

Methodology to produce a **GREEN MAP** using GIS desktop

By PhD student:

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Introduction

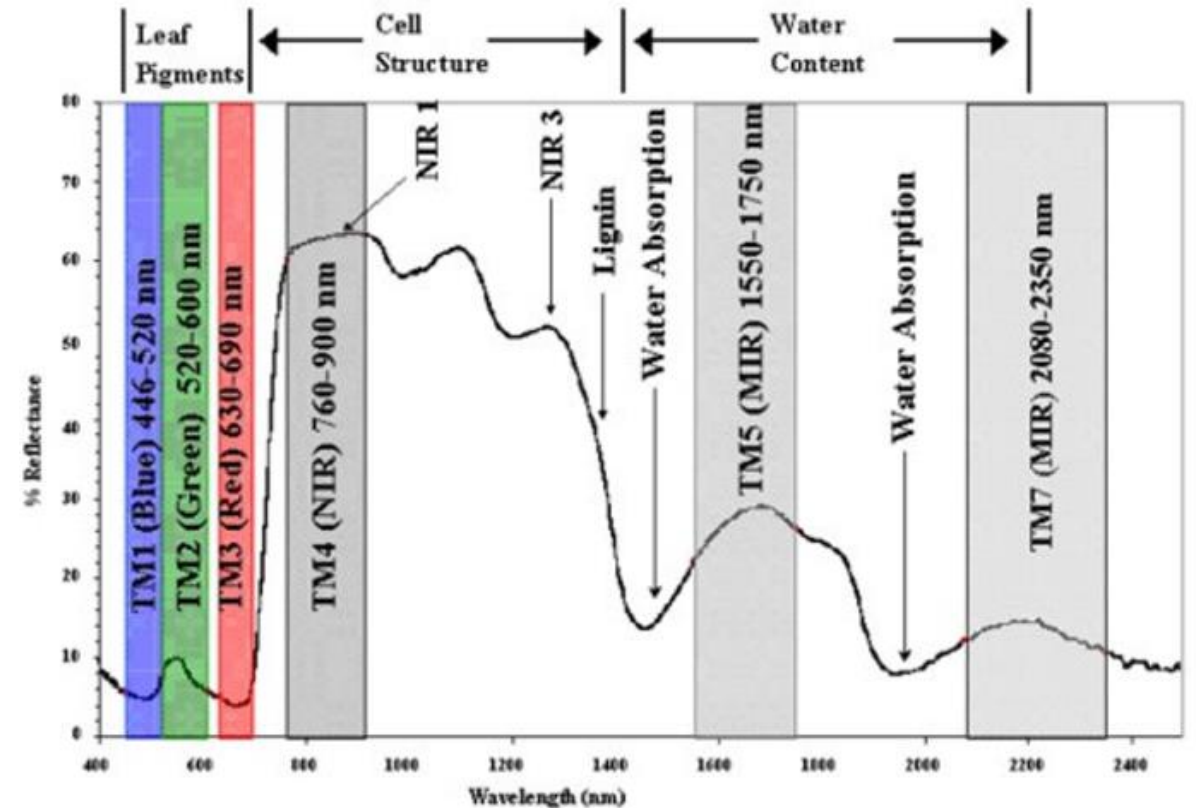
- To produce the green map, we divided into two steps:
 - Getting satellite image data by sentinel-2
 - <http://apps.sentinel-hub.com/eo-browser/> or <https://scihub.copernicus.eu/>
 - Applying the NDVI

Sentinel-2 and Copernicus platform

- Copernicus Sentinel data, from the European Space Agency's (ESA) SENTINEL-2 mission, is the European Union's earth observation and monitoring program that provides global satellite, ground-based, airborne and seaborne data, in near real time.
- **All data is free and open** through its European public funded services, developed, among others, to serve urban and regional planning through support for sustainable management and resilience.
- Sentinel -2 is adequate to study the green areas because it provides the bands red and infrared (we will explain more further ahead)


Red and infrared band

- As can be seen through a prism, many different wavelengths make up the spectrum of sunlight. When sunlight strikes objects, certain wavelengths of this spectrum are absorbed and other wavelengths are reflected.
- The pigment in plant leaves, chlorophyll, strongly absorbs visible light (from 0.4 to 0.7 μm) for use in photosynthesis. The cell structure of the leaves, on the other hand, strongly reflects near-infrared light (from 0.7 to 1.1 μm). The more leaves a plant has, the more these wavelengths of light are affected, respectively.



Sentinel-2

- The sentinel-2 satellite provides 13 spectral bands.
- It has a spatial resolution of **10m**.
- To apply NDVI we will use the bands 4 and 8.



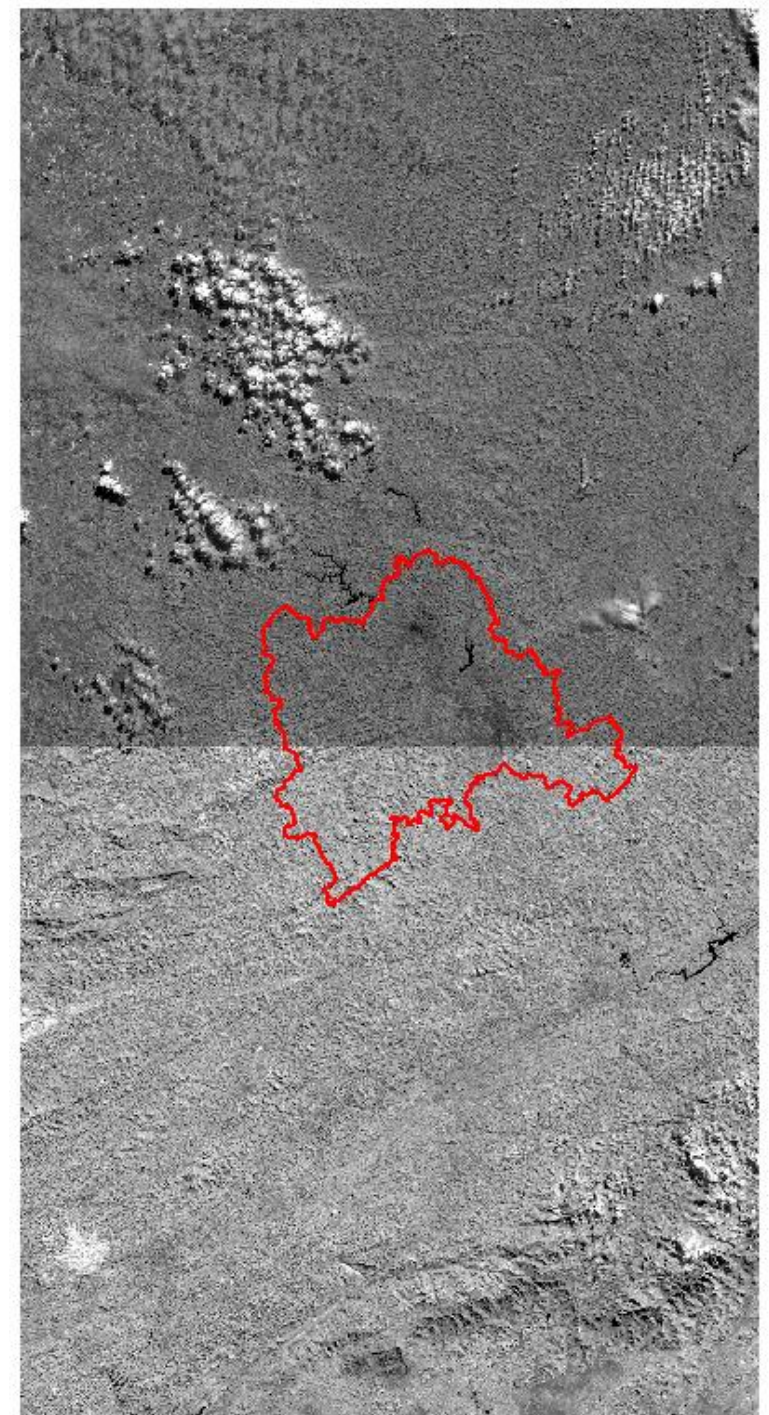
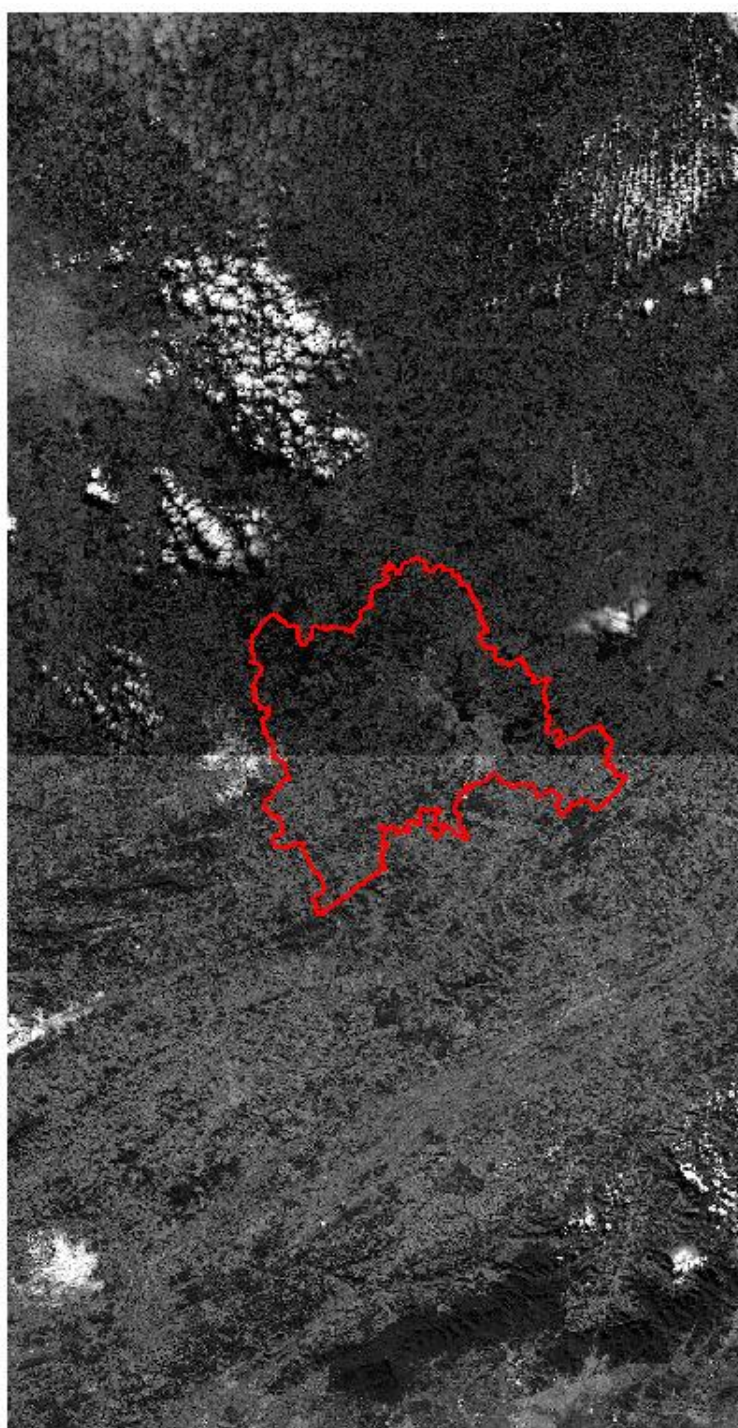
Sentinel-2 Bands	Central Wavelength (μm)	Resolution (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

Normalized Difference Vegetation Index - NDVI

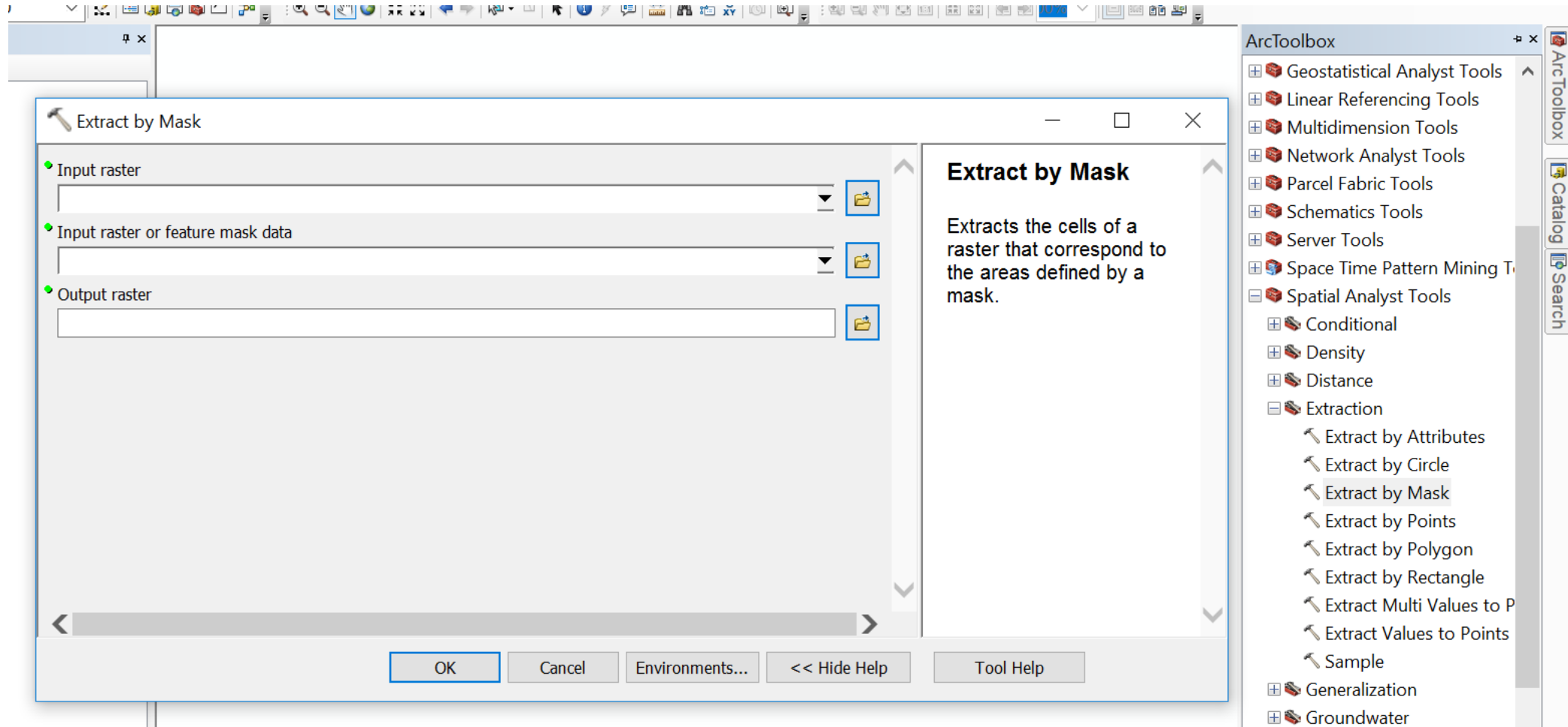
- We used a mathematical combination the Normalized difference vegetation index (NDVI) which is a simple graphical indicator that can be used to analyze remote sensing measurements, quantities vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs).
- The mathematical formula for NDVI calculation:
 - $NDVI = (NIR - Red) / (NIR + Red)$
- Calculations of NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus one (+1)
- The closer to 1, the greater is a vegetative activity at the site represented by the pixel. Negative values or close to 0 indicate areas of water, buildings, soil, and finally, where there is little or no chlorophyll activity.

Working with Sentinel-2:

- First, select the data: red (4) and infrared (8) bands.
- We need a boundary to define the area of the case study (we used the municipality of Juiz de Fora in Brazil).

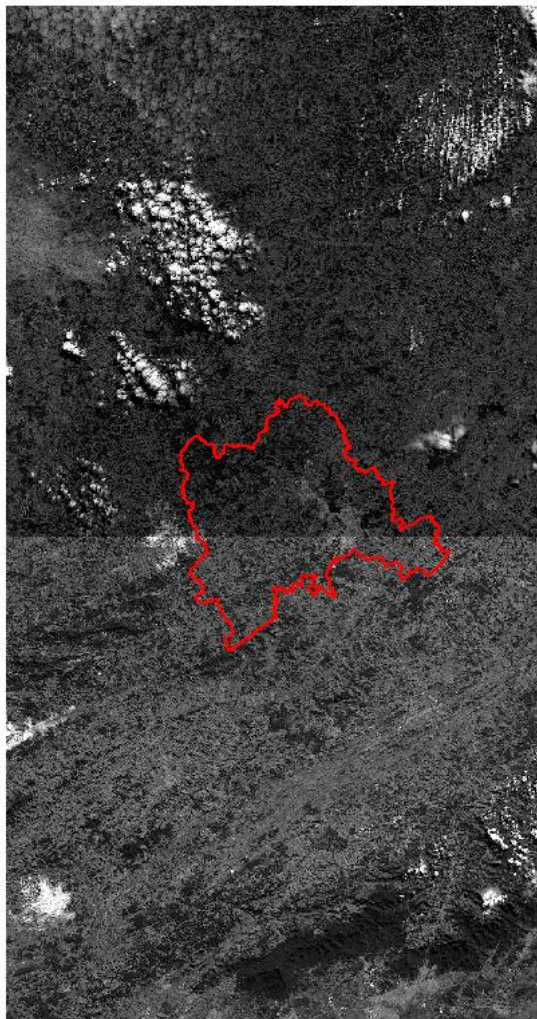


- Cut the bands according to the boundary (using Extract by mask)

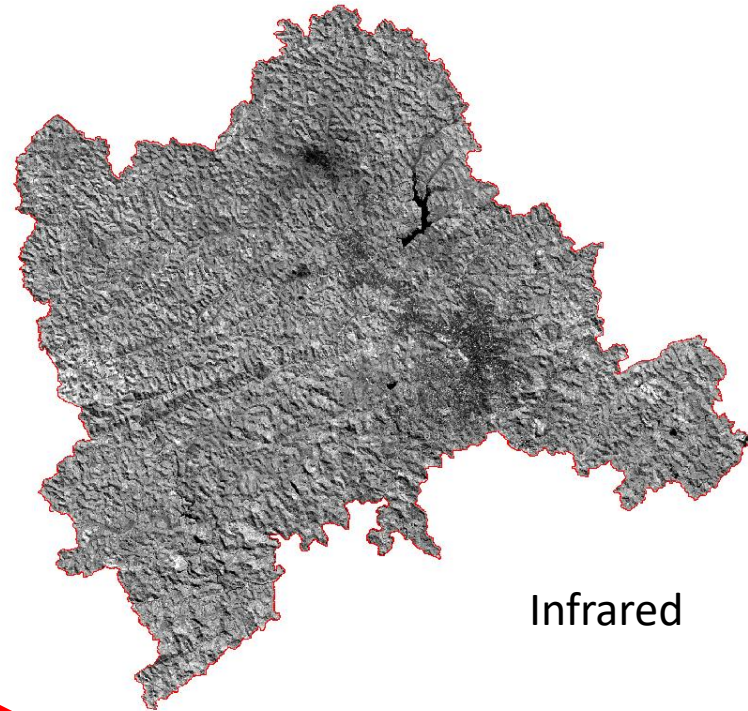
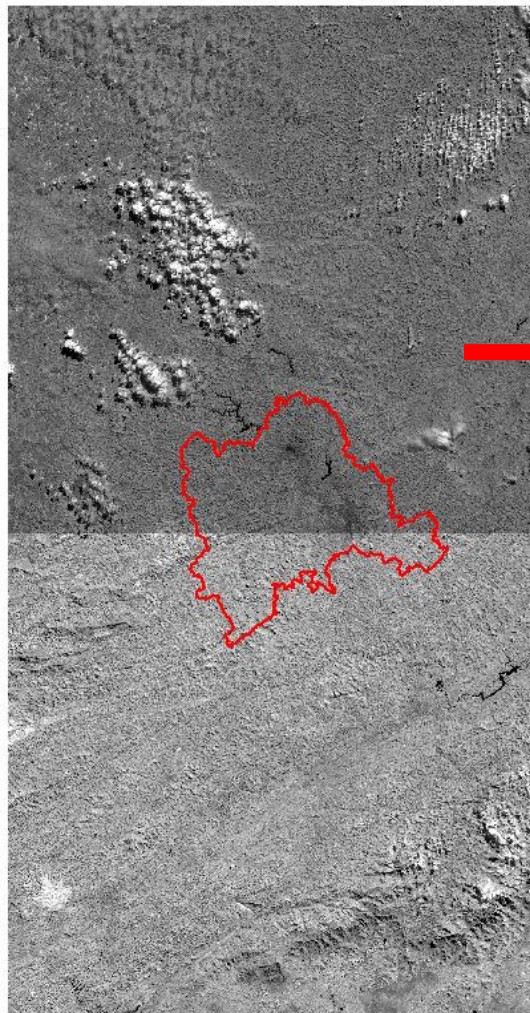


Result of the extraction

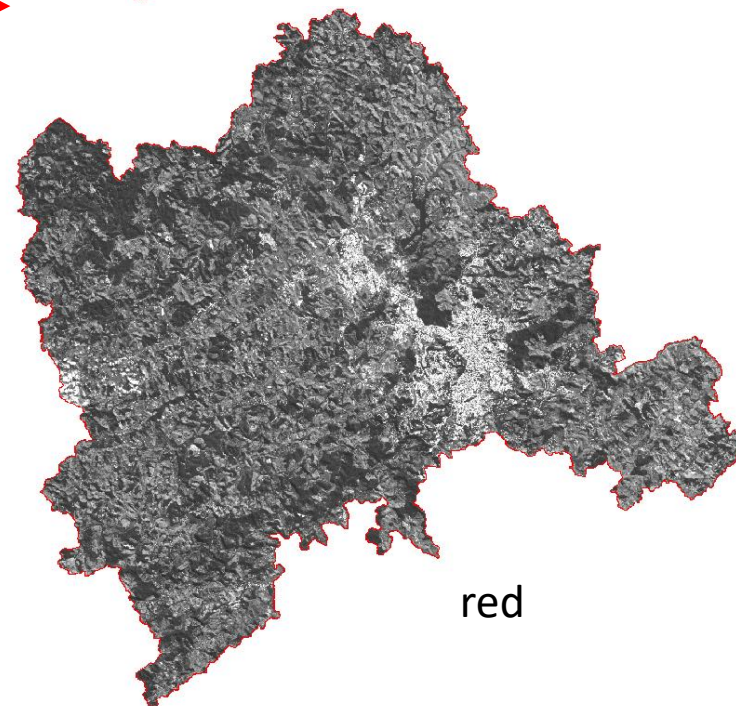
Infrared



red

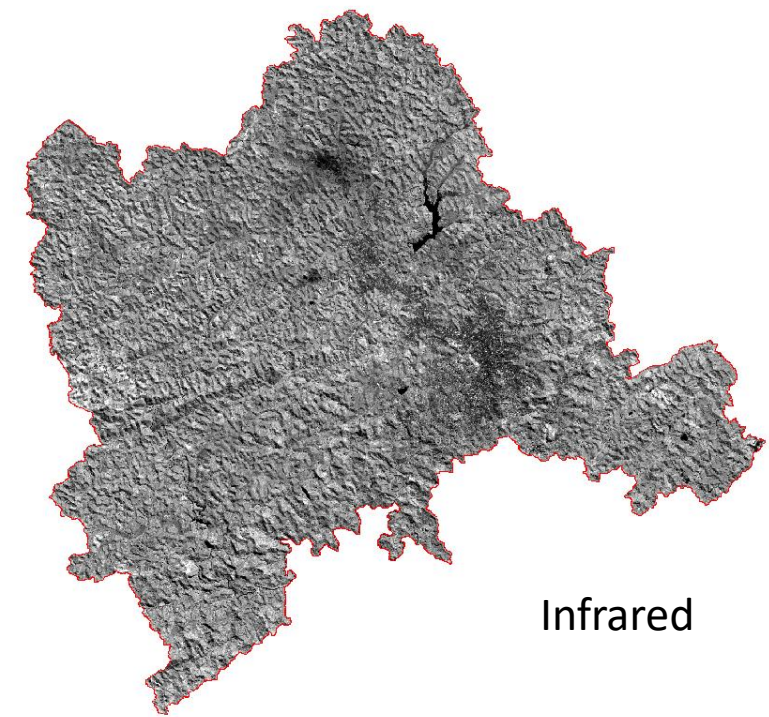
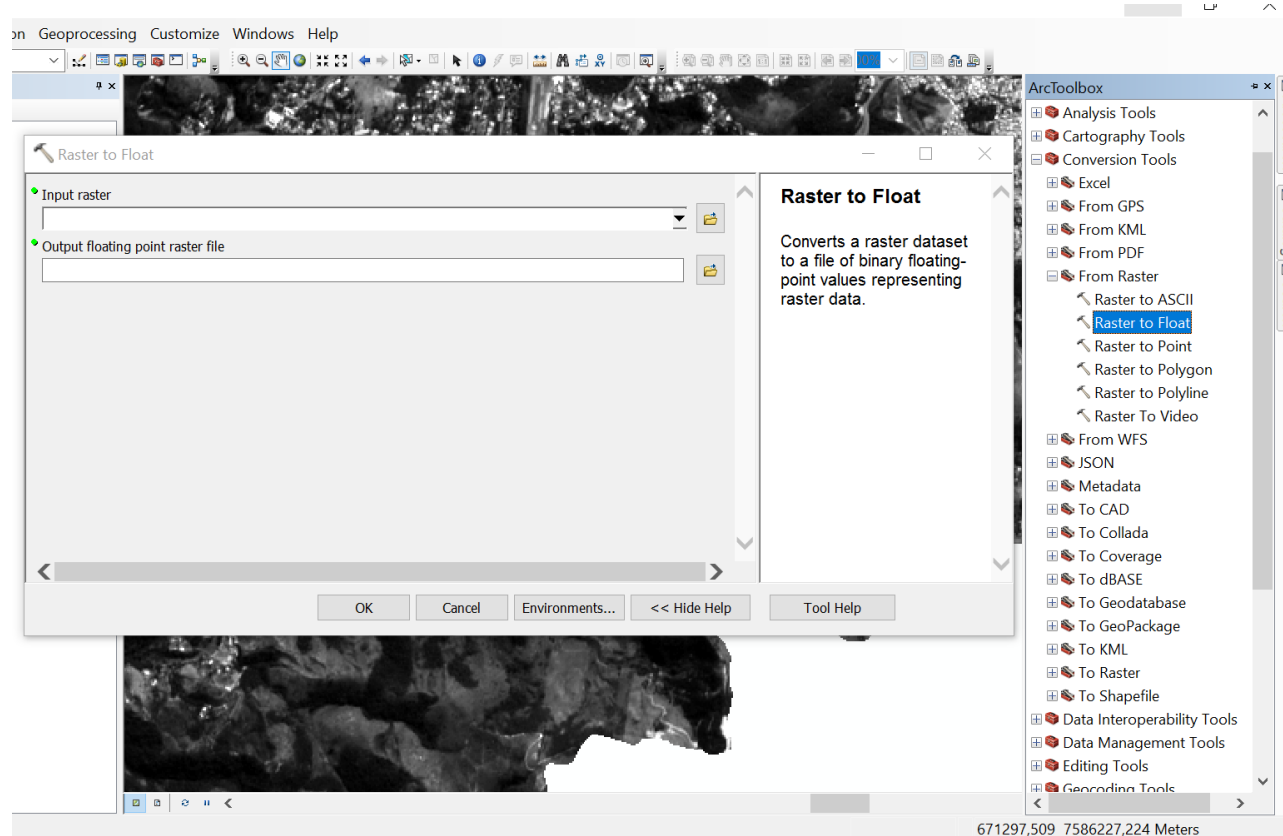


Infrared

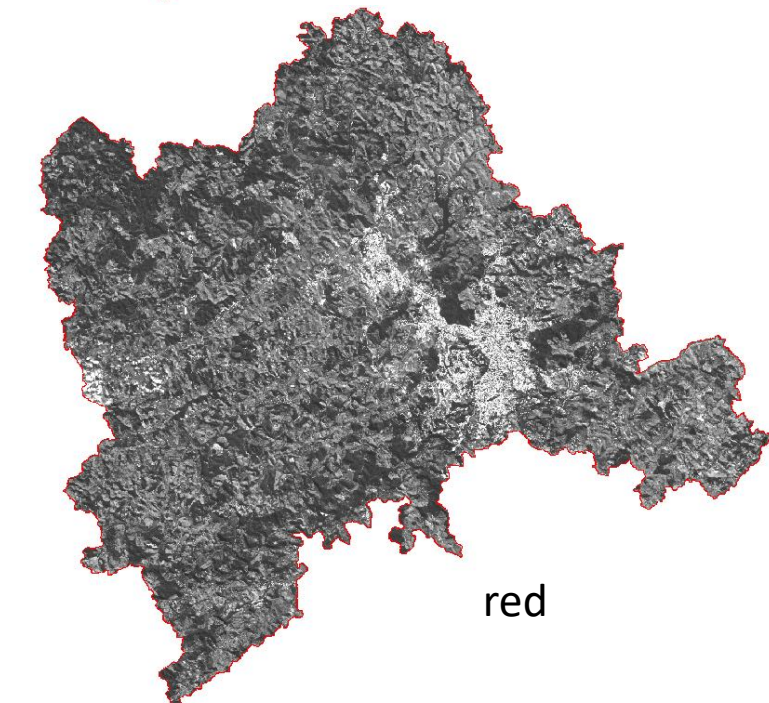


red

- After, you need to make the transformation of bands red (4) and infrared (8) from image to float **to allow calculations using decimals**



Infrared

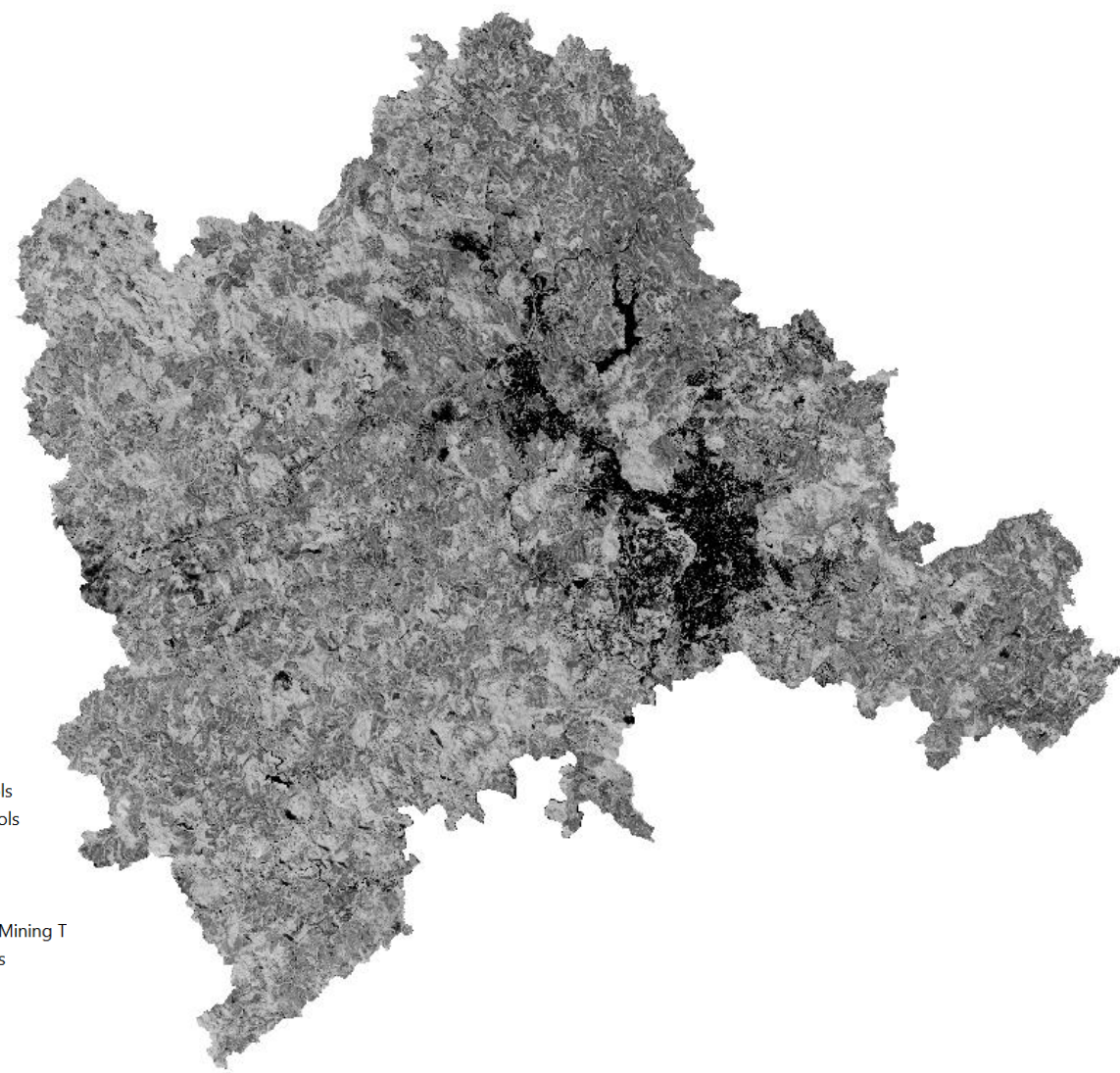


red

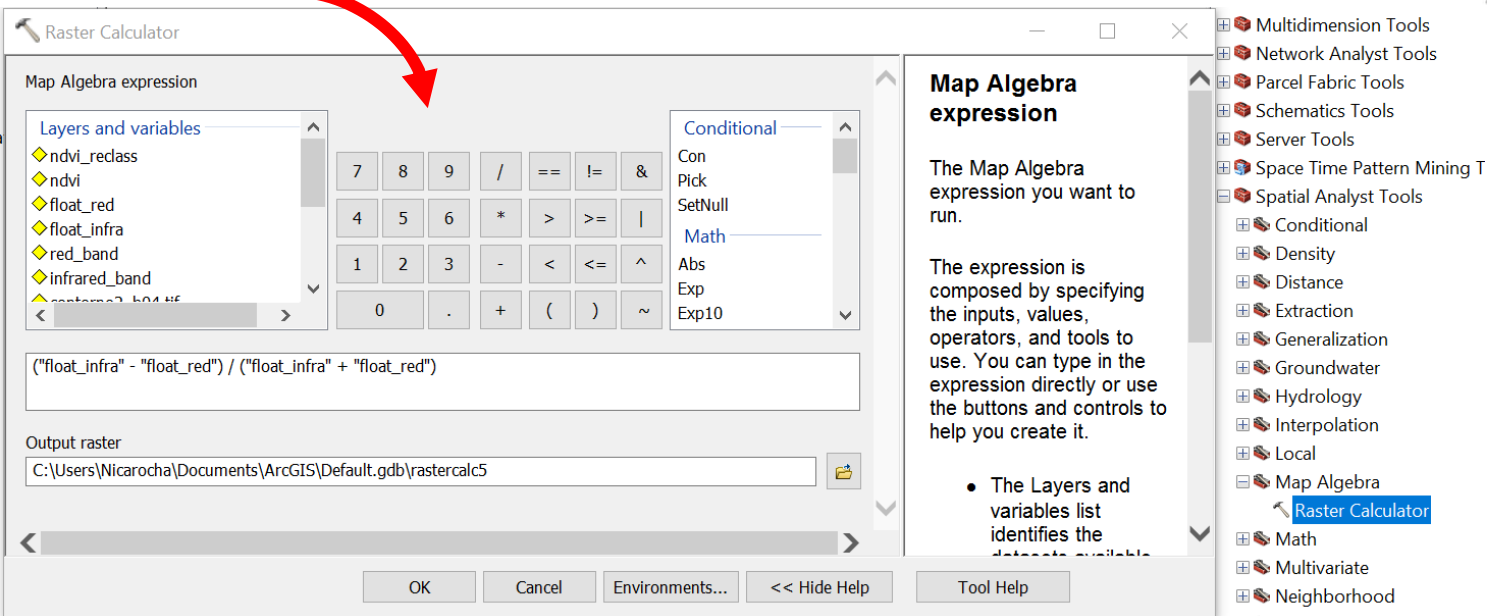
- To calculation of NDVI use the raster calculation command using the bands red and infrared;

- Raster calculation – apply the formula

$$\text{NDVI} = (\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red})$$

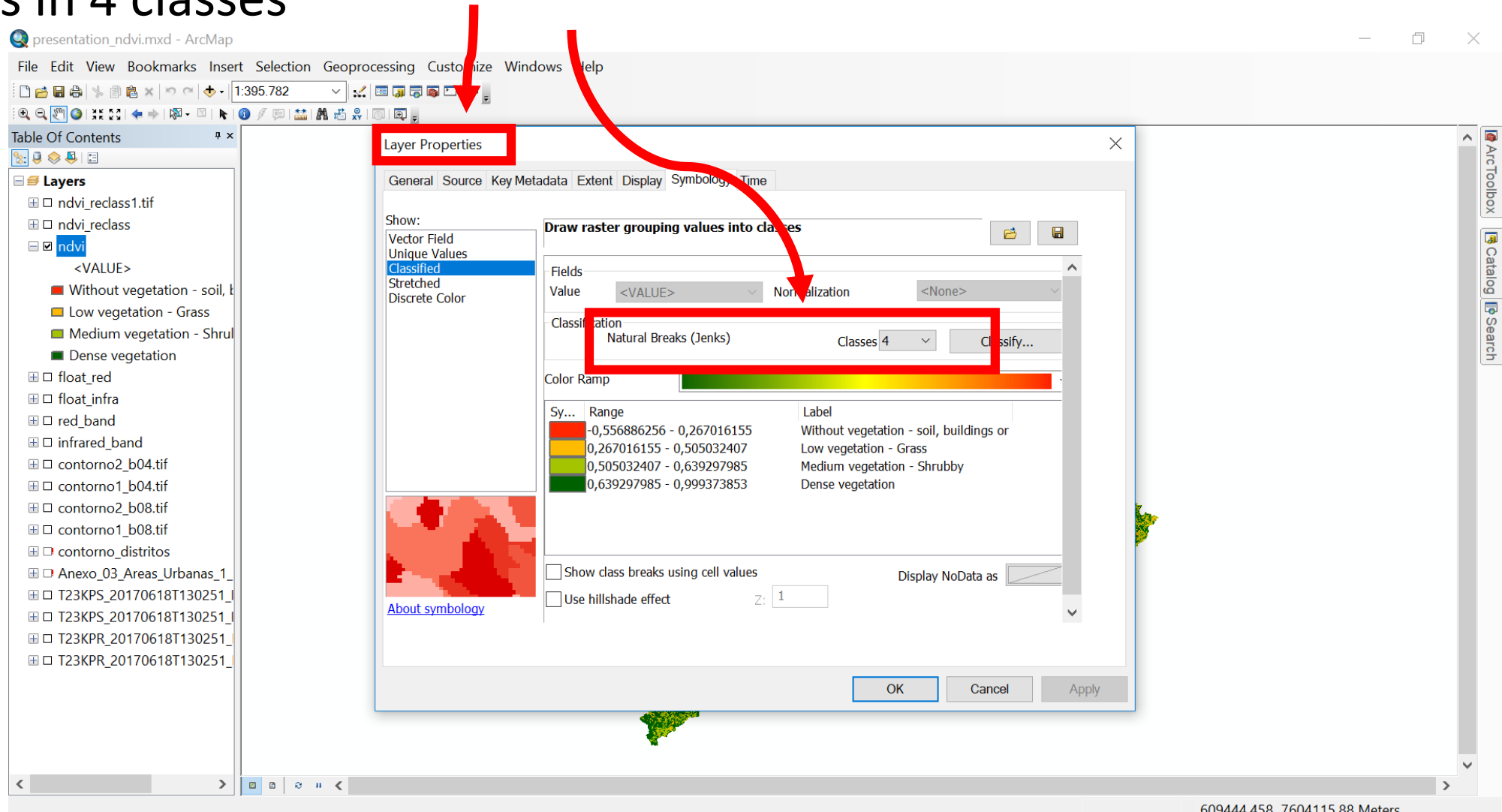


NDVI result - no treatment

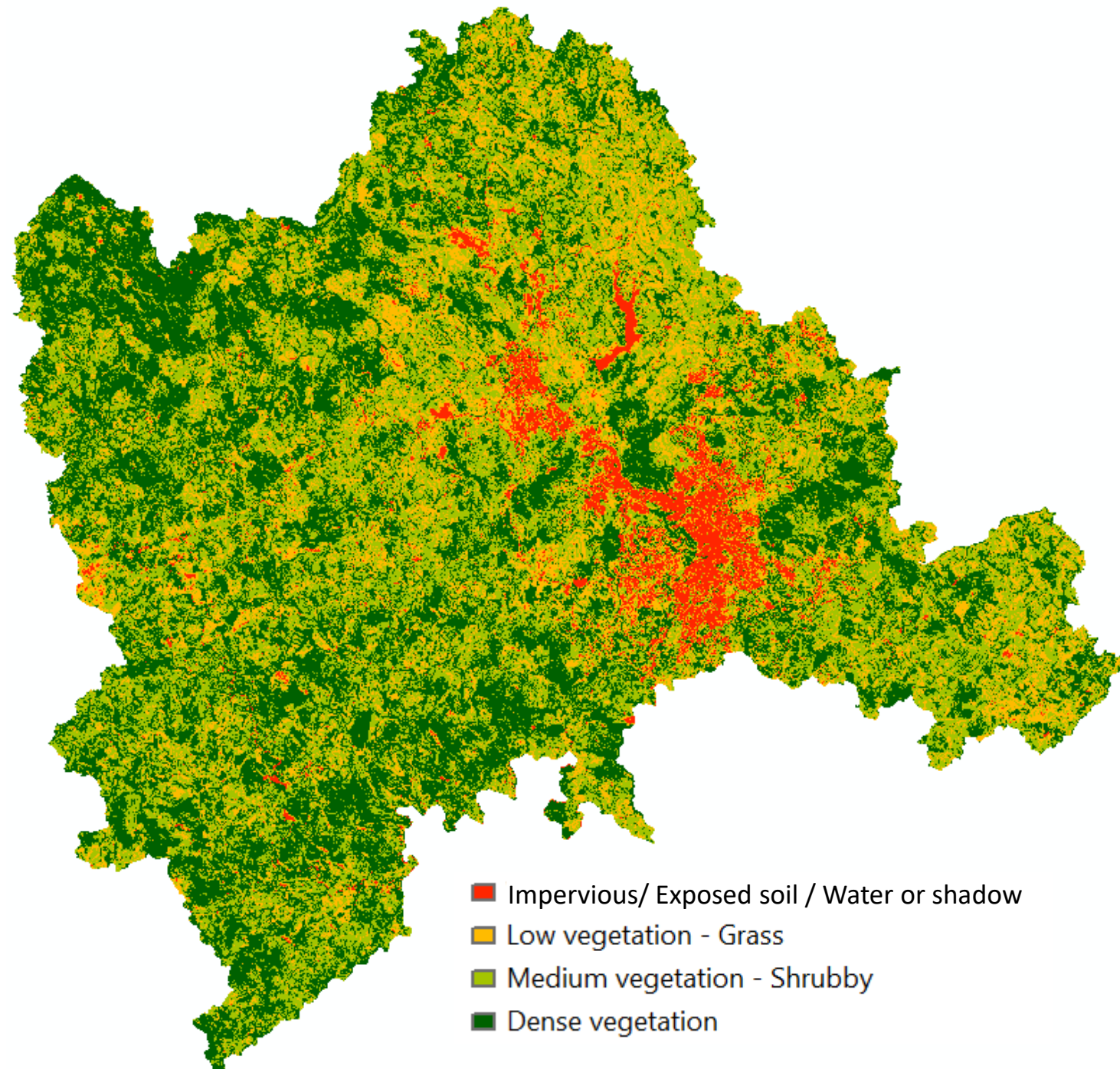


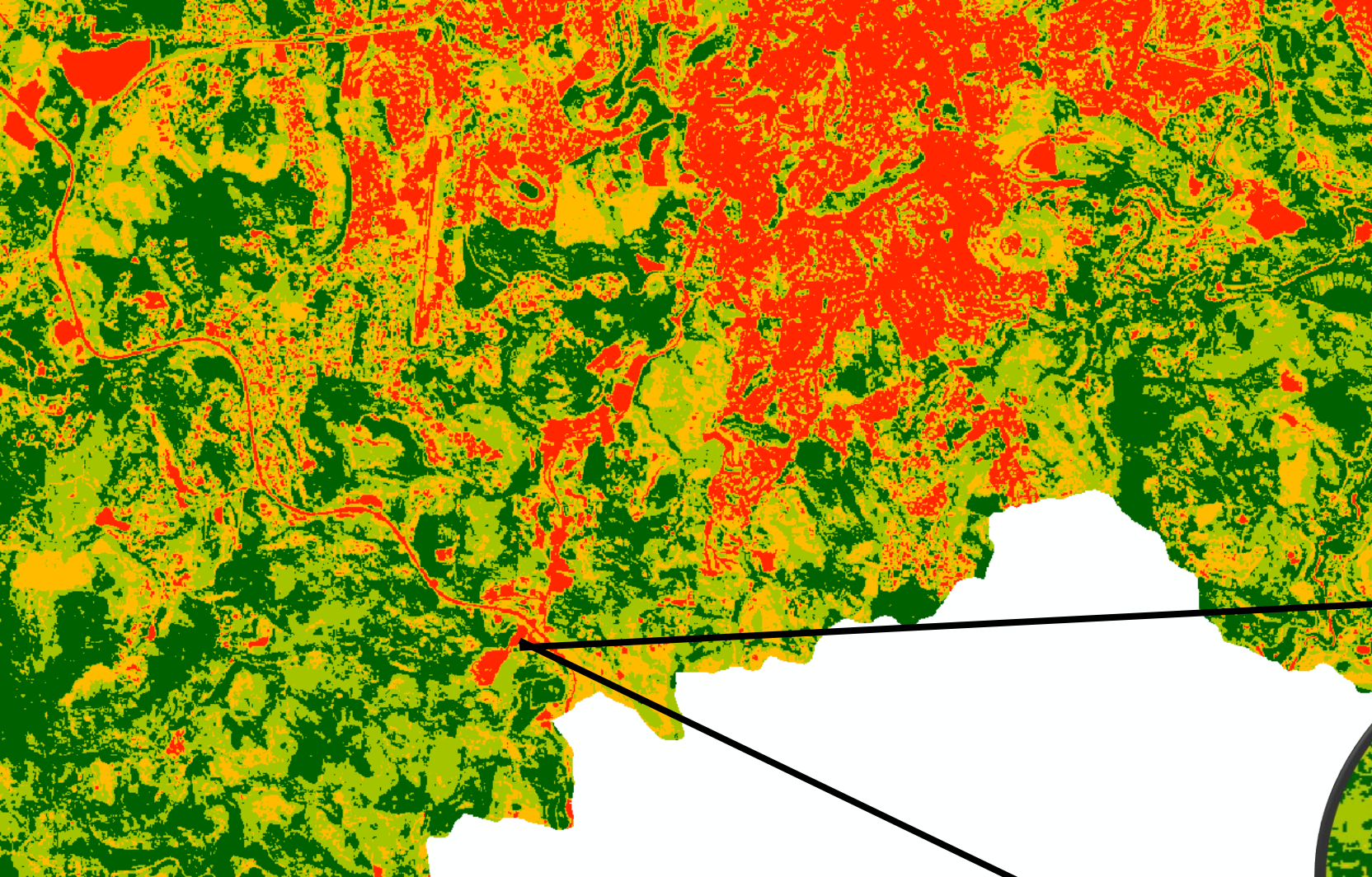
Treatment of the result:

- Open Layer properties - tab Symbology - Classification: Natural Breaks in 4 classes



- The subdivision of value ranges from NDVI results, according to local references, in the land uses:
 - Without vegetation, composed by **Impervious areas/ Exposed soil /water or shadow**
 - Buildings and/or low occurrence of vegetation - **Grassy**
 - Buildings and/or occurrence of medium vegetation - **Shrubby**
 - **Dense vegetation** (mainly woody, robust)





- Impervious/ Exposed soil / Water or shadow
- Low vegetation - Grass
- Medium vegetation - Shrubby
- Dense vegetation

