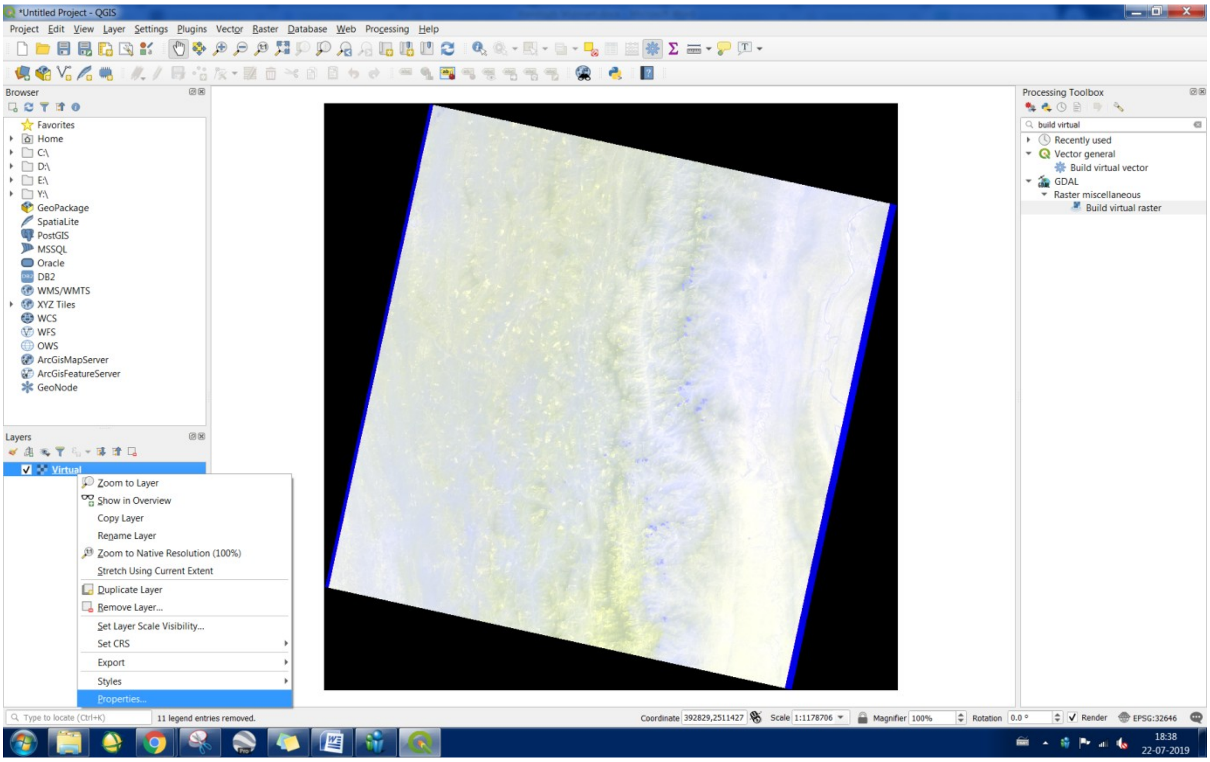




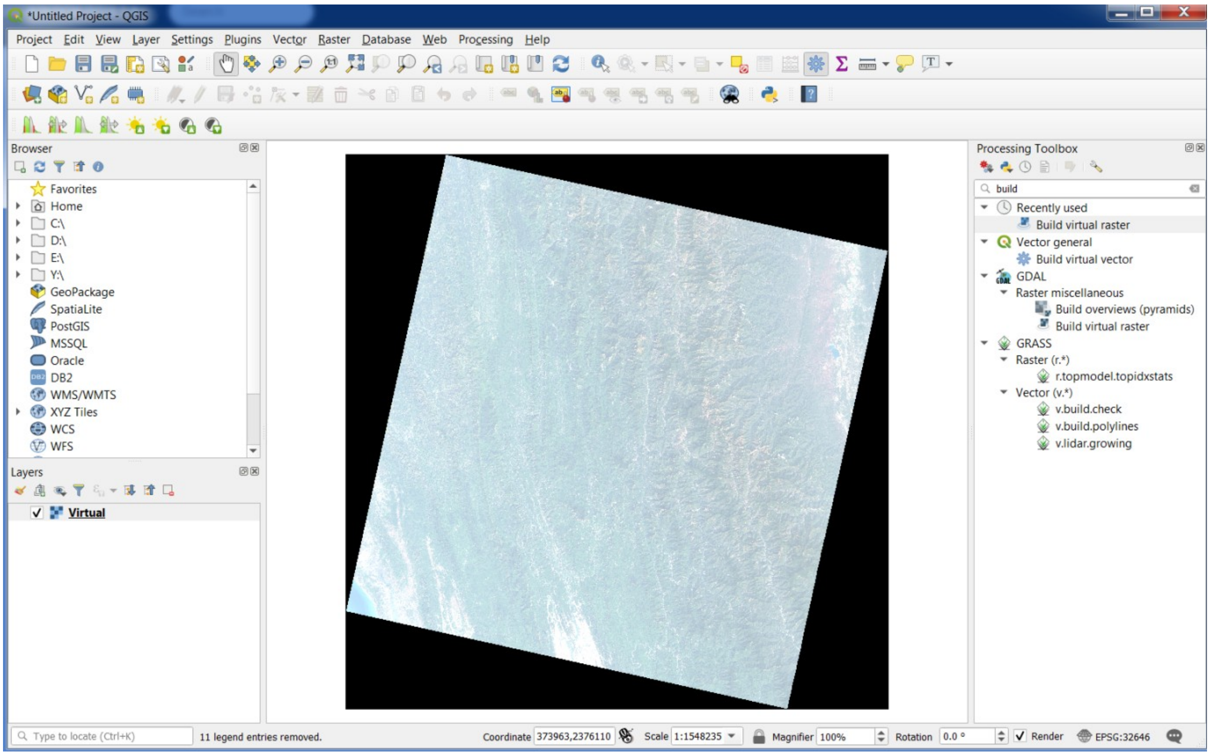
Once the virtual Raster is generated, the other layers are redundant and may be removed by right-clicking and selecting remove. The QGIS view is as follows:



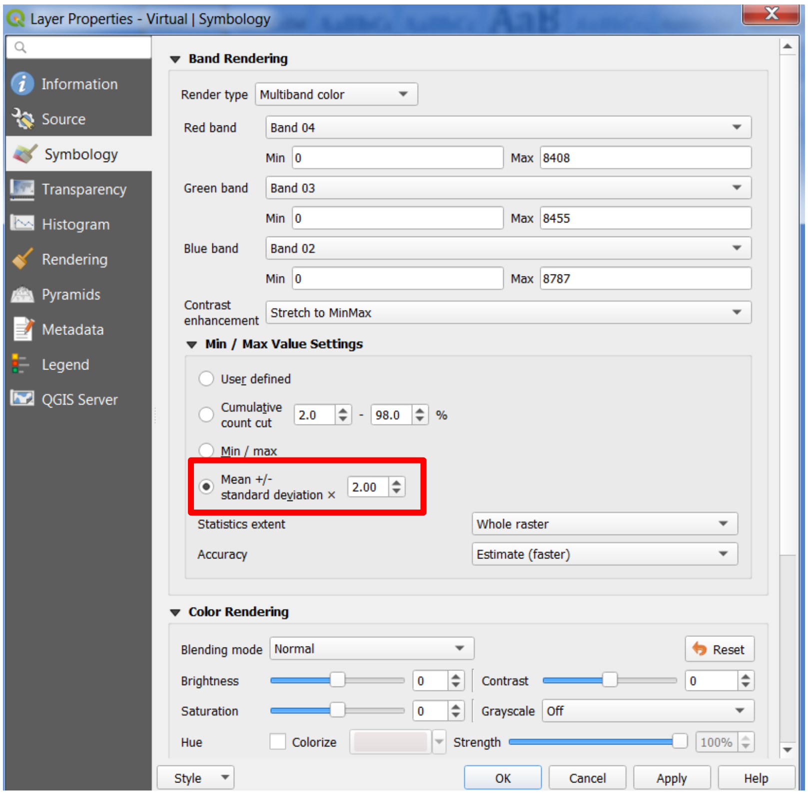
This is because B1 (Ultra-blue) has been assigned the colour red, B2 (Blue) -> green and B3 (Green) -> blue. In order to see the image the way humans can see it, we need to assign B4 (Red) to the Red channel, B3 (Green) to the Green channel and B2 (Blue) to the Blue channel. For this, right click on the Virtual Raster image and select properties.



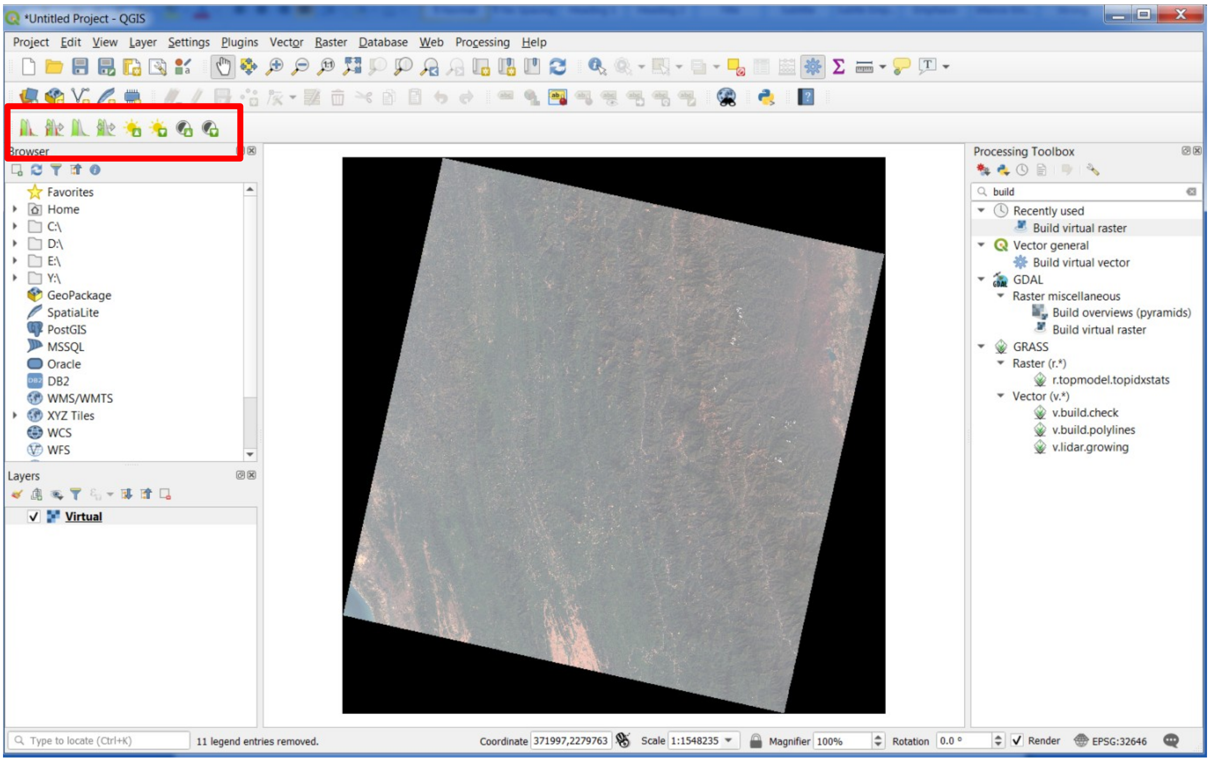
In the resulting window, change the bands under the Symbology option. Click apply and OK.



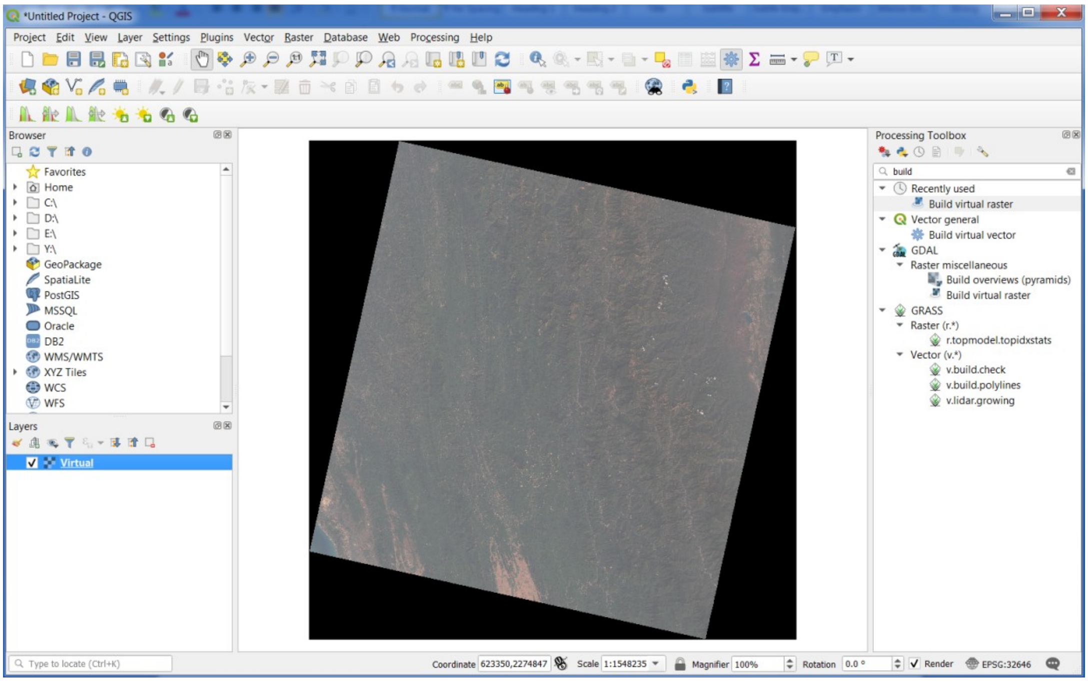
You will notice that the bands appear to be very unclear and lacks contrast. In order to enhance the image, we stretch the image. This can be done under the Properties>Symbology. Click on the Min/Max Value Settings and select the fourth option. Click apply and OK.



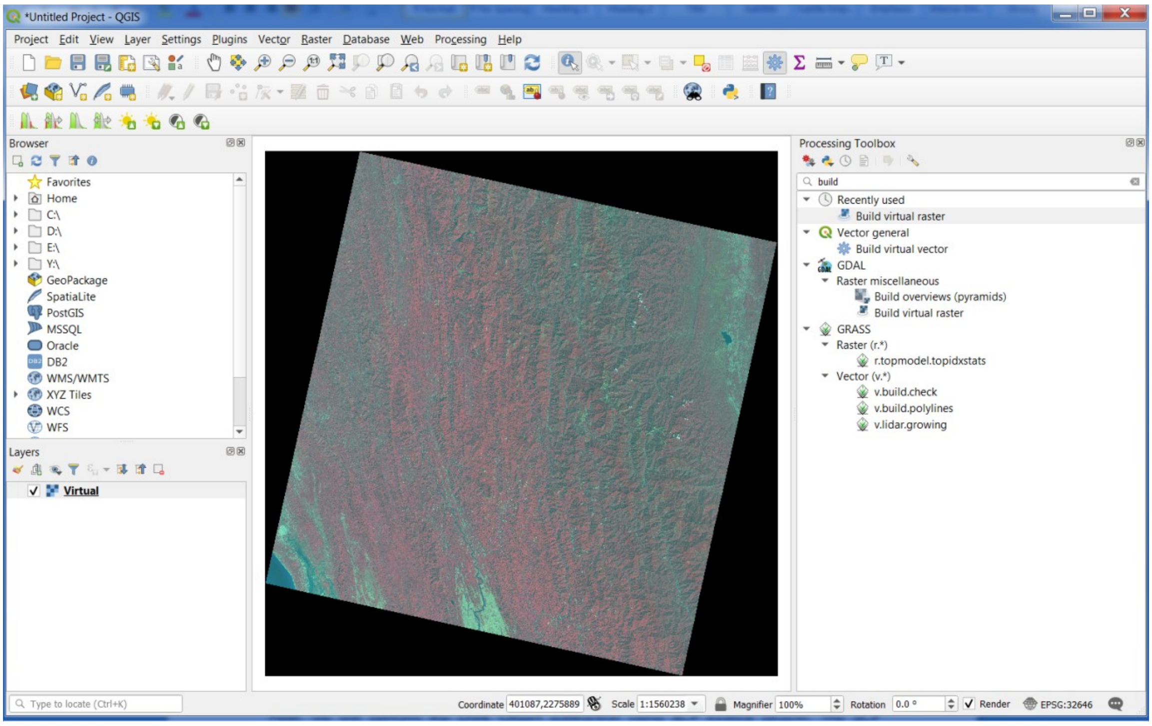
The image can still be further enhanced by stretching as per the histogram. For this, select the Histogram Stretch Option in the Raster Toolbar. In case the Raster Toolbar is not available, go to View>>Toolbars and check the Raster Toolbar.



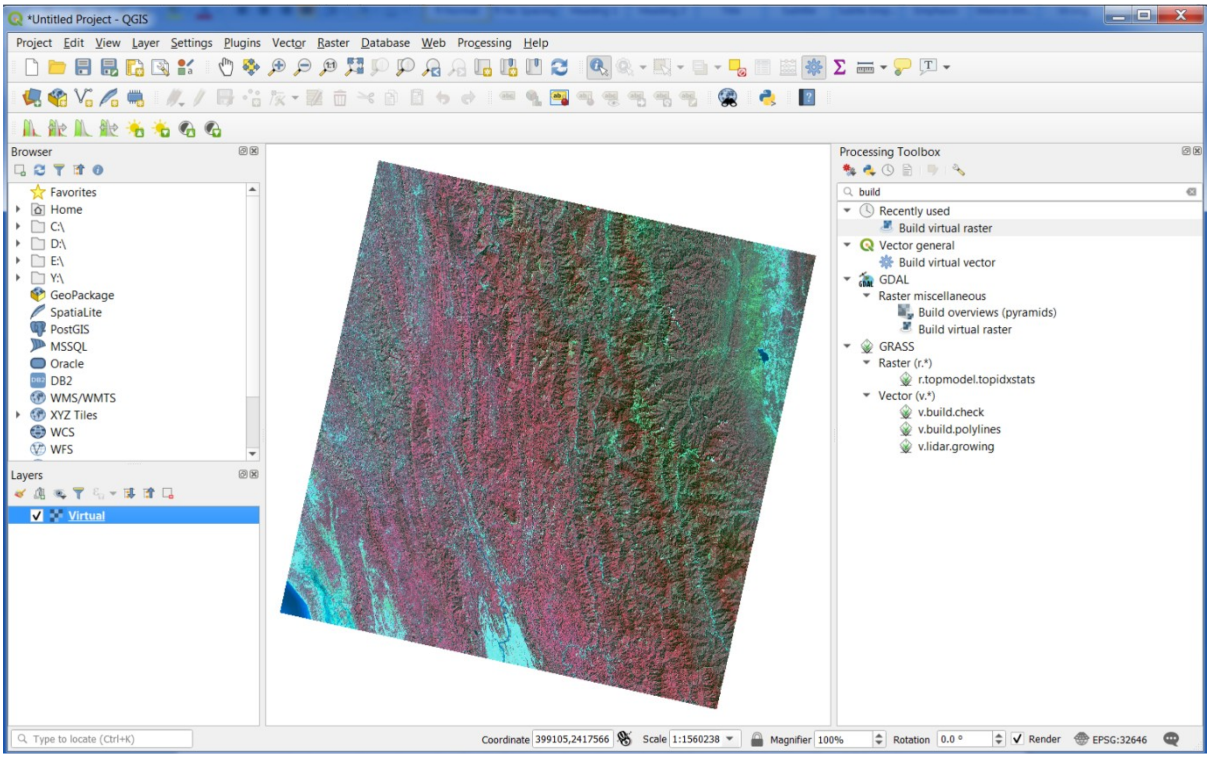
Experiment with all the above tools until you find a visualization you are comfortable with.



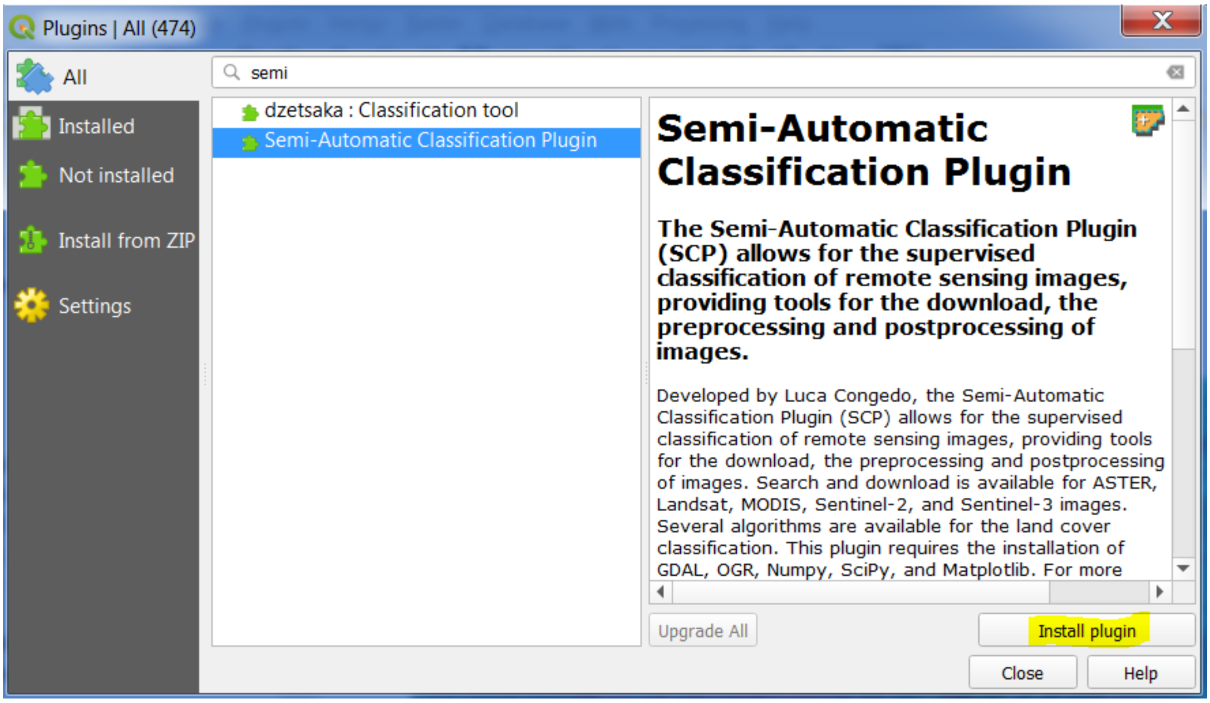
Now, we have viewed the images exactly like how humans view it. But the avantage of using remote sensing is that the remote sensing sensors can see beyond what we humans can see. The band 5 is NIR. Vegetation is particularly reflective in the NIR. So a commonly used image visualization is in the form of a false colour composite with B5 (NIR) being assigned the red channel, B4 (Red) being assigned the green channel and B3 (Green) being assigned the Blue channel. Experiment with the enhancement until you get a view like this:



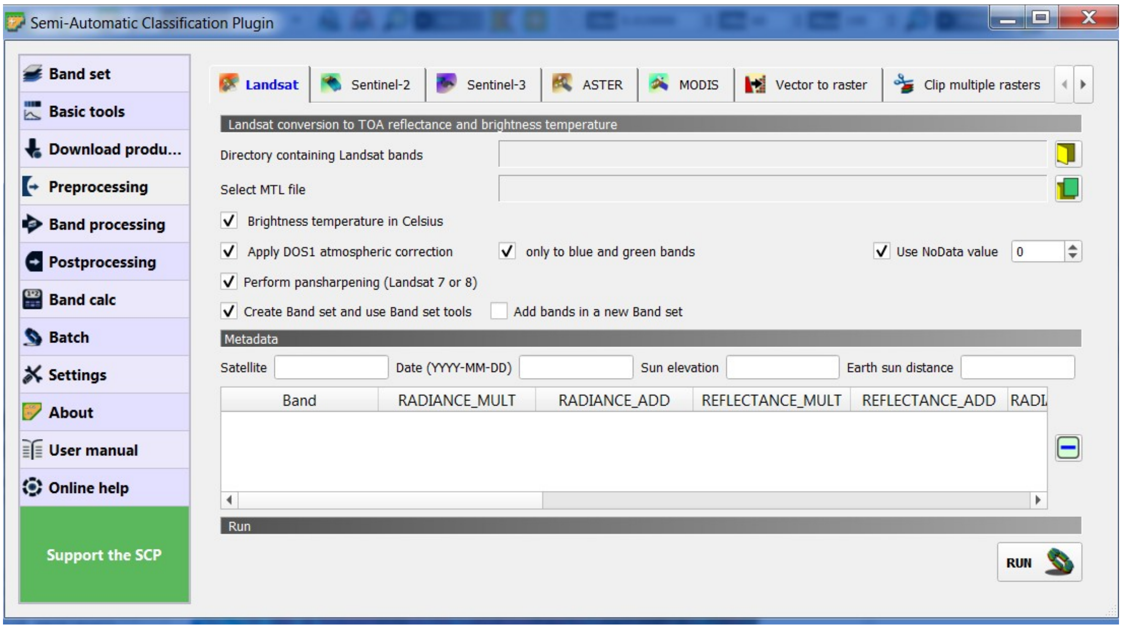
Before we proceed, the black border around the image can be removed by setting No Data constrain in the transparency. For this, right click on the Virtual Raster>Properties>Transparency. Set the Additional No Data value to 0 and click OK.



Next, we will perform the Dark Object subtraction using SCP toolbox plug-in. The SCP toolbox is an external plug-in you will have to install. For doing so, go to the plugins option on the toolbar and select Manage and Install Plugins. Under the resulting pop-up window, select All and search for the Semi-Automatic Classification Plugin (SCP) and click install.



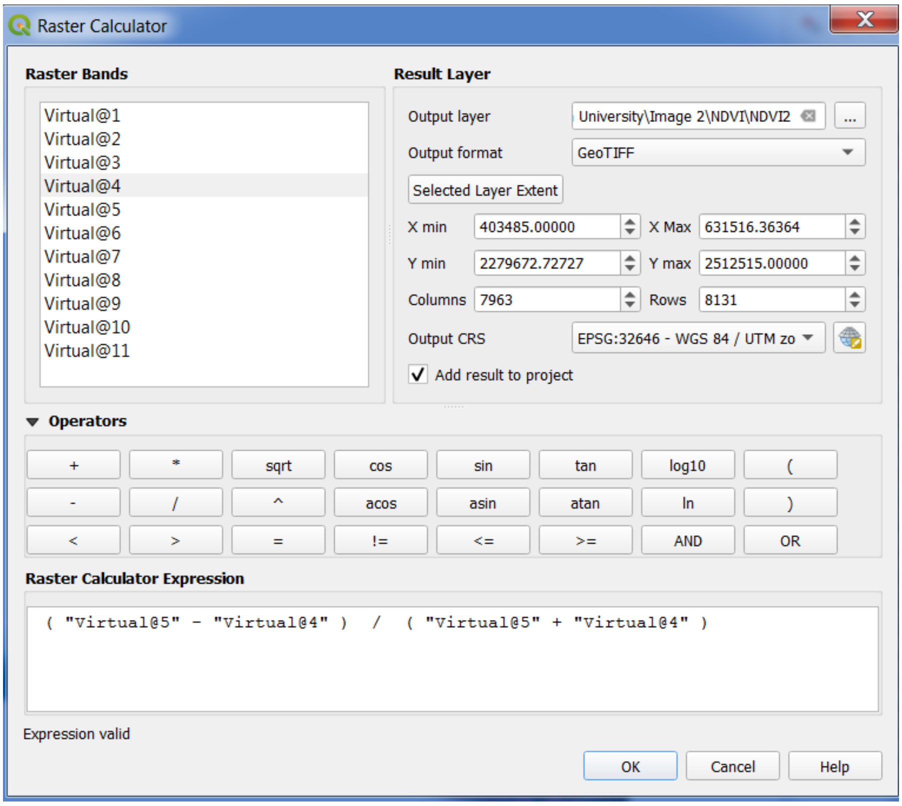
Open the SCP tool and select the pre-processing tab followed by the Landsat tab. Select the folder containing your images and the MTL file assosiated with it. Click on the Dark Object Subtraction (DOS) checkbox. This is a preliminary correction technique which scales down the image into relative reflectance. Also click the pan sharpen check-box if you wish to transform all the 30m/px images to 15/px images using the Band 8. Brightness temperature in Celcius option can be checked if you are using the thermal bands. Click Run.

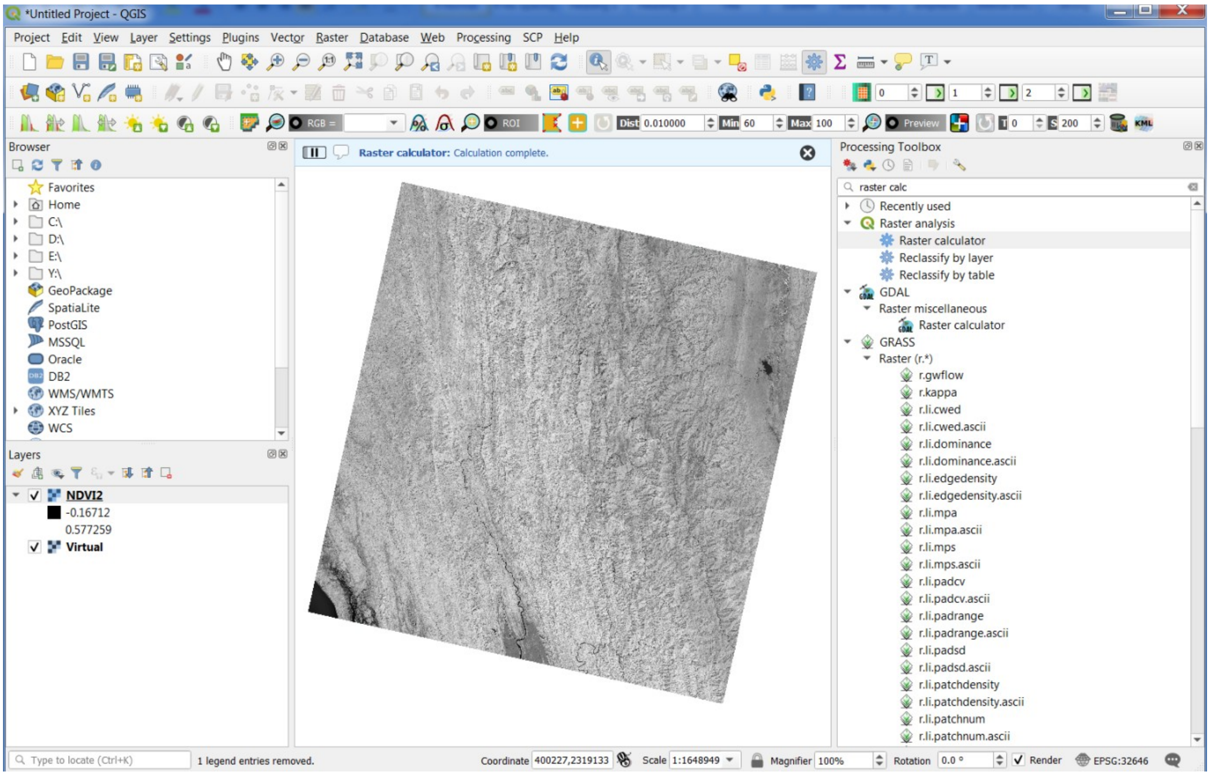


Our next task is to generate spectral indices. We will generate a commonly used vegetation index called Normalized Difference Vegetation Index (NDVI). NDVI is calculated as the normalized difference between the Near Infra-Red band and the Red band given by the following expression:

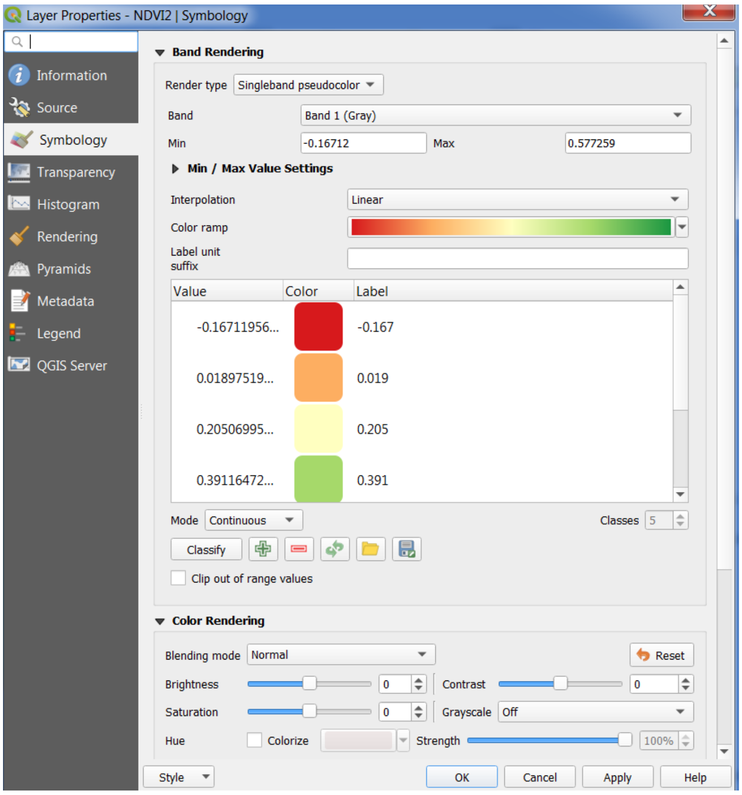
$$NDVI = \frac{NIR - Red}{NIR + Red}$$

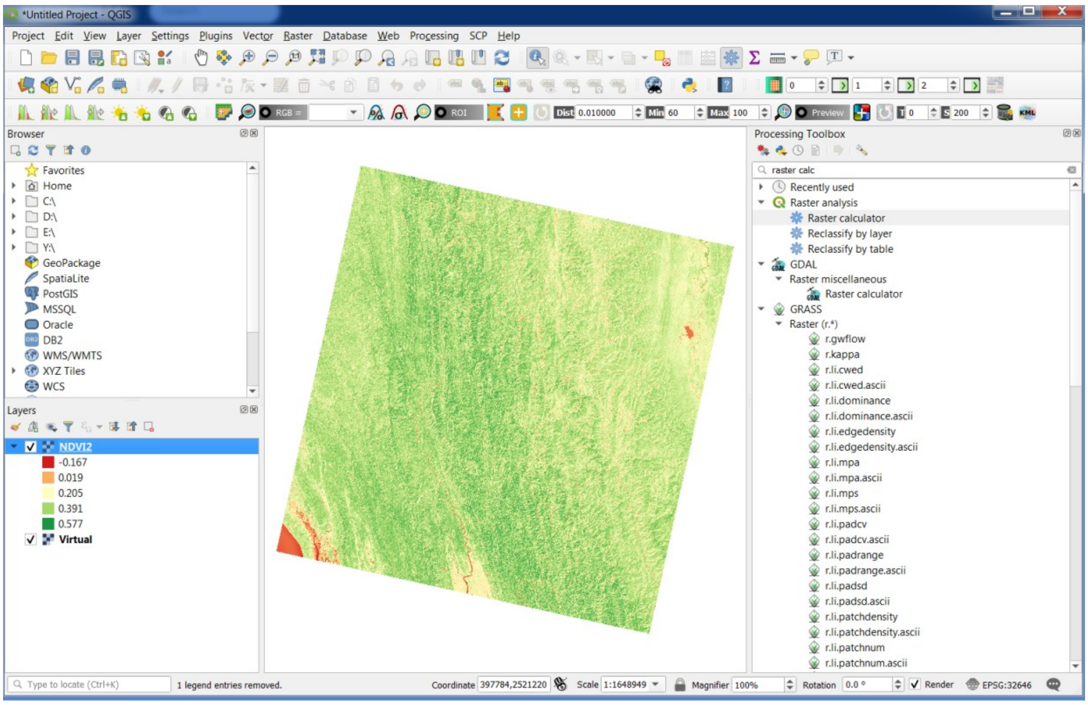
The NDVI image is generated using the raster calculator. Go to the Raster tab and select Raster Calculator. Apply the formula given above and click run. An NDVI band is created.





This NDVI can also be visualized in different colours for better understanding. This is done using the Properties>Symbology tab as before. Select the Single Band pseudo-colour option and experiment with the colorization parameters.





NDVI is an important parameter to estimate vegetation. As vegetation has a very high reflectance in the NIR and minimum reflectance in the Red, NIR reflectance dominates and hence vegetation is characterized by high NDVI values. We can also use the raster calculator to threshold the raster values and select vegetated regions from the above. This uses the logical expressions on rasters. We leave this as an exercise for you to try.

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