Advanced GIS

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Today's plan

1. Advanced GIS: overview
2. Coursework
3. Student rep election
4. Overall feedback on your final reports for 1st term
5. Raster data

1. Advanced GIS: Overview

Advanced GIS

Sessions 1-2: Dealing with raster data

Session 2: Digitization and georeferencing

Session 3: Bivariate choropleths

Session 4: Cartograms

Sessions 5-6: Multi-Criteria Decision Analysis

City of focus: London - see London Data Store

Course format and resources

Online until further notice.

When online: **1 hour** Zoom call to leave time for doing the tutorial independently

Tutorial shared ahead - Each session starts with a discussion, questions, debugging on the tutorial

Course format and resources

Course material (slides and tutorials) are all available online at this address.

If you need to go back to Intro material, you also have access to the Intro to GIS course material.

Participation: Slack and in class

As always, **Slack** to share resources, ask questions, help each other !

Each session will start with a 10 minute discussion on the tutorial. This shouldn't take you too much time to prepare! It is designed to strengthen your engagement with the material.

We will spend **roughly 10 minutes on this**, and 4 students will speak each time so it's about 2 minutes per student. During those 2 minutes, you can talk about:

- What you've understood about the material
- What would be possible use cases for the tools / techniques introduced
- Ask questions about the things you find confusing

Do **not** prepare a formal presentation, and there is **no need** to prepare collectively.

This will be followed by additional Q&A to answer any question you may have.

2. Coursework

Final coursework: Policy brief (100%)

Deadline: Monday 4th April, 23.59 Paris time.
If late: -1 point penalty for each day past the deadline.

- Groups of 2-3 students
- 3 pages minimum, 5 pages **maximum**
- **Policy brief** aimed at the Mayor of the European city you're studying (*/!\ writing style !*)
- You may - and are encouraged to - build upon your first term report and push the methodology further. You can also pick a completely different topic and/or study area
- You **must** use at least one of the advanced techniques learnt in the Advanced module, while ensuring it's well suited to answer your research question.

Final coursework: Policy brief (100%)

Proposed outline

- Executive summary (maximum ½ page, bullet points are fine)
- Introduction / Problem / Context
- Data sources in a table
- High-level methodology. Keep it short but use precise terminology
- 2 to 4 maps. Careful, you only have 5 pages maximum in this report so these maps must be very relevant to answering your policy question *(i.e. for a suitability analysis, I don't need every step in your weighted overlay, just the final potential sites you've identified, which you can pair with a map of some key variables in your analysis)*
- Analysis of the findings
- Policy recommendations to decision makers

In this exercise, concision and precision are key! Your analysis must lead to actionable results.

3. Student representative election

4. Intro to GIS final reports: Overall feedback

Great work!

Great work overall !

- You all managed to produce your own maps
- You had tons of interesting research questions on various themes and in different cities. They were fun reports to read and assess!
- You challenged yourselves using sometimes geoprocessing tools, experimenting with symbology, attribute joins, etc.

Room for improvement

- I still saw a lot of maps that were not colourblind-safe. Remember to check that.

- Balance in the layout elements was not always achieved. Think carefully when positioning your legend, title, north arrow etc. You can find lots of online content on cartographic design principles and basic rules that will help your produce prettier maps.

- Some had trouble with the writing style. Try not to overshare some anecdotal elements and adopt a more scientific style of writing, focussing on what you achieved, not all the errors you made / unfruitful options you tried / details about your data management choices.

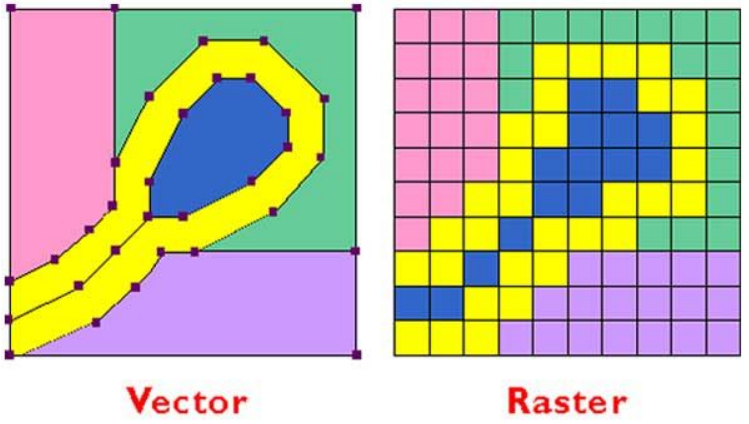
5. Raster data in GIS

1. What is raster data?

Raster vs vector

Spatial data can be represented in two ways:

- **Vector**: geometries: Point, Line, Polygon
- **Raster** : pixels, like a photo (each pixel is assigned a value)

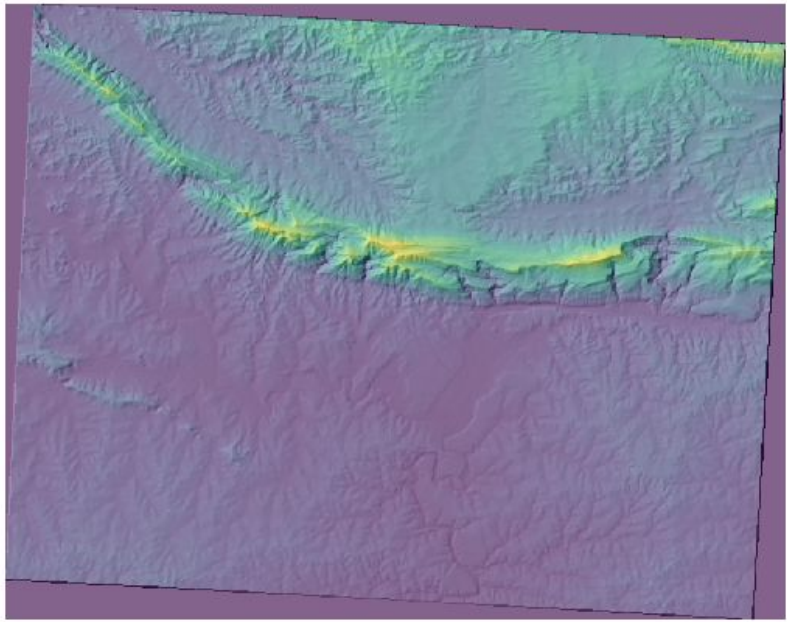


1. What is raster data?

In its simplest form: it's a **matrix of cells** where each cell contains a value representing information, such as temperature.

Raster data is generated by sensors on satellites or aircrafts, digital pictures, or even scanned maps.

Example: Digital elevation model (LiDAR), where each cell contains one altitude value. Typically LiDAR data is generated by flying an aircraft that sends a laser beam at regular intervals and records the time it takes to hit back the onboard sensor → the altitude is derived from that information.



1. What is raster data?

Raster data formats

ASCII Grid (.asc)
ENVI (.dat)
ERDAS Imagine (.IMG)
TIF (GeoTIFF)
PNG (.png)
JPEG (.jpg)
Digital Elevation Model (.dem)
etc...

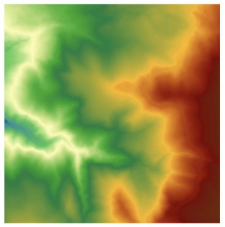
2. Continuous vs thematic raster data

Raster data models are used to represent continuous data like surface temperature or elevation...

But also thematic (= discrete = categorical) data such as land-use or soil class data.

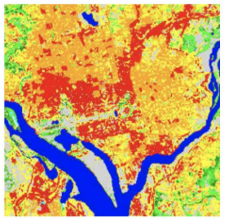
Continuous Data:

- Elevation
- Temperatures
- Precipitation
- Reflectance (light)



Categorical Data:

- Land Cover Type
- Soil Type
- Vegetation Type



2. Continuous vs thematic raster data

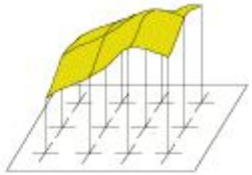
The value of your pixel can represent the centre of your cell (for example: the altitude measured at that point) or the entire cell (e.g. the type of land use).

Conceptually those two options are quite different. If you are trying to extrapolate or interpolate values, you should determine which option you are working with.

Value applies to the center point of the cell

For certain types of data, the cell value represents a measured value at the center point of the cell. An example is a raster of elevation

315	319	321	323
317	323	328	326
313	318	325	323



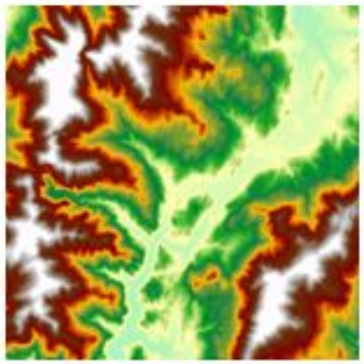
Value applies to the whole area of the cell

For most data, the cell value represents a sampling of a phenomenon, and the value is presumed to represent the whole cell square.

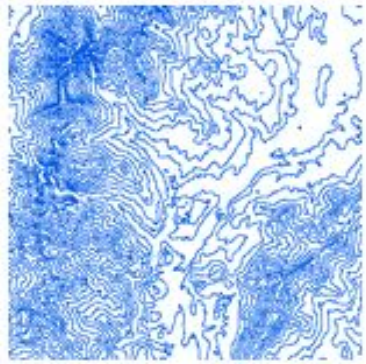
50	45	40	35
35	40	35	25
20	25	30	20

2. Continuous vs thematic raster data

When the value represents the centre of your cell, you can extract patterns from your continuous raster dataset using an extra processing step: for example by generating contour lines.



Input elevation raster

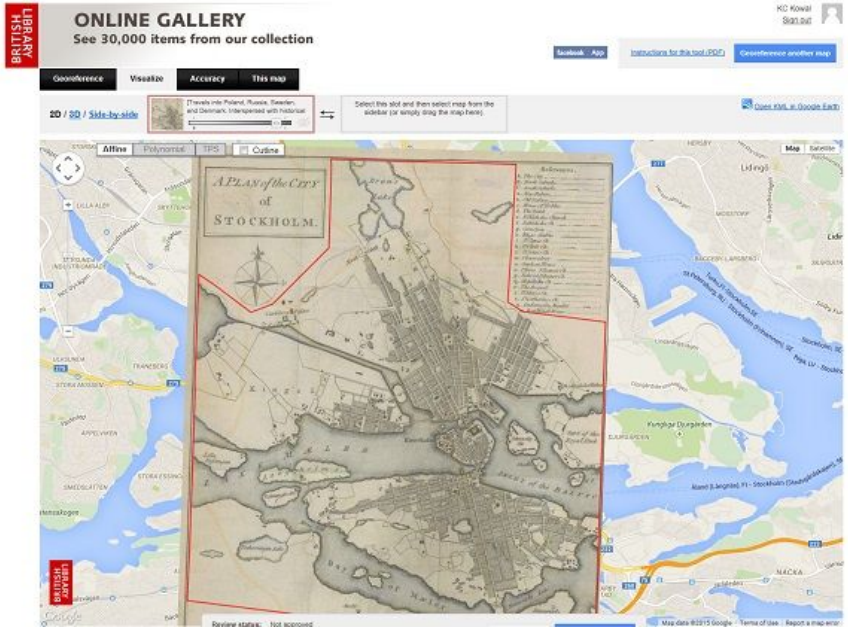


Output contours

But also…. Basemaps !

These images have been georeferenced

You'll do that next week too!



3. Spatial Resolution

Images with a pixel size covering a small area are called ‘high resolution’ images because it is possible to make out a high degree of detail in the image.

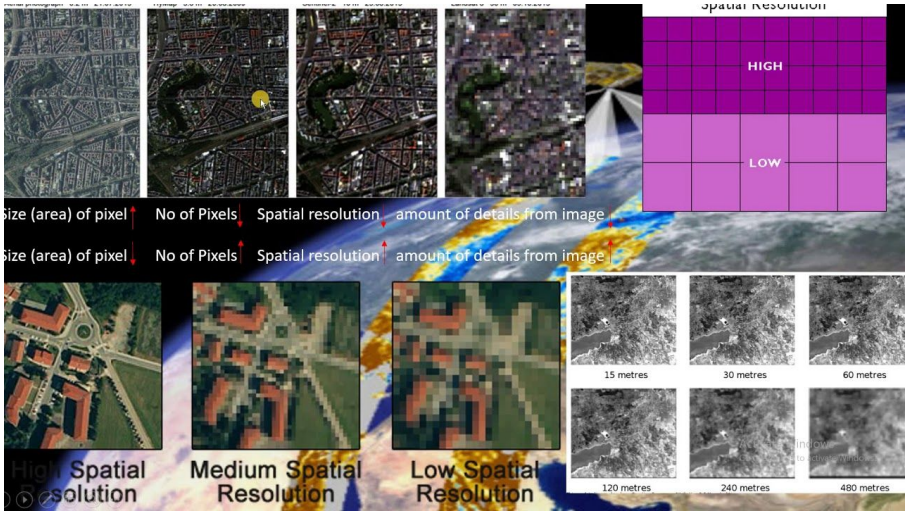
Images with a pixel size covering a large area are called ‘low resolution’ images.

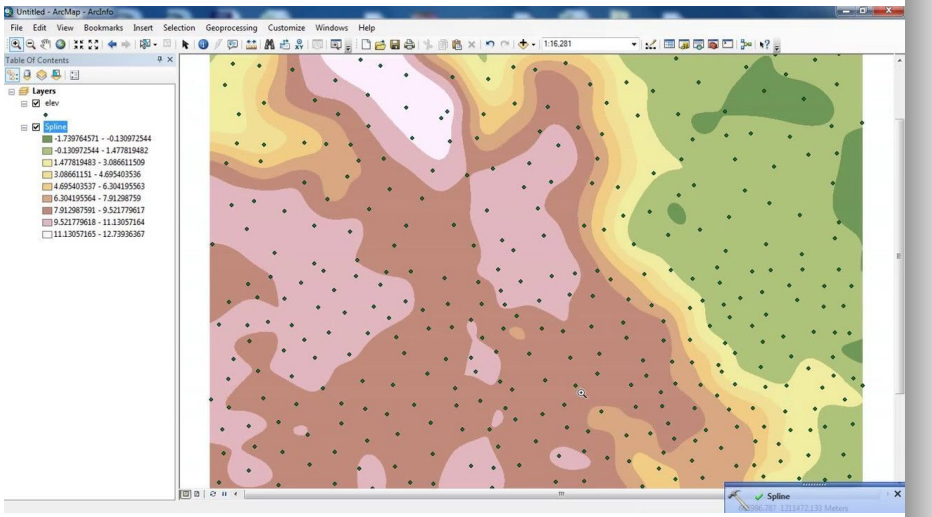
Your resolution needs depend both on which scale you’re working at (world/ country/ city/ neighbourhood) and your storage capacity.

3. Spatial Resolution

For remote sensing data, spatial resolution depends on the sensor used to take an image.

For raster data computed by spatial analysis (e.g. rainfall), resolution will depend on your sampling scheme (e.g. number of weather stations).



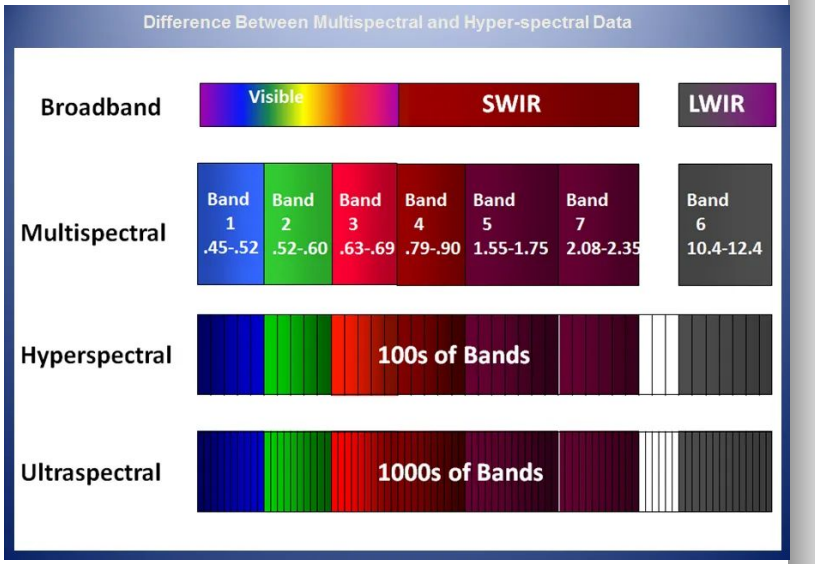


4. Spectral Resolution

With digital pictures, the camera uses electronic sensors to detect red, green and blue light. The red, green and blue (RGB) information is combined to show you an image that your eyes can interpret, but in fact RGB information is stored in **separate colour bands.**

This is the case for satellite images.

But remote sensing devices can also capture other wavelengths. They can record infra-red for instance (very useful in environmental science to detect bodies of water).

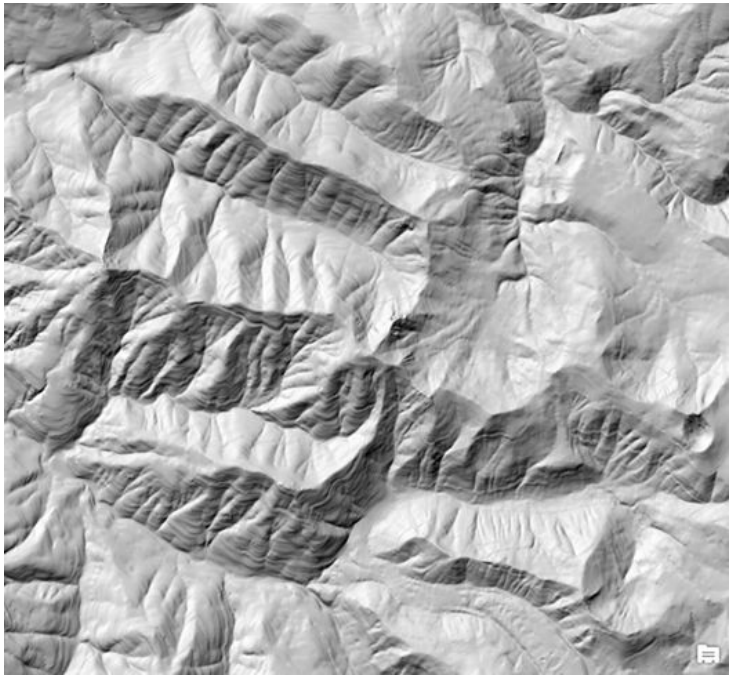


4. Spectral Resolution

Images containing multiple bands of light is very useful in GIS, so raster data often come as multi-band images. **Each band in the image is like a separate layer**.

Spectral resolution = The number of bands in the raster image

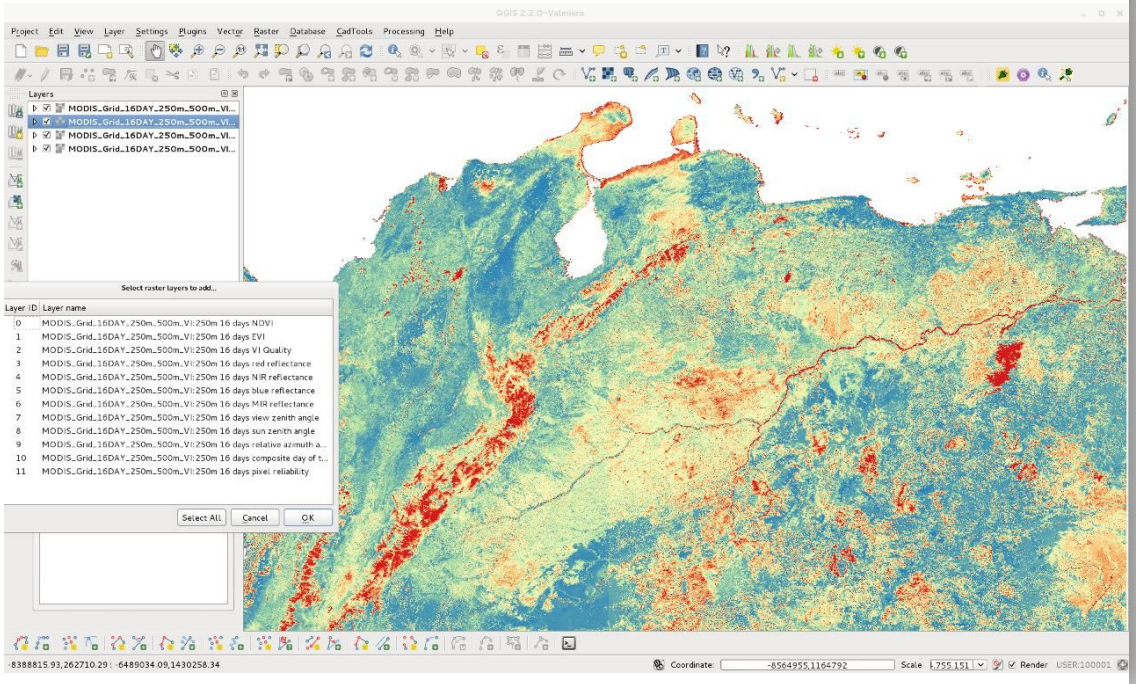
If one band only : “grayscale” image (e.g. hillsahde for elevation maps), shown using pseudo-colour



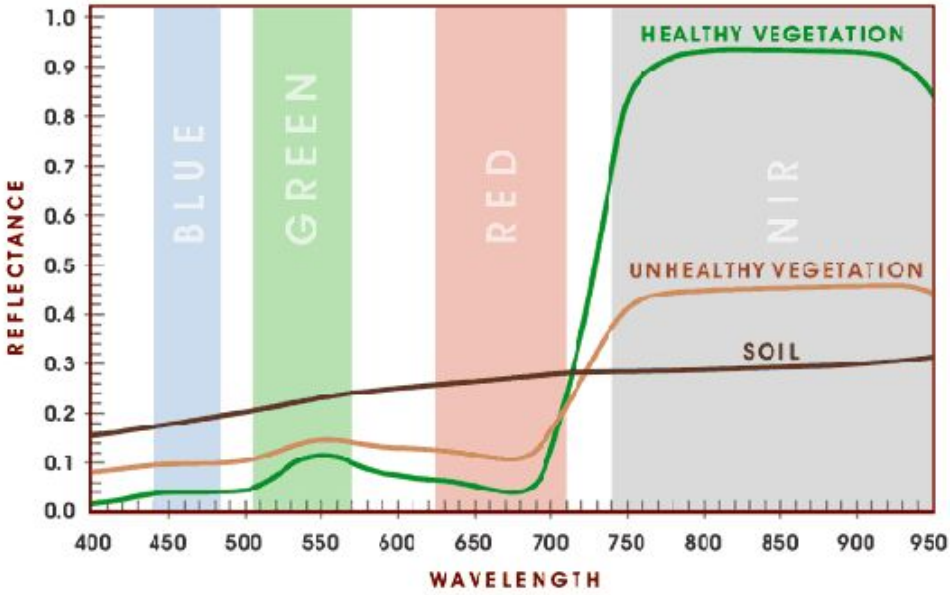
5. NDVI

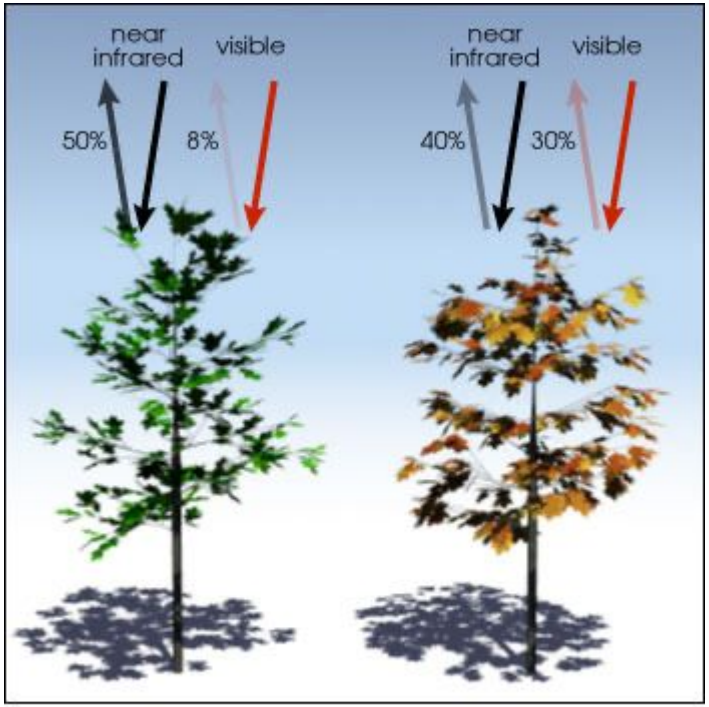
The normalized difference vegetation index (NDVI) allows us to infer the presence of green (healthy) vegetation based on the amount of light and near infrared wavelengths reflected from the surface of the Earth.

This is an index you can calculate in QGIS from satellite data (Sentinel-2, Landsat, SPOT etc)



4. NDVI


REFLECTANCE
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
BLUE
GREEN
RED
NIR
HEALTHY VEGETATION
UNHEALTHY VEGETATION
SOIL
400
450
500
550
600
650
700
750
800
850
900
950
WAVELENGTH


near infrared
visible
50%
8%
near infrared
visible
40%
30%
(0.50 - 0.08) / (0.50 + 0.08) = 0.72
(0.4 - 0.30) / (0.4 + 0.30) = 0.14

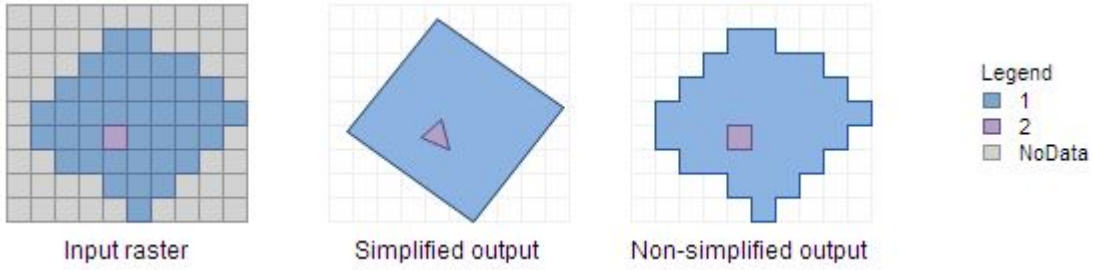
6. Raster can be converted to vector

(and vice versa)

You may want to convert your raster to vector:

- Because some operations can only be carried out on vector data
- Because raster data uses a lot of storage space

There are various options such as simplifying or not the output



Next week