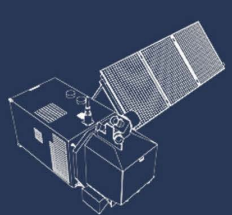
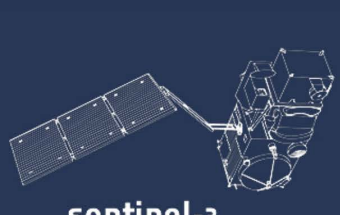
UNIVERSITY COURSE EARTH OBSERVATION WITH ESA MISSIONS

TUTORIAL FOR EXERCISE 4

Mapping deforestation using ESA satellites





esa FBERG

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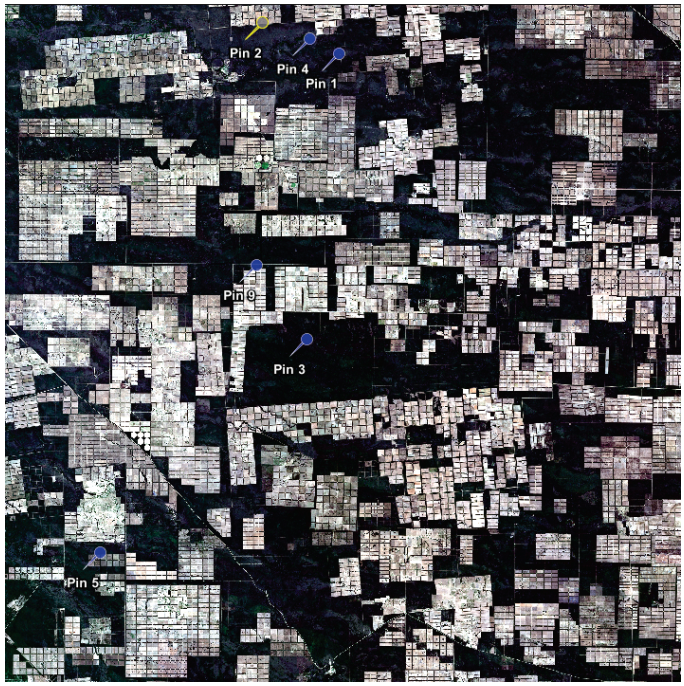
Table of Content

1 Exercise outline

In this exercise we will learn the basic steps to calculate the deforestation area based on S2 images:

- We will download images of the same area of interest over a period of 3 years
- We will open 3 images in SNAP
- Create a reprojection to WGS 84 UTM Zone 19 South
- Perform image preprocessing by creating a GraphBuilder graph
- Using Batch Processing, perform preprocessing for the 3 images together
- The result will be 3 NDVI images showing vegetation
- Perform image classification based on the created training region on all 3 images, resulting in forest/non-forest masks
- Export the resulting masks to QGIS and colour the masks by year



2 Mapping deforestation using ESA satellite mission S2

Forests contribute to ecosystem services differently depending on the economic and ecological environment. Boreal and peat forests regulate the climate ecologically through their large underground carbon stocks, while tropical forests contain almost all the carbon above ground. Socioeconomically, in dry tropical forests with relatively dense populations of poor people dependent on forests, forests contribute substantially to livelihood needs such as firewood and fodder for livestock. In temperate forests, the recreational value of forests for populations with disposable income for tourism or the need to protect watersheds of large urban centres becomes more important. This heterogeneity in services and pressures on forests creates different monitoring needs in different parts of the world.

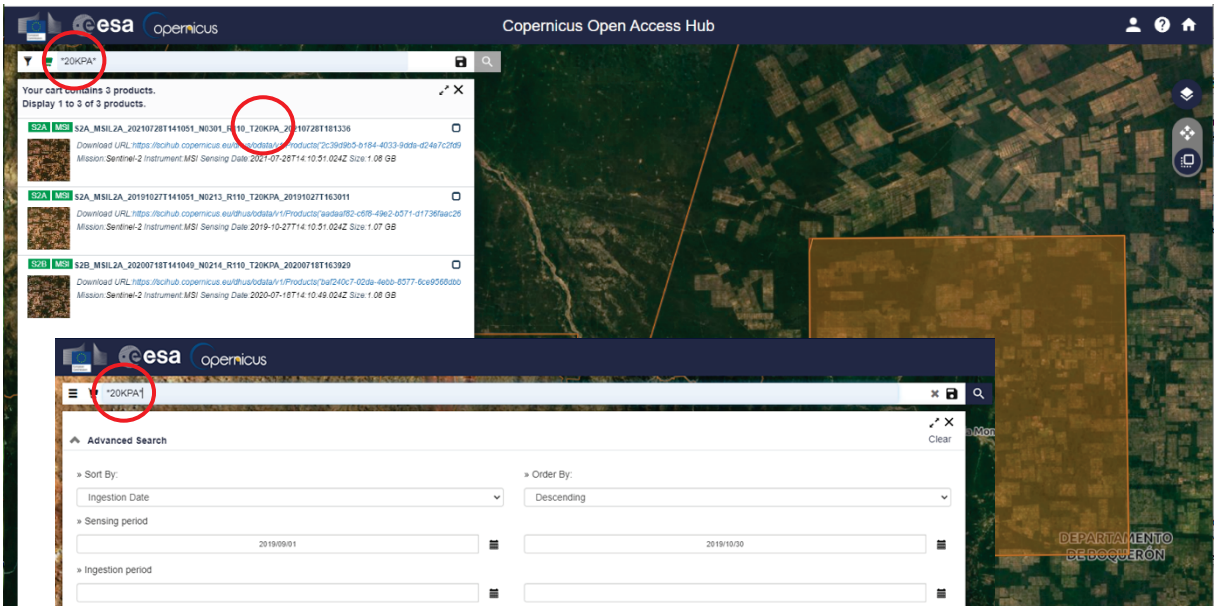
Data from RS can play an important role in planning for and responding to wildfires on forest lands. Such data and derived products on tree cover, species, and volume/biomass estimates can be used to input spatially explicit fire load models. Once a wildfire becomes active, imagery acquired near real-time can be critical to fire management and control efforts.

Many of the applications of RS in agriculture are also relevant to forest. For example, multispectral or hyperspectral imagery can be used to detect stress in tree leaves associated with insect or pathogen populations, nutrient imbalances, impacts from herbivores and other wildlife, environmental degradation (due to ozone, acid deposition, smog, and other factors), and meteorological conditions (moisture stress, drought, and storms).

2.1. Study area and image download

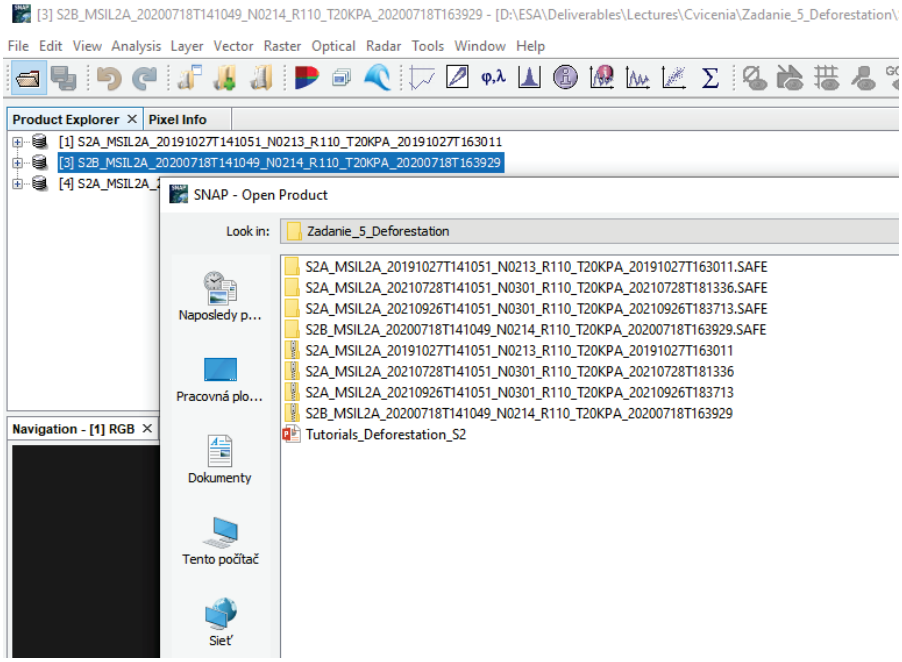
Download three images of the same area using the Tile Number *20KPA* for years 2019, 2020, and 2021 from the Copernicus Open Access Hub.

[*https://scihub.copernicus.eu/dhus/#/home*]

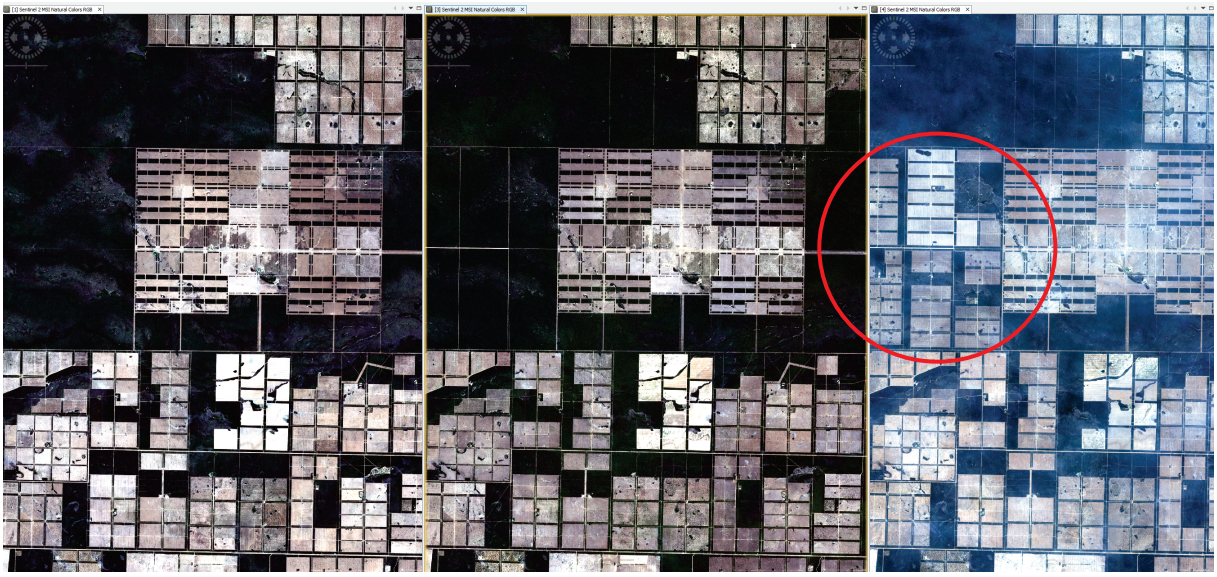


2.2. Open product

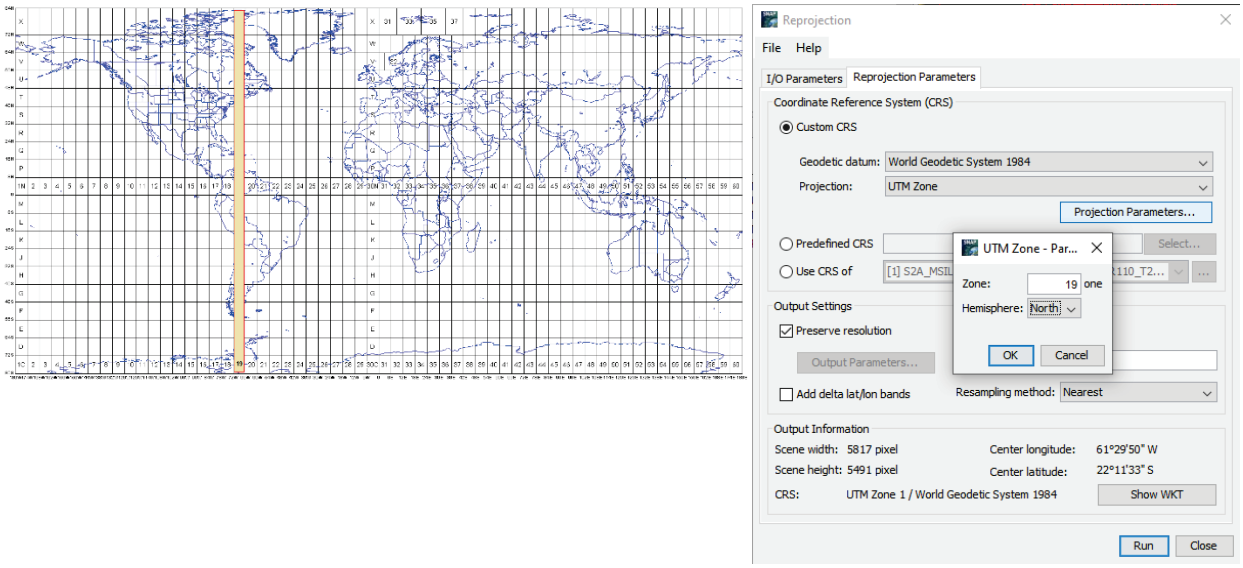
In SNAP, we will open 3 satellite images from Sentinel 2 to map the deforestation between 2019, 2020, and 2021.



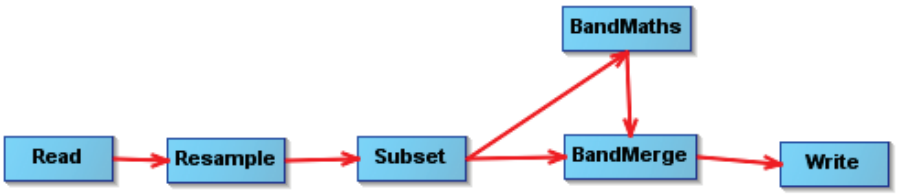
By opening and displaying all 3 images at once, we can take a first visual interpretation of deforestation in the years 2019, 2020 and 2021 - from the left.



Before processing the images, it is advisable to reproject them to the system WGS 84, UTM Zone 19 South – Paraguay.

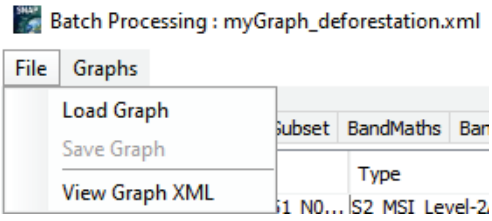


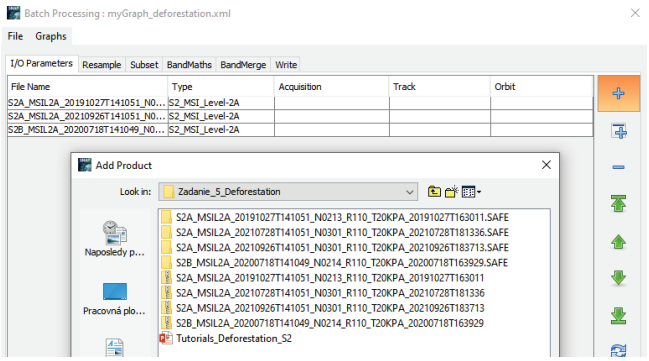
By creating a common processing graph using the *GraphBuilder* function, we specify the processing sequence:

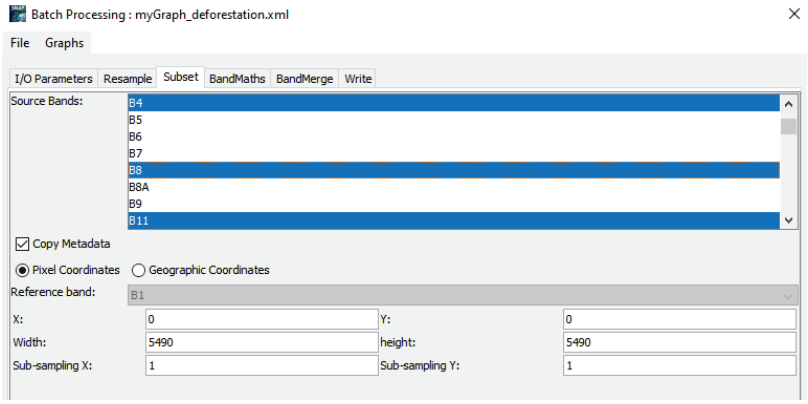


To avoid having to repeat the preprocessing step separately on each image, we create a batch process that gives the desired result in the common processing:

- *Resample* - perform resampling to a common pixel size (20 m by the band B11 is sufficient),
- Then we *export* only the Subset of 2 to 4 bands that enter the next NDVI calculation.





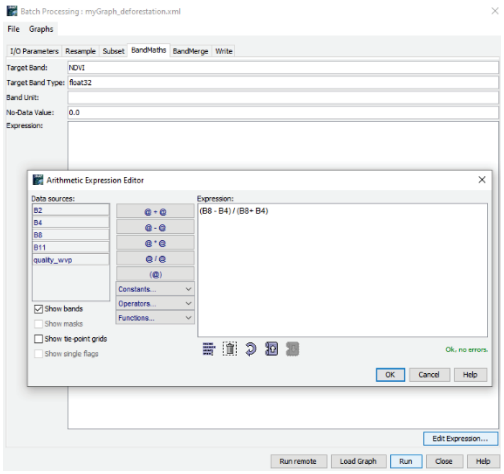


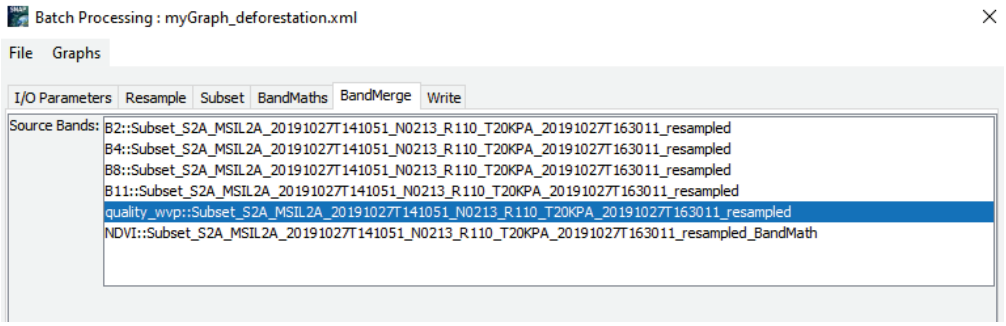
2.3. NDVI calculation

In *BandMath*, we enter the calculation of the NDVI index according to the equation:

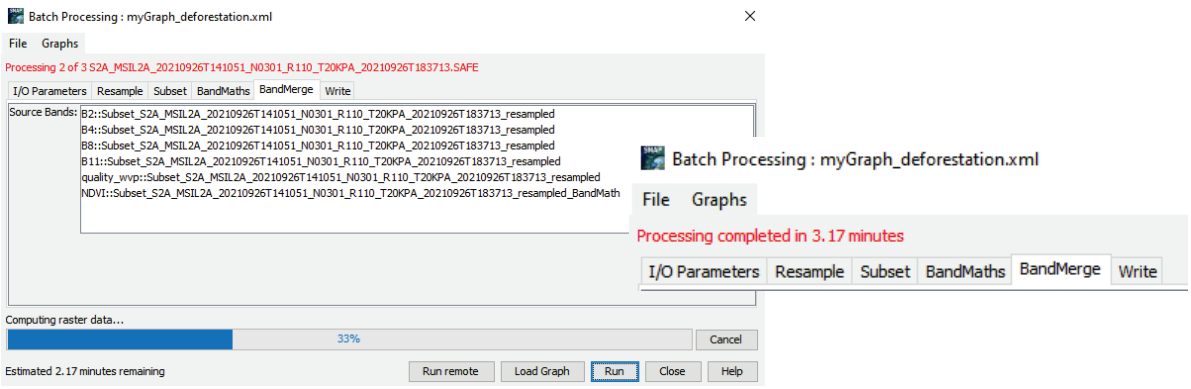
(B8-B4)/(B8+B4)

Then we can combine the resulting bands into the resulting file.

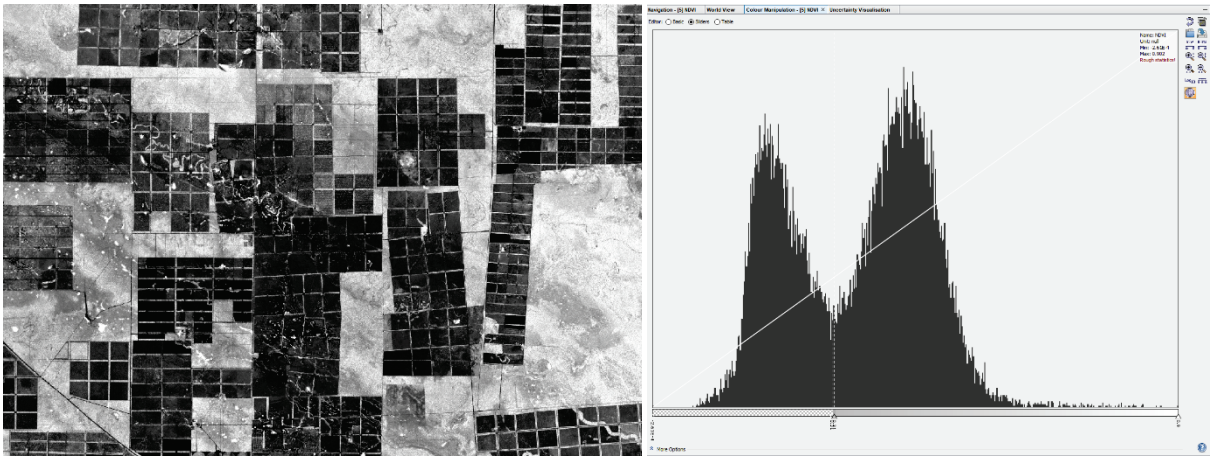




The common processing process can be monitored; we get the result depending on the speed of the computer.

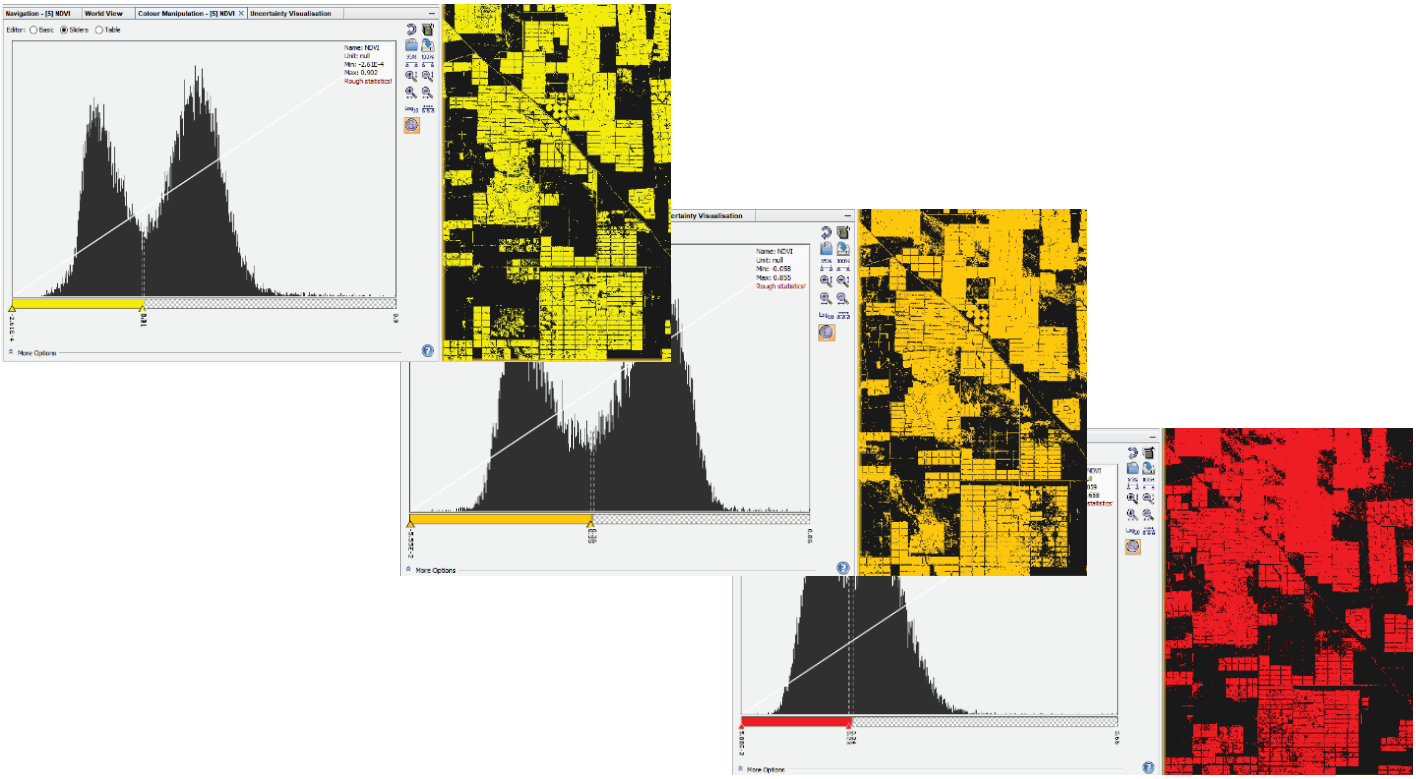


NDVI image - have values from < -1, 1 >, where forested areas are displayed in values higher than 0. The two peaks of the histogram point to 2 extremes - forested and logged area.



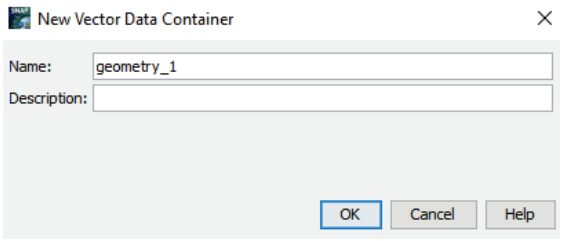
2.4. Classification

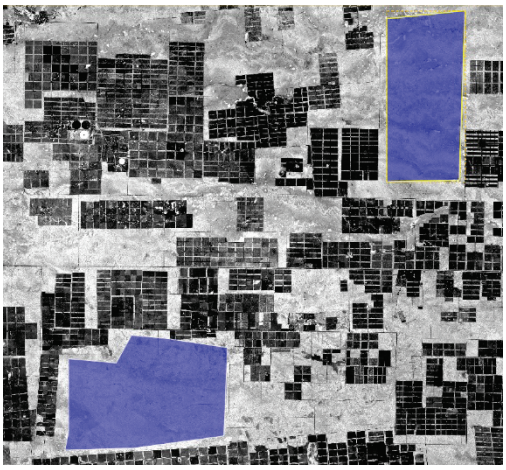
Image analyses - by adding sliders, changing the colour display and setting the transparency, we can make the first visual analyses of the extracted areas. By using grayscale thresholding, it is possible to create a forest/non-forest image.

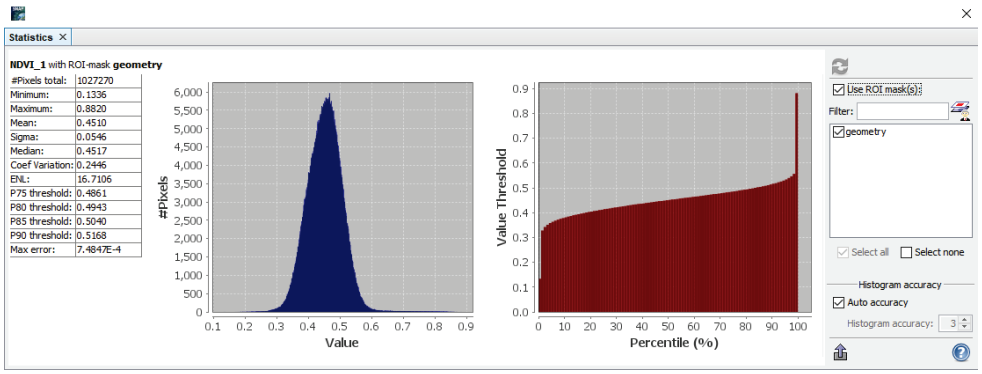


In addition to grayscale thresholding, a supervised classification can be used by specifying training regions where the operator defines which polygons represent the forest regions. Based on the statistical data shown in the table, we can create a mathematical condition „if NDVI > „parameter“ and NDVI < parameter“ then 0 else 1“.

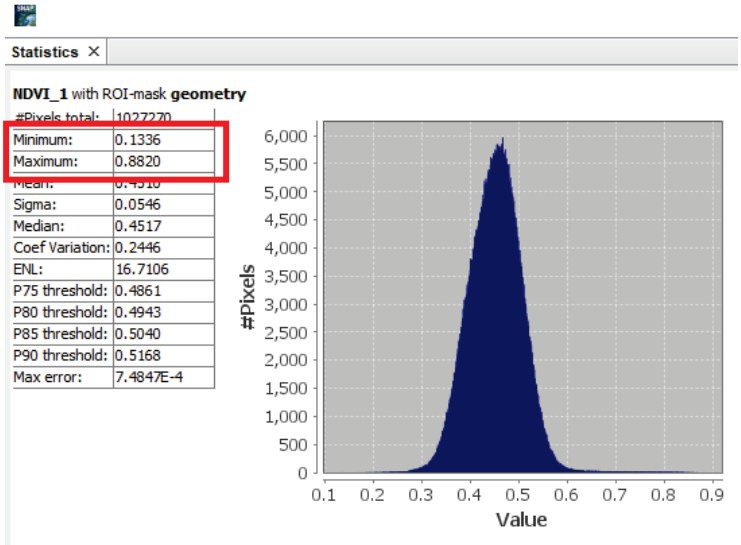
The value 1 shows the extracted areas.





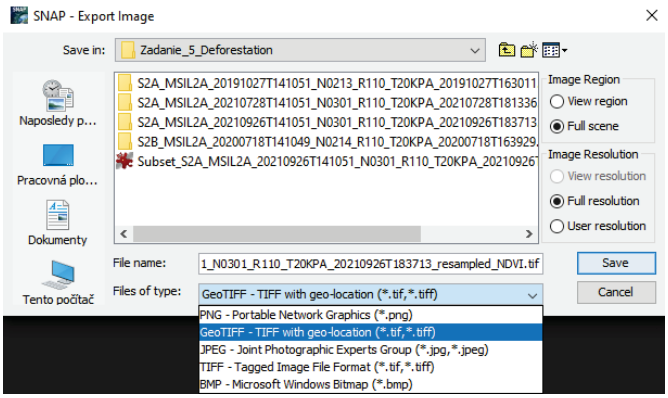


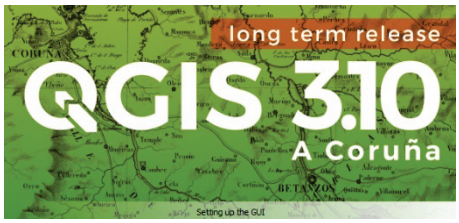
Detail of statistical results defined by training areas:



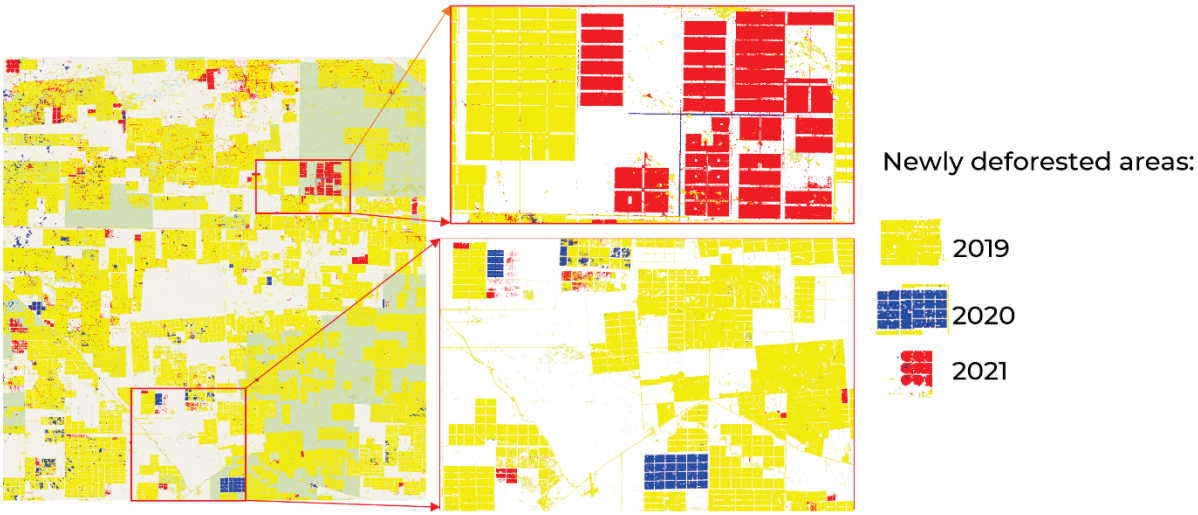
2.5. Postprocessing

The resulting masks are exported to GIS software (for instance qGIS) in *GeoTIFF* format as the full scene at the full resolution.



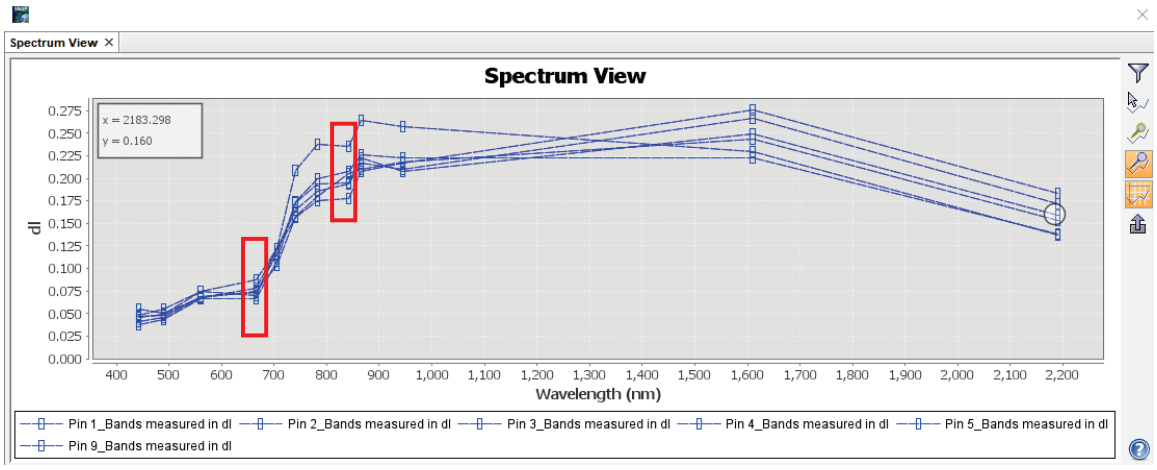


The subsequent processing in qGIS consist in applying different colours for layers of individual years:

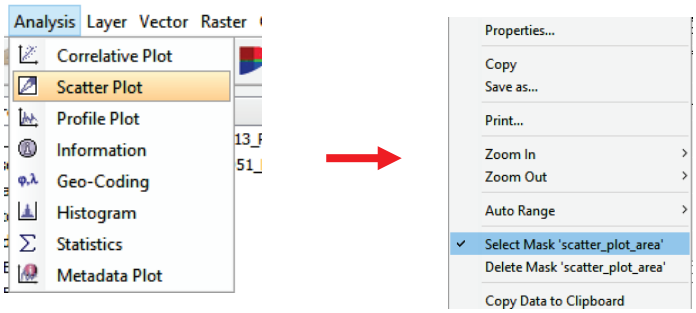


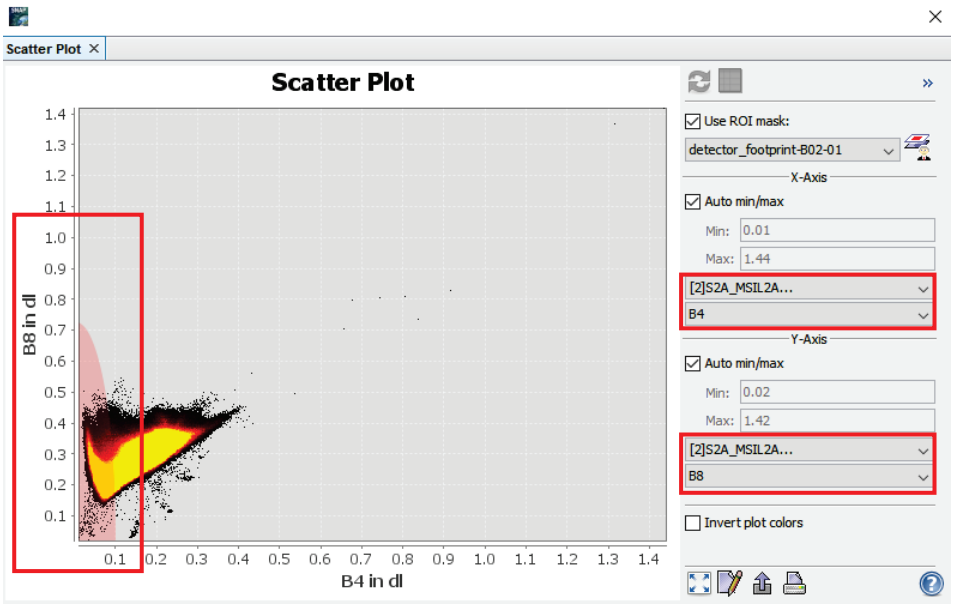
We can do additional analysis using the spectral curves. In Spectrum View, we can display spectral curves of multiple vegetation pins.

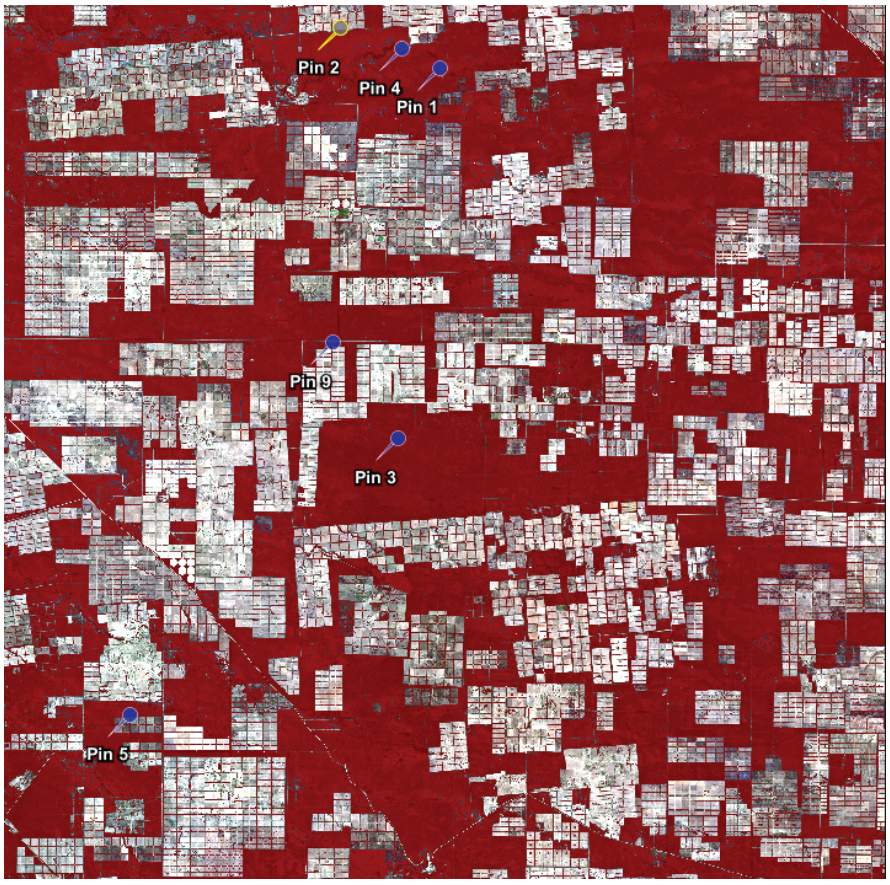
In Spectrum View, bands B4 and B8 are shown in the box, which depict the reflectance at given wavelengths.



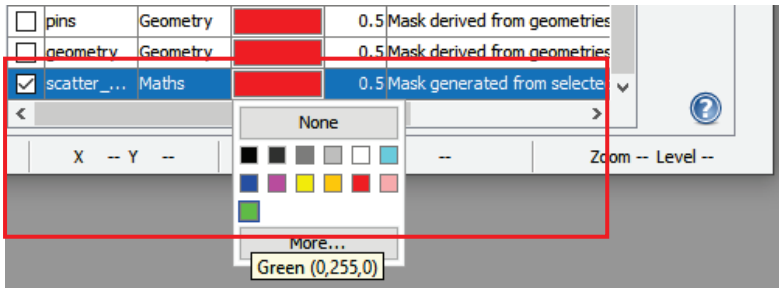
Opening the *Scatter Plot* in the *Analyses* tab displays a dependency plot of the common display of the B4 and B8 bands. By plotting the region dl $\in <$ 0.1, 0.5 $>$ according to the spectral curves, we obtain the colour selection of the vegetation pixels using the *Scatter Plot*.


Analysis
Layer
Vector
Raster
Correlative Plot
Scatter Plot
Profile Plot
Information
Geo-Coding
Histogram
Statistics
Metadata Plot
Properties...
Copy
Save as...
Print...
Zoom In
Zoom Out
Auto Range
Select Mask 'scatter_plot_area'
Delete Mask 'scatter_plot_area'
Copy Data to Clipboard

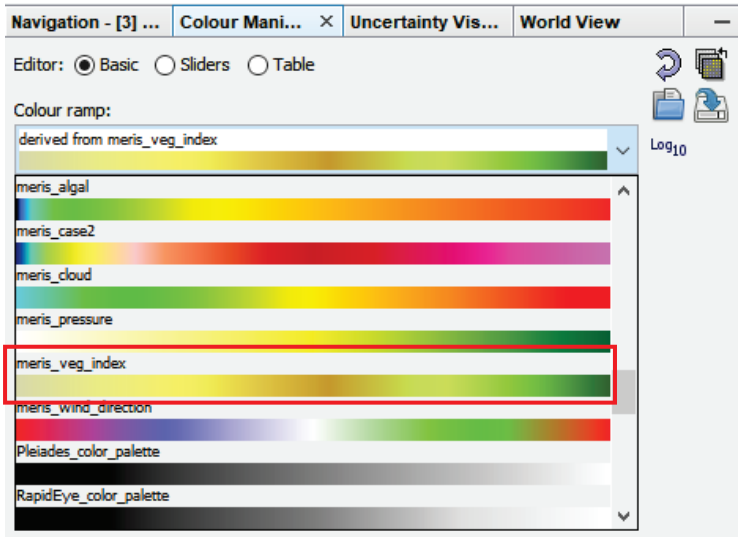

Scatter Plot
Scatter Plot
B8 in dl
B4 in dl
Use ROI mask:
detector_footprint-B02-01
X-Axis
Auto min/max
Min: 0.01
Max: 1.44
[2]S2A_MSIL2A...
B4
Y-Axis
Auto min/max
Min: 0.02
Max: 1.42
[2]S2A_MSIL2A...
B8
Invert plot colors

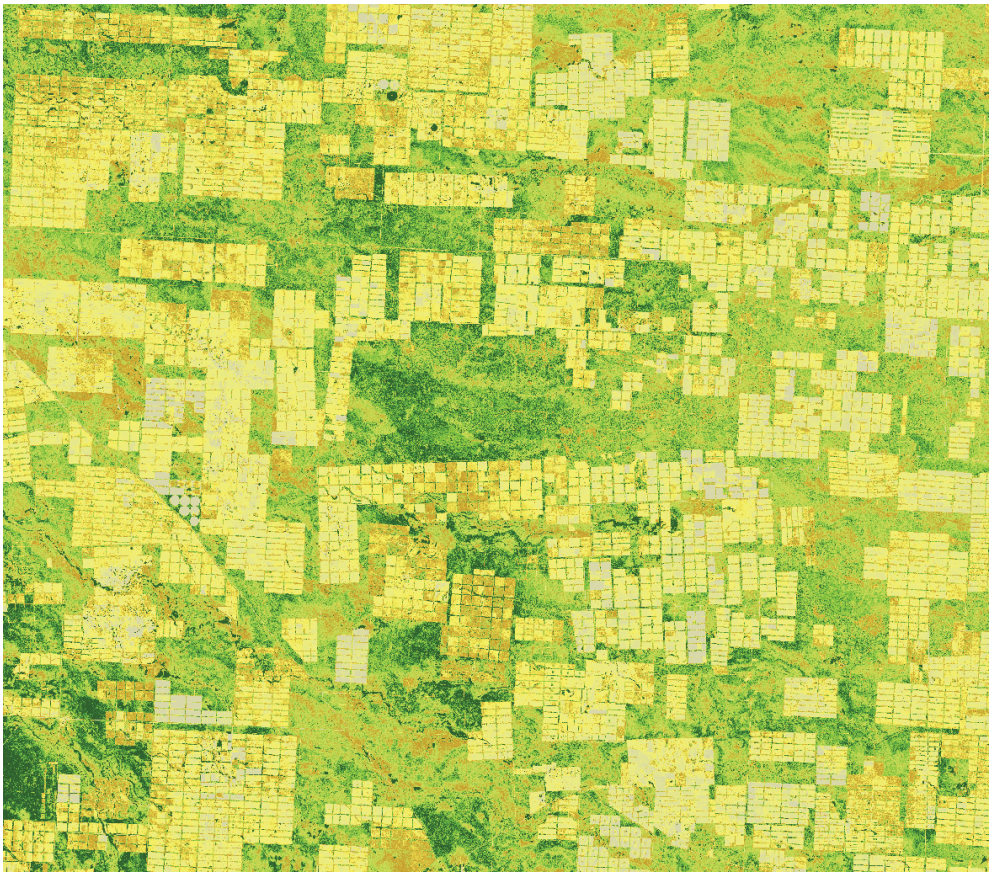

Pin 2
Pin 4
Pin 1
Pin 9
Pin 3
Pin 5

By creating a plot and selecting an area, a new mask called *Scatter_plot* is created in the *Mask manager*. We can change the colour of the vegetation by setting the display colour to green.



Finally, the vegetation can be displayed using the created NDVI mask by applying the *meris_veg_index* colour scale in the *Colour manipulation/Basic tab*.





THANK YOU FOR FOLLOWING THE EXERCISE!