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DEVELOPMENT OF A TRAINING PROGRAM FOR ENHANCING THE USE OF ICT TOOLS IN THE IMPLEMENTATION OF PRECISION AGRICULTURE

2018-1-ES01-KA202-050709

T.P.3 – Remote Data Mapping Exercise in QGIS

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Contents

1 UAV Data Mapping Exercise in QGIS

You are given a set of remote sensing data[1], consisted of four single-band UAV imagery orthomosaics of an agricultural field (open field broccoli), generated from a flight at 30m above ground level (AGL). The UAV carried a passive multispectral sensor that captured high resolution imagery data in the Green, Red, Red-edge and Near Infrared spectra, which correspond to your 4 raster data files. Generate three gridded maps of the vegetation indices NDVI, NDRE and GNDVI.

Index	Formula
NDVI	$\frac{NIR-Red}{NIR+Red}$
Green NDVI (GNDVI)	$\frac{NIR-Green}{NIR+Green}$
Red-edge index (NDRE)	$\frac{NIR-(Red\text{-}edge)}{NIR+(Red\text{-}edge)}$

2 Tasks

1) Import your data to QGIS.

2) Use the raster files to generate new raster layers with the respective vegetation indices in them.

3) Mask the soil and weed pixels from your data.

4) Clip the raster vegetation index files to the boundaries of your field / area of interest.

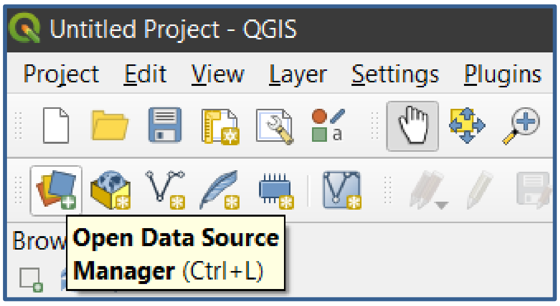
5) Construct a 10x10 meters resolution grid layer with the statistical values of the respective Vegetation Indices for a selected area in the field.

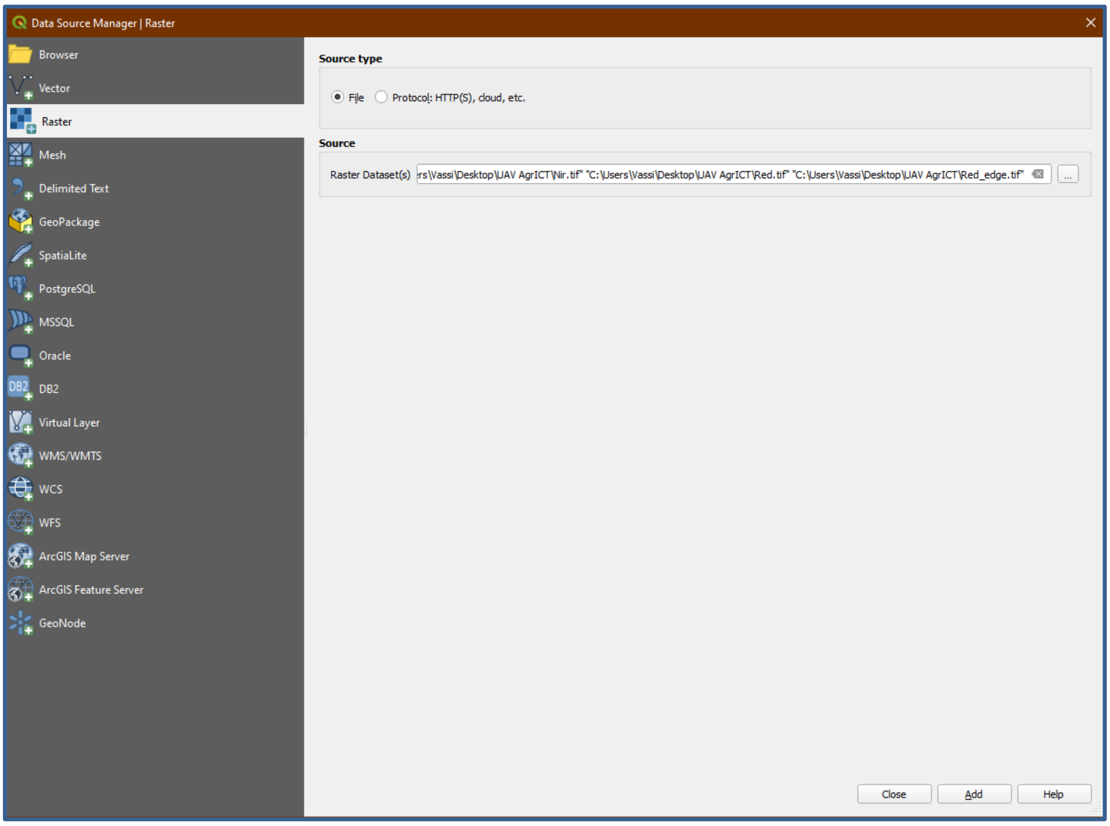
[1] https://drive.google.com/drive/folders/1wMnoyVxWruXKDqhDXmLnMFcOkiu1vCy7?usp=sharing

3 Example on how to create a VI map from UAV raster files

The following section will provide analytical guidelines for the creation of one vegetation index map, similar to the ones asked in the introduction.

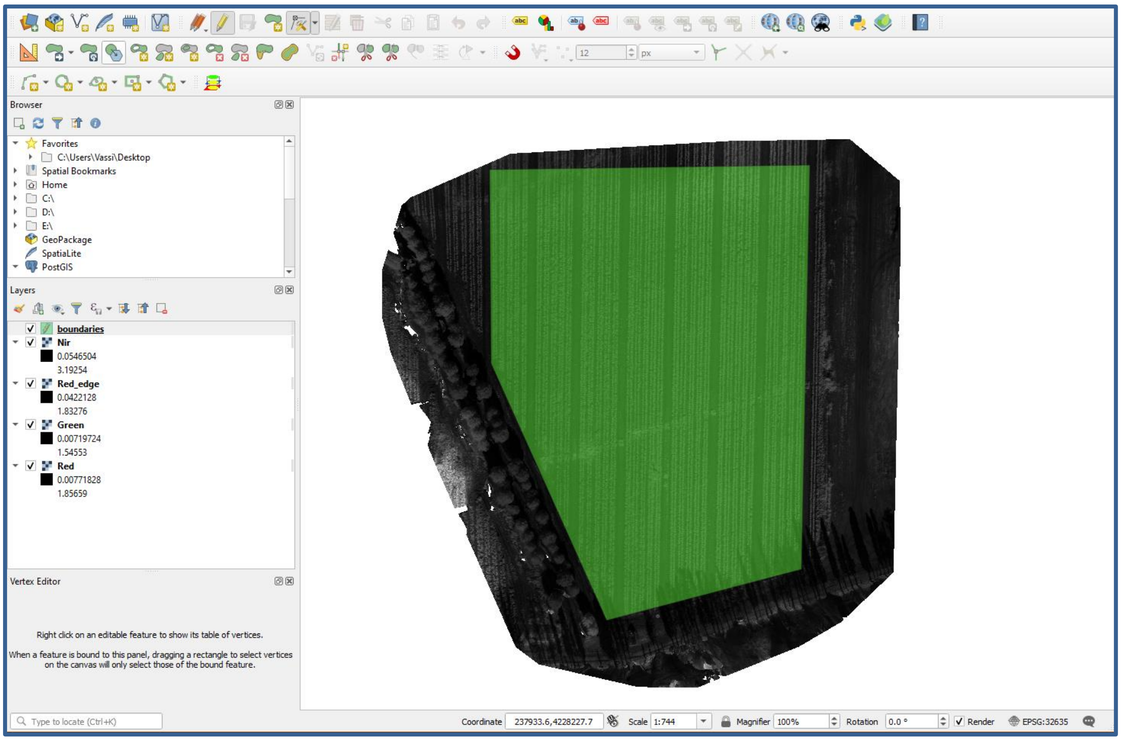
1) Import your data into QGIS by using the **Open Data Source Manager** and select to import a **Raster file**. Then, browse to your files.





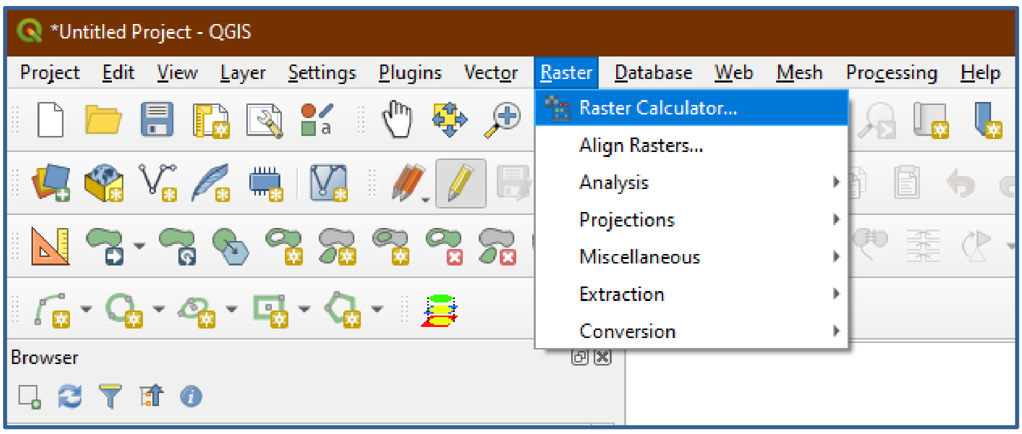
2) Now your files should have been added as layers. The second step is to define the boundaries of your field, within which all processing will take place. In our case, we will only slightly trim the edges of the field, but in applications were larger orthomosaics are used, this step is crucial to ensure the efficiency of your project, especially when working with limited computational resources. The creation of the boundary file follows the exact same steps described in the **Proximal Practical**

Activity guidelines, were we created a new shapefile and then drew and edited the edges (vertices) until the polygon shapefile obtained the desired shape. Once you are finished, your project should look like Figure 1.

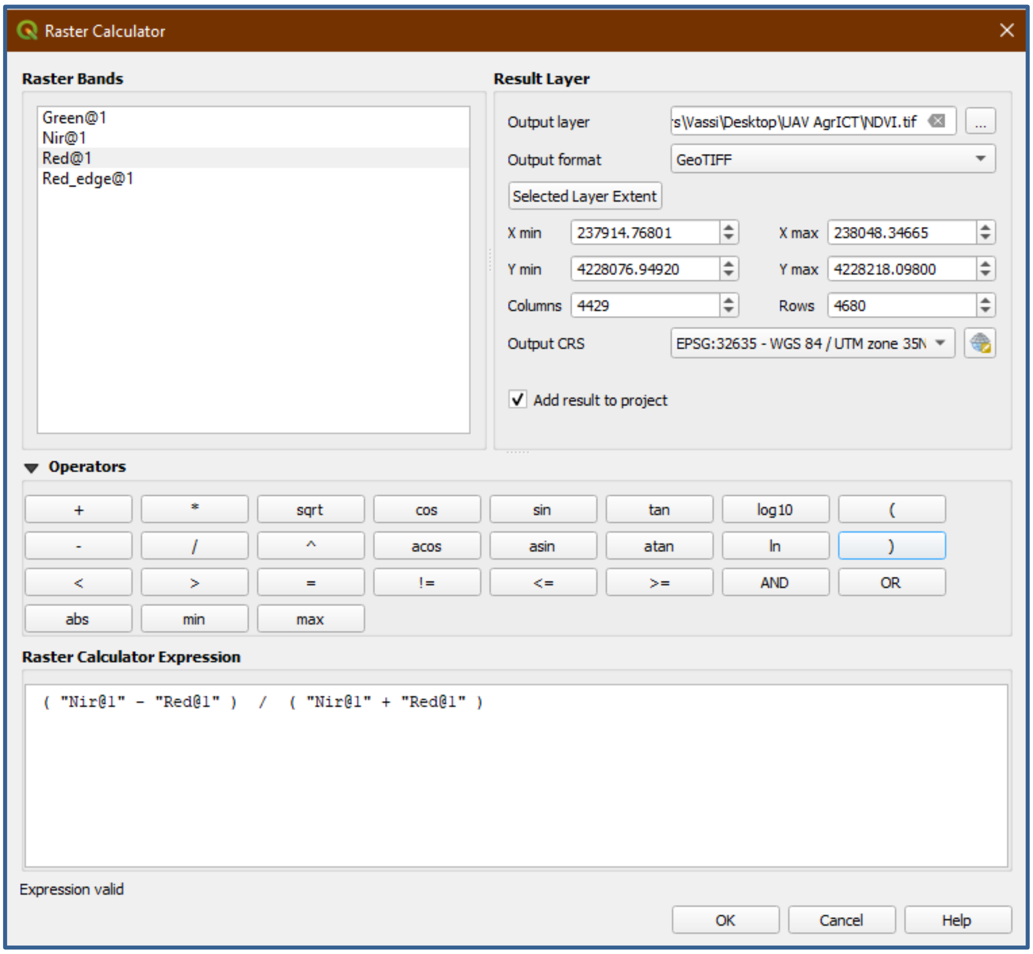


3) Once the boundaries have been defined, the following step can either be cutting the single-band raster files one by one using the boundary file, or to create the vegetation indices first and then cut these layers instead. For our example, we will first create the index raster file, and then extract it using the boundaries as a mask.

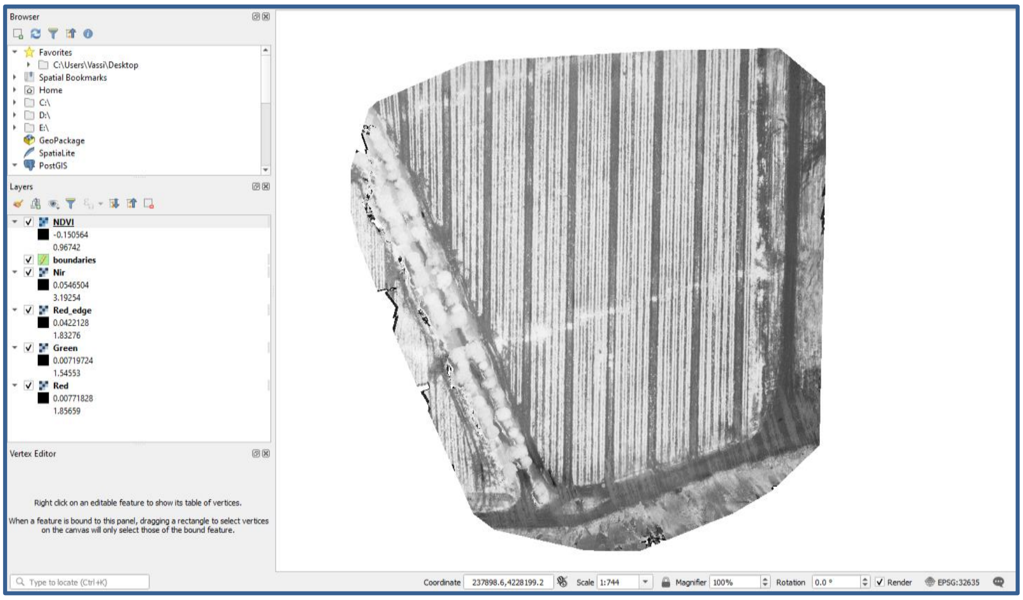
4) To create a new vegetation index raster file, we simply click on the **Raster** menu and select the **Raster Calculator**.



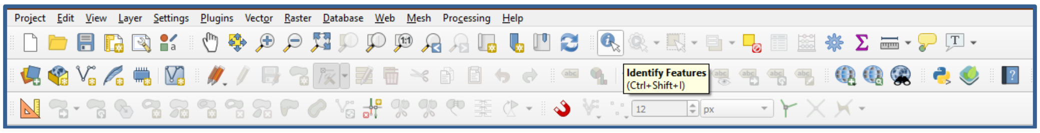
5) In our example, we will use the NDVI index. We construct its formula by replacing the spectra with the respective single-band images in the index's equation, to apply the index equation on every pixel of the initial images. To import one of the available raster layers as a variable in our equation, we simply double-click its name in the Raster Bands window, and it is instantly added in the expression window below. Finally, we select where the new vegetation index raster file will be saved through the "Output layer".



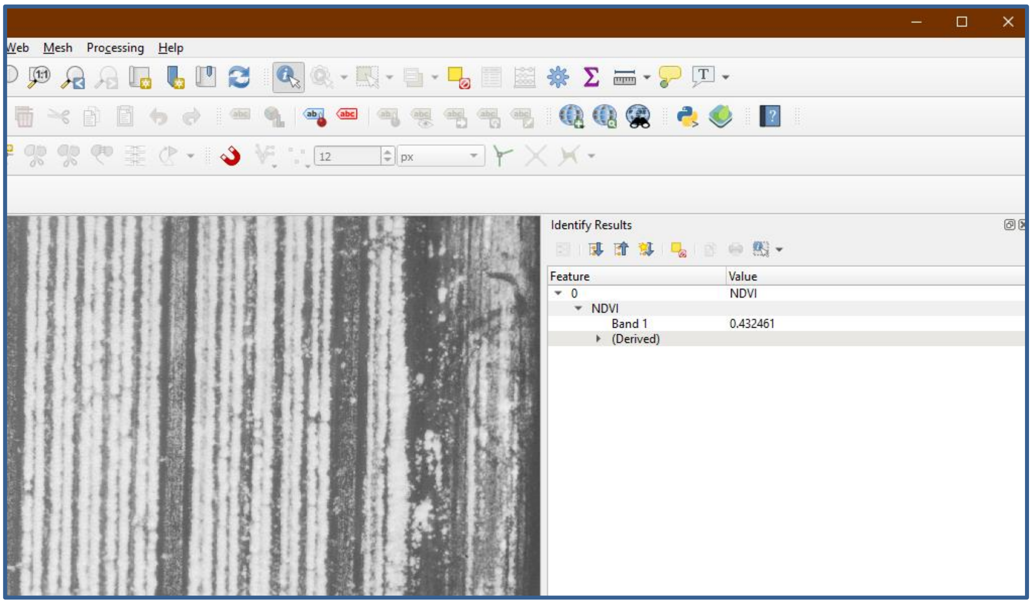
6) The index raster file should look like the following Figure. You will notice that, naturally, pixels that represent vegetation have high values (close to 0.7-0.9), while soil pixels between our planting rows have significantly lower values. Similarly to the previous exercise, we will exclude the pixels that contain these "noisy" data before we calculate the statistics for each grid.



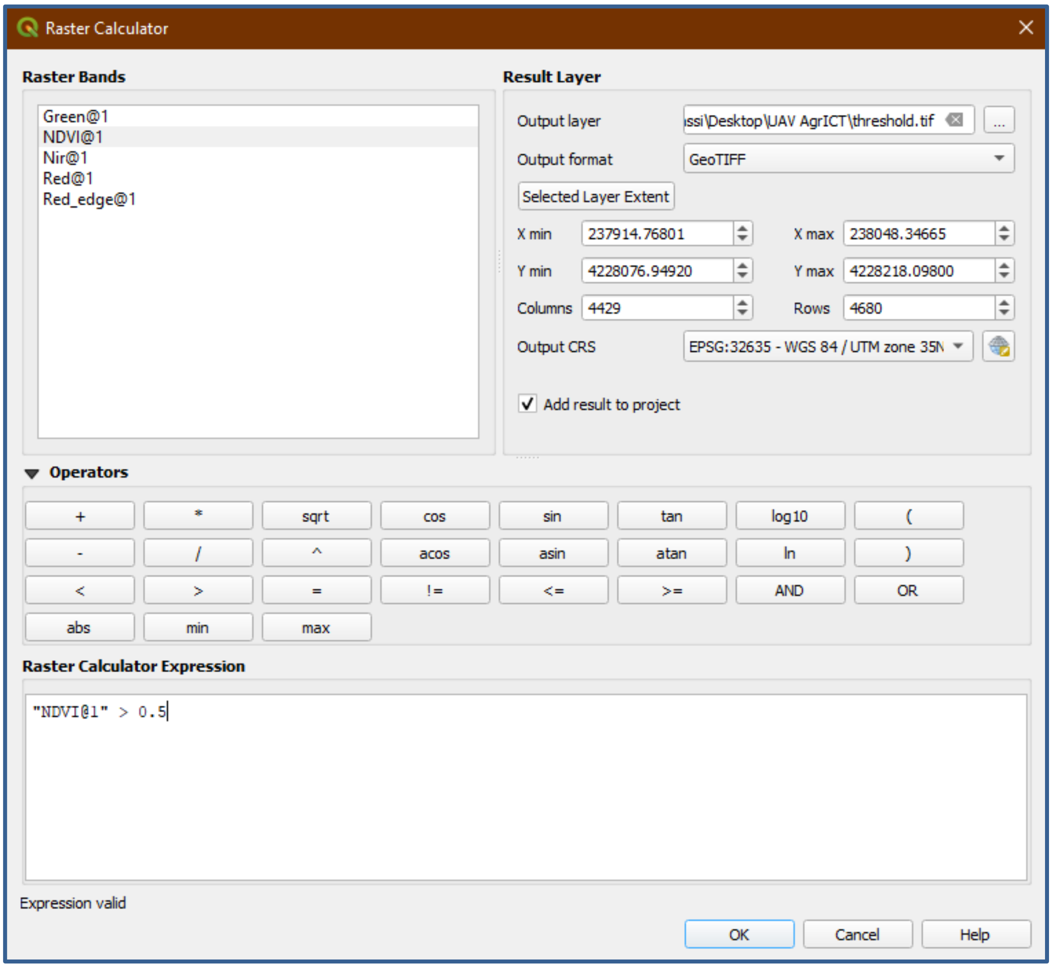
7) To delete all pixels that contain no vegetation, we will use a trick. First, we will create another raster file, one that can only have two possible values in its pixels, 1 and 0, based on whether they represent vegetation or not. To do this, we must first identify the index value of the soil pixels, using the **Identify Features** tool, as seen below, and click on of the (darker) soil pixels.

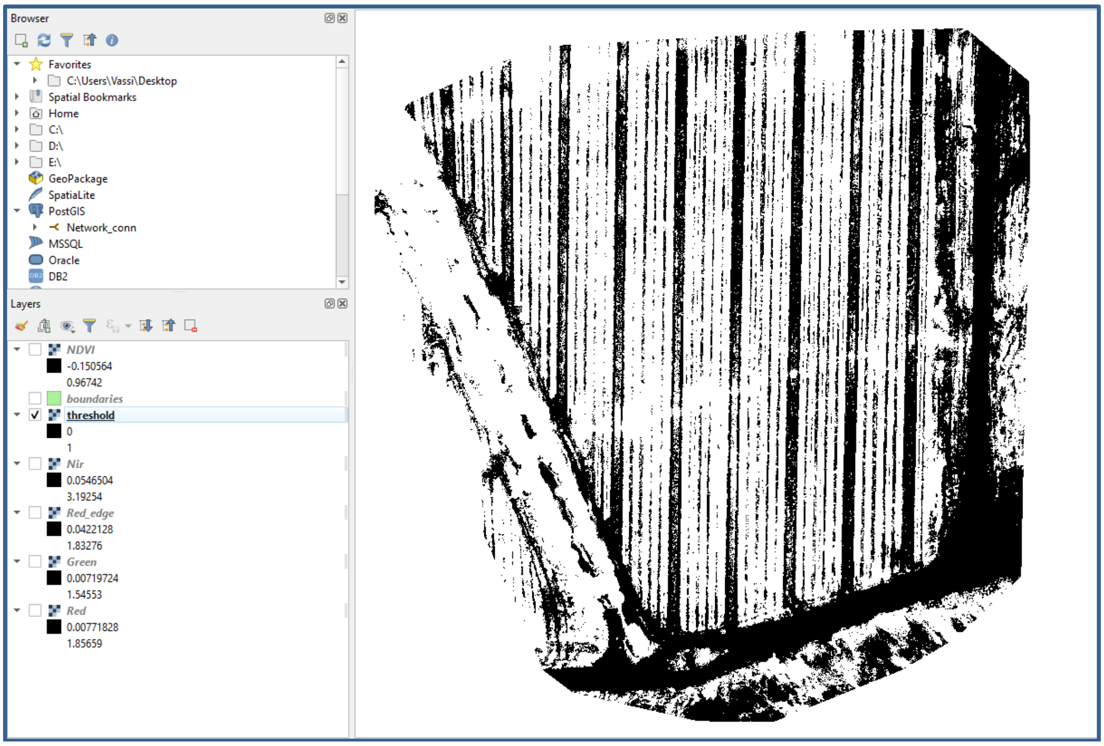


We notice that the soil has a rather high NDVI index as seen below. This can be due to two reasons: the soil characteristics or weed presence. Soils with high organic matter content or high water retention capacity have higher reflectance in the near infrared spectrum, thus demonstrating higher NDVI values. Weeds on the other hand, are vegetation nonetheless, but most of the time demonstrate significantly lower reflectance in the infrared spectrum, which makes them easily distinguishable from the cultivated crops (in our example the broccoli plants). Therefore, for our example, we will have to use a high masking value (0.5) to effectively isolate the vegetation pixels from the soil and weed pixels. Our new threshold layer will take the value 0 if the original NDVI value of a pixel is lower than 0.5, and the value 1 if it is higher than 0.5.

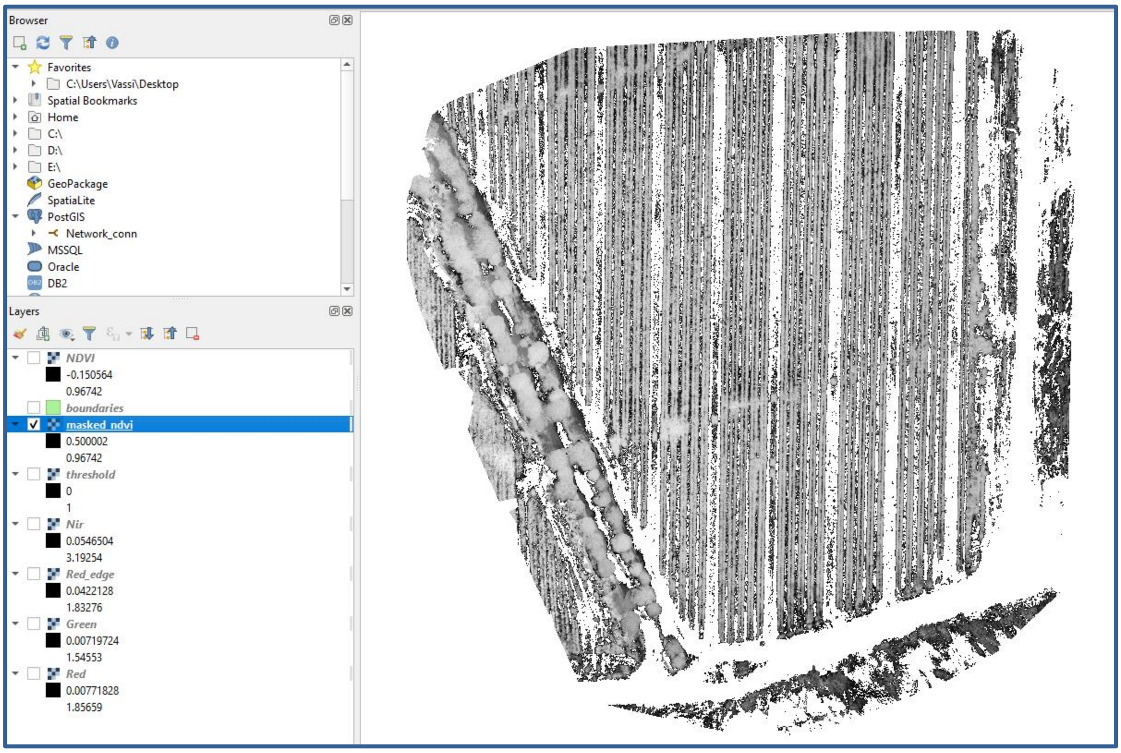


8) To create the new threshold raster, we will once again use the Raster calculator, using the equation that appears below, which converts the NDVI layer into a binary map, as explained before.



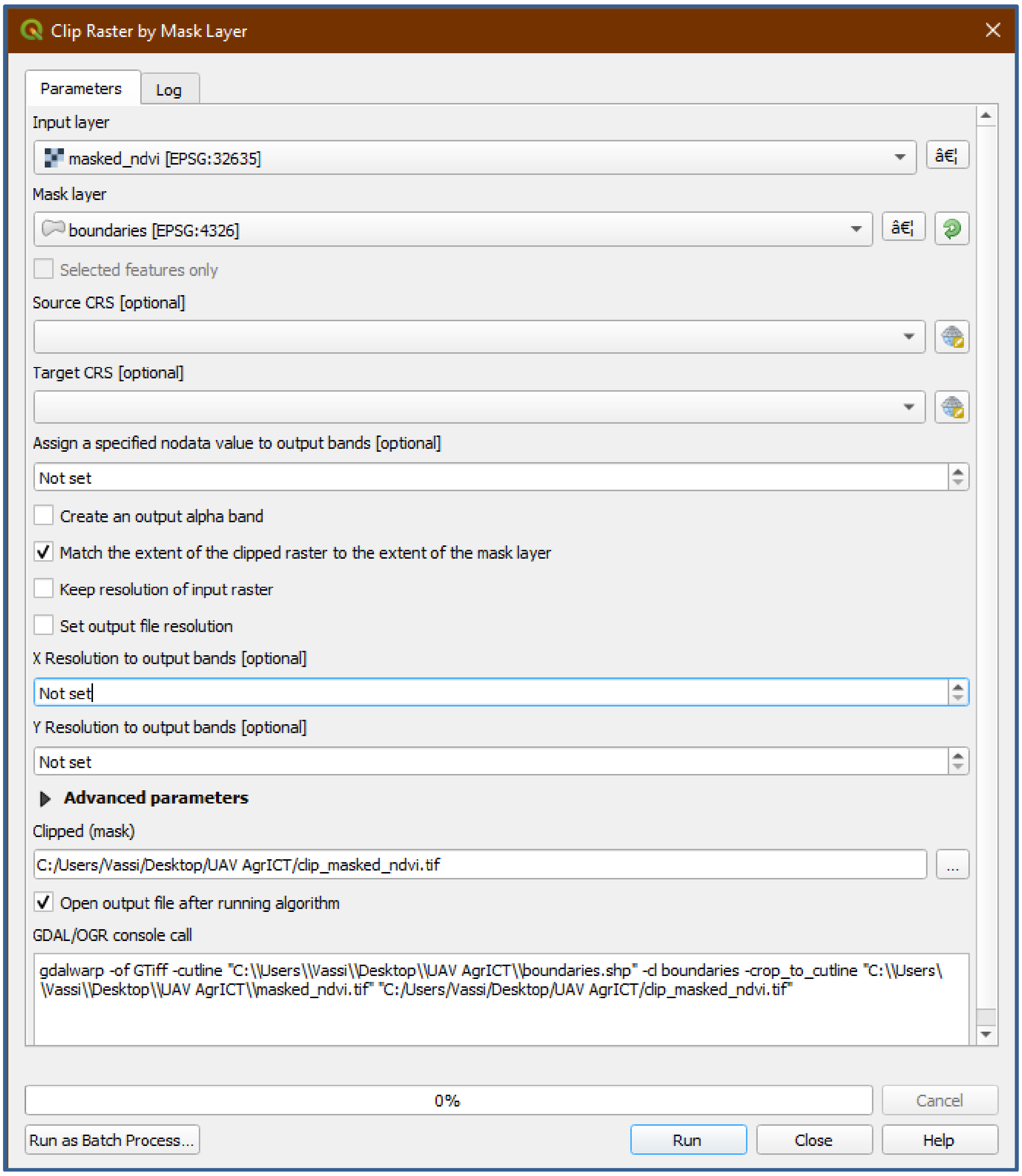


9) We will then use Raster Calculator one last time, to divide our original NDVI layer, with the new binary one. This way, all pixels that contain soil or weeds (0 in the binary threshold layer) will be attempted to be divided by 0, and therefore, will not be created. On the other hand, pixels that contain our crops of interest (1 in the binary threshold layer) will be divided by 1, and will therefore maintain their original NDVI value. The final result will look like the following Figure.

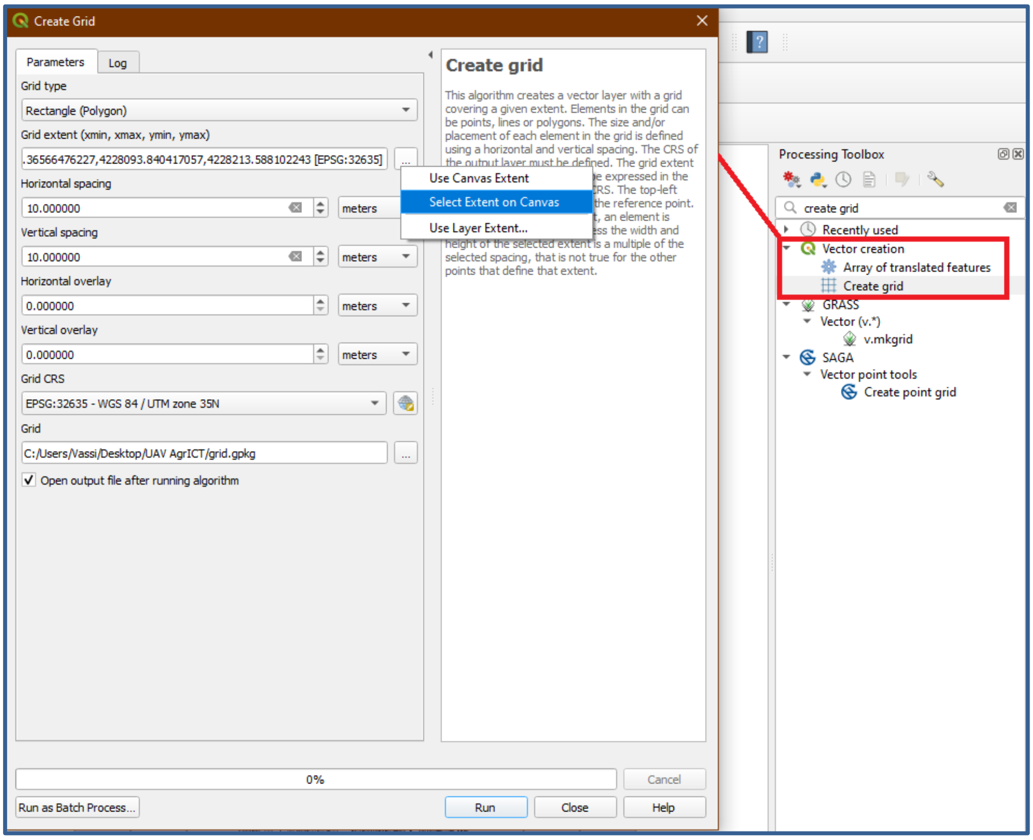


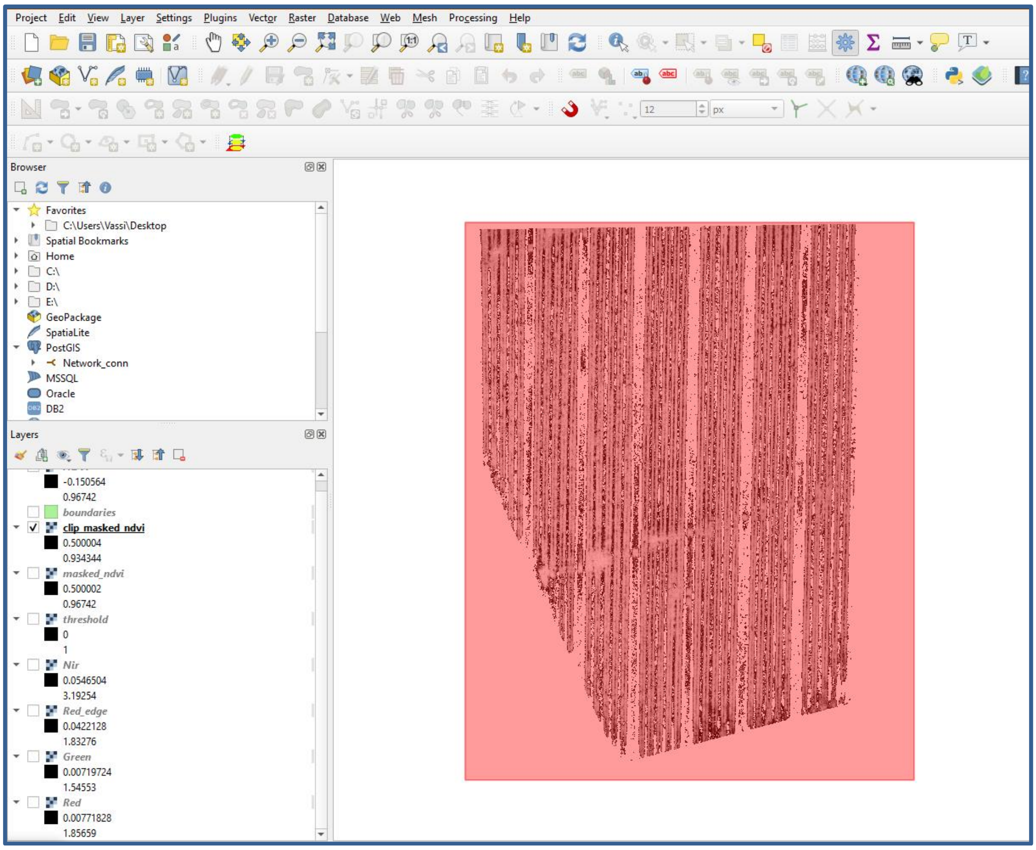
Notice that, even after the masking process, some pixels between the cultivation lines still remain. These pixels are certain to contain weeds of high infrared reflectance / NDVI values. Generally, it is advised to not increase the threshold value too much, in an attempt to delete such pixels, since by doing so (i.e. if we tried to mask all pixels with NDVI lower than 0.6), we might as well loose a significant number of our cultivated crop's pixels, and more specifically the segments of the field with low vigour, which are the ones that we might have focus on.

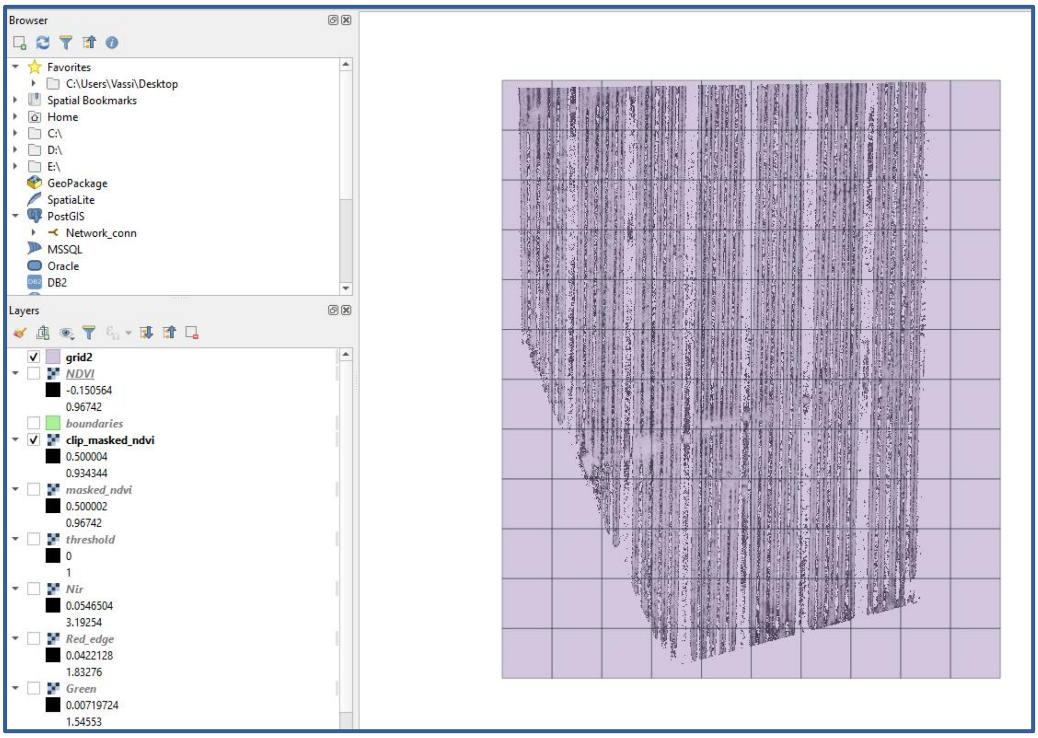
10) Now we can cut the newly created layer that only contains the pixels with the broccoli crops, using the boundaries' polygon shapefile, with **Raster -> Extraction -> Extract Raster by mask layer**. We also select the path where the new clipped raster will be saved, otherwise QGIS will create a temporary file which will only exist until we close it.



11) The final step is to create the grid vector file that we will use to delineate our field in cells of equal area and calculate the statistics for each segment. In the Proximal Practical Activity exercise, the grid file was provided. Now, we will create one, using **Create Grid** from the Vector Creation toolbox. When selected, we will define the type of the grid, which will be '*Rectangle (Polygon)*', as well as the dimensions of each grid cell (10 x 10 meters). Then, we select the extent of the grid into the canvas, by selecting a larger area in the map as seen in the second Figure below. Finally, we save the layer as a file to not have it only as a temporary file. After fixing the opacity of the newly created grid (right clip on the grid layer -> Properties), the final result must look like the third Figure below.

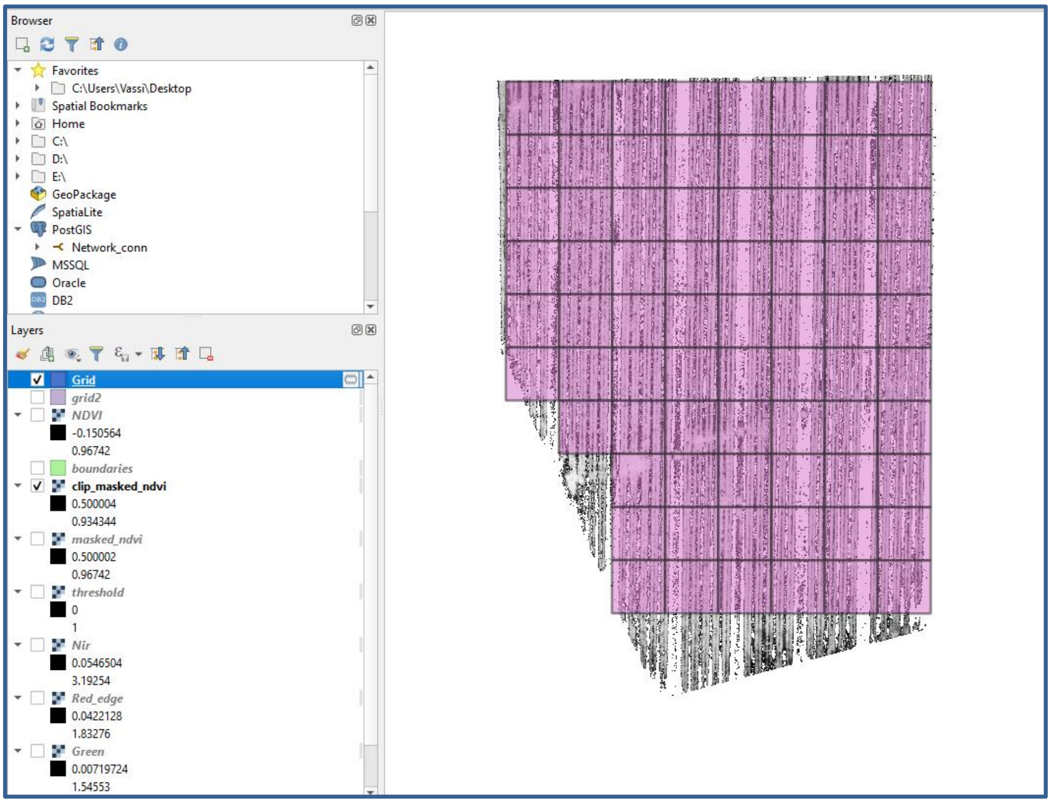




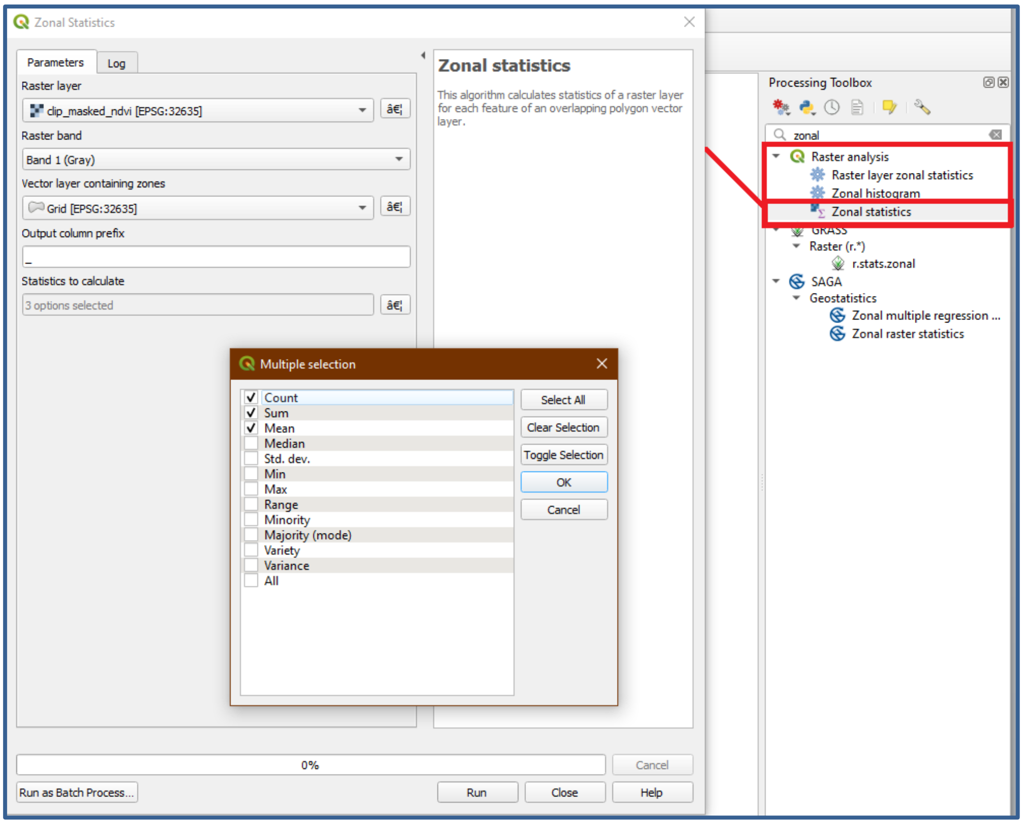


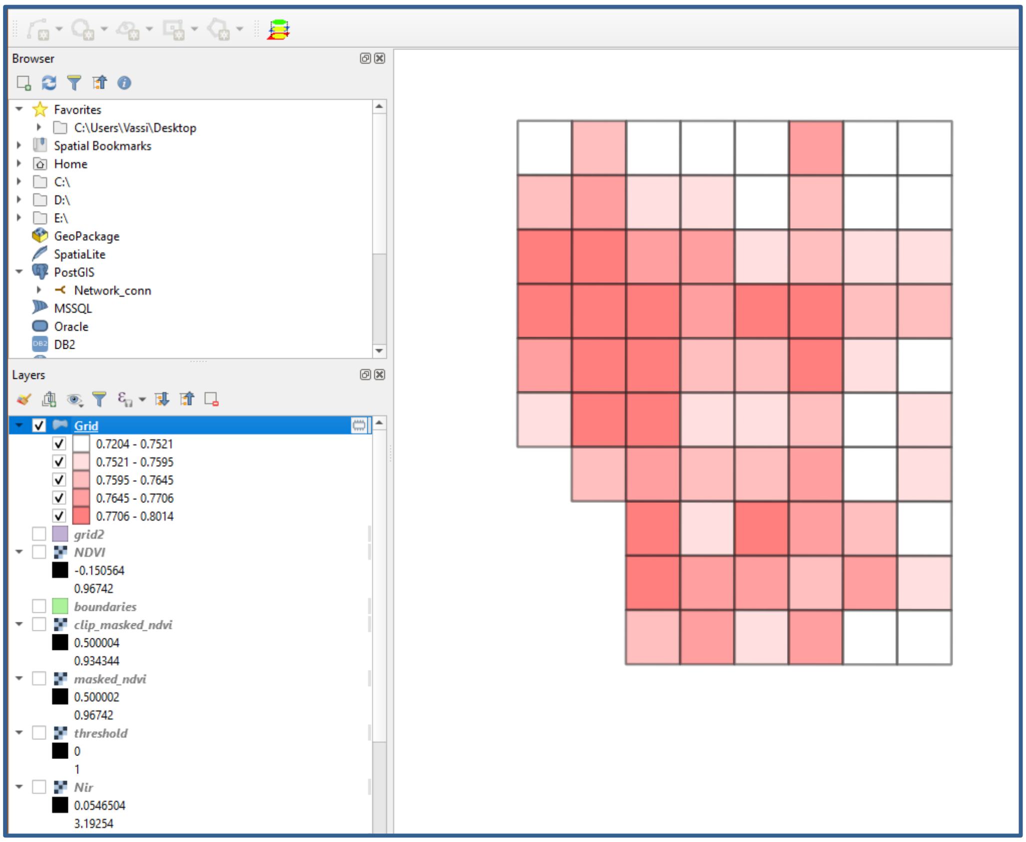
The grid we just created is a polygon vector file, which we can therefore freely edit using the Editor tool. If the toolbox "Advanced digitizing tools" is not active in your taskbar, you should enable it (Right click -> Toolboxes -> tick the new toolbox). This way we can move / adjust our grids and delete the ones that are out of our field of interest.

In our example since we do not have a rectangular field, we will set an focus area and keep only the “pure” cells in these cultivation lines (the ones with almost full vegetation coverage and not the boundary planting lines which leave a lot a spaces in the rectangular cells, thus making them susceptible to outliers in statistical processes such as when calculating the mean values of the cell). After deleting all the other cells and moving/rotating our grid to better fit the cultivation lines using the Editor tool, the final result should look similar to the following Figure.



12) Finally, the last step of this exercise is to calculate the statistics for each grid cell in our field. To do so, we will use the **Zonal Statistics** tool, which will write the selected statistics as rows in our grid vector file, which can naturally access from its Attribute Table (right click on layer). After formatting the symbology of the new map, so that the visualized value is the desired statistic, your final map should look like the final Figure bellow (in this example map we selected a **Graduated** map with 4 classes and ‘Quantile’ classification).


Zonal Statistics
Parameters
Log
Raster layer
clip_masked_ndvi [EPSG:32635]
Raster band
Band 1 (Gray)
Vector layer containing zones
Grid [EPSG:32635]
Output column prefix
_
Statistics to calculate
3 options selected
Zonal statistics
This algorithm calculates statistics of a raster layer for each feature of an overlapping polygon vector layer.
Multiple selection
Count
Sum
Mean
Median
Std. dev.
Min
Max
Range
Minority
Majority (mode)
Variety
Variance
All
Select All
Clear Selection
Toggle Selection
OK
Cancel
0%
Cancel
Run as Batch Process...
Run
Close
Help
Processing Toolbox
zonal
Raster analysis
Raster layer zonal statistics
Zonal histogram
Zonal statistics
GRASS
Raster (r.*)
r.stats.zonal
SAGA
Geostatistics
Zonal multiple regression ...
Zonal raster statistics


Browser
Favorites
C:\Users\Vassi\Desktop
Spatial Bookmarks
Home
C:\
D:\
E:\
GeoPackage
SpatiaLite
PostGIS
Network_conn
MSSQL
Oracle
DB2
Layers
Grid
0.7204 - 0.7521
0.7521 - 0.7595
0.7595 - 0.7645
0.7645 - 0.7706
0.7706 - 0.8014
grid2
NDVI
-0.150564
0.96742
boundaries
clip_masked_ndvi
0.500004
0.934344
masked_ndvi
0.500002
0.96742
threshold
0
1
Nir
0.0546504
3.19254