Introduction to Remote Sensing for IWRM

Better understanding of (monitoring) processes

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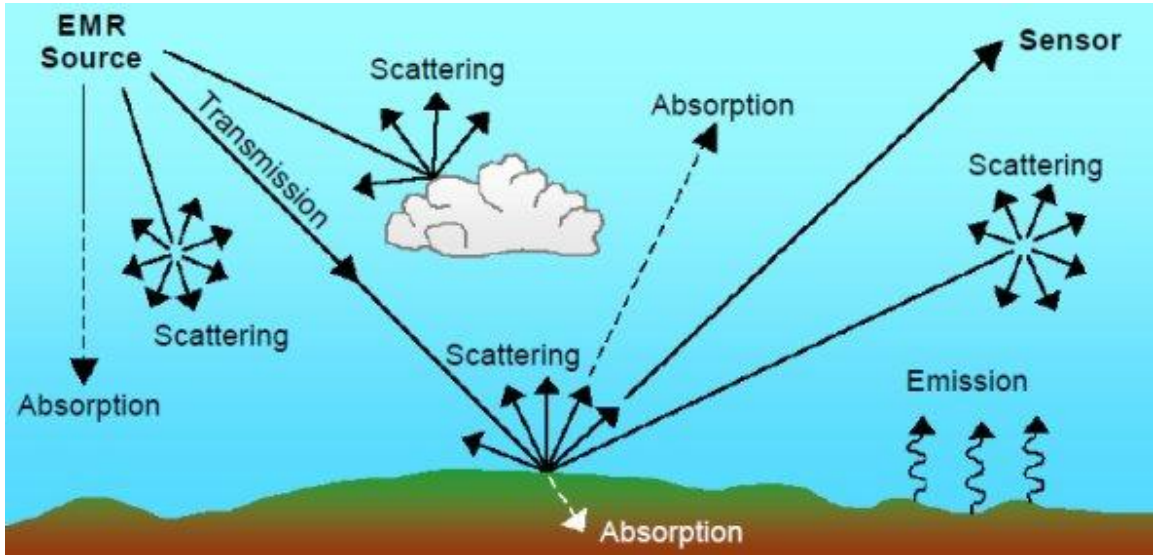
ACACIA WATER

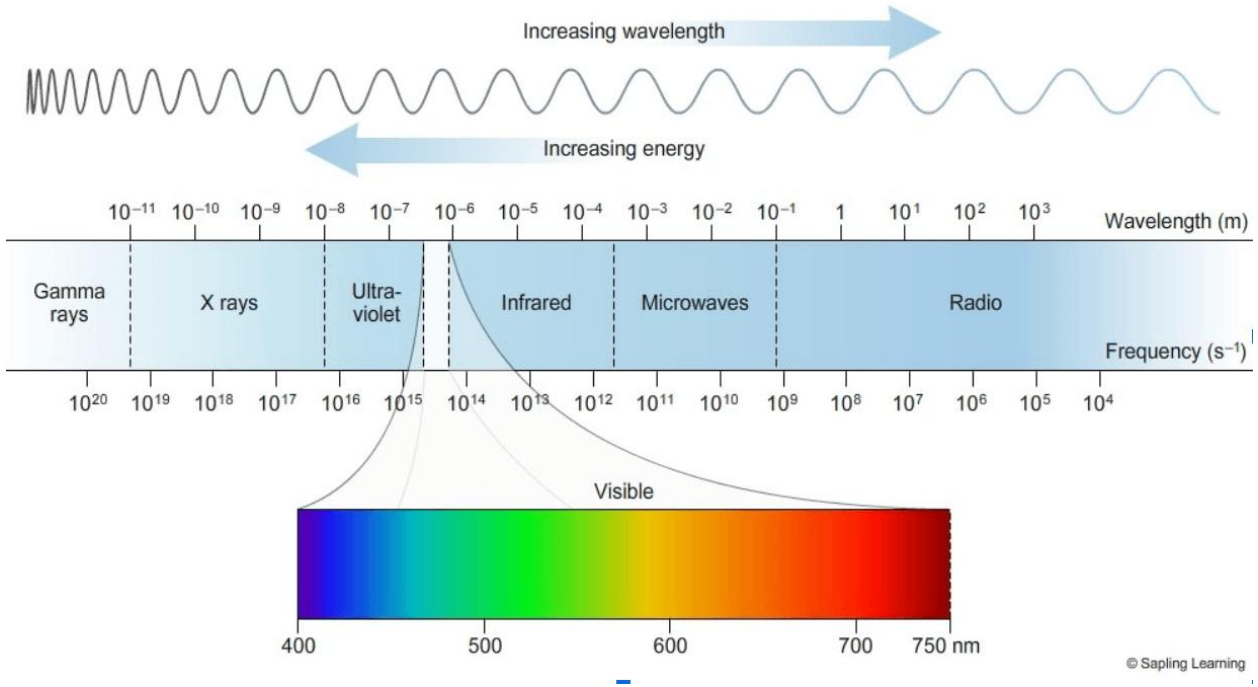
What is Remote Sensing?

- A way of collecting and analyzing data to get information about an object **without being in direct physical contact**
- The observed object = the Earth.
- How? By using sensors mounted to a satellite (or an aircraft, or drone) that measure electromagnetic radiation (energy)
- The way objects interact with this energy differs



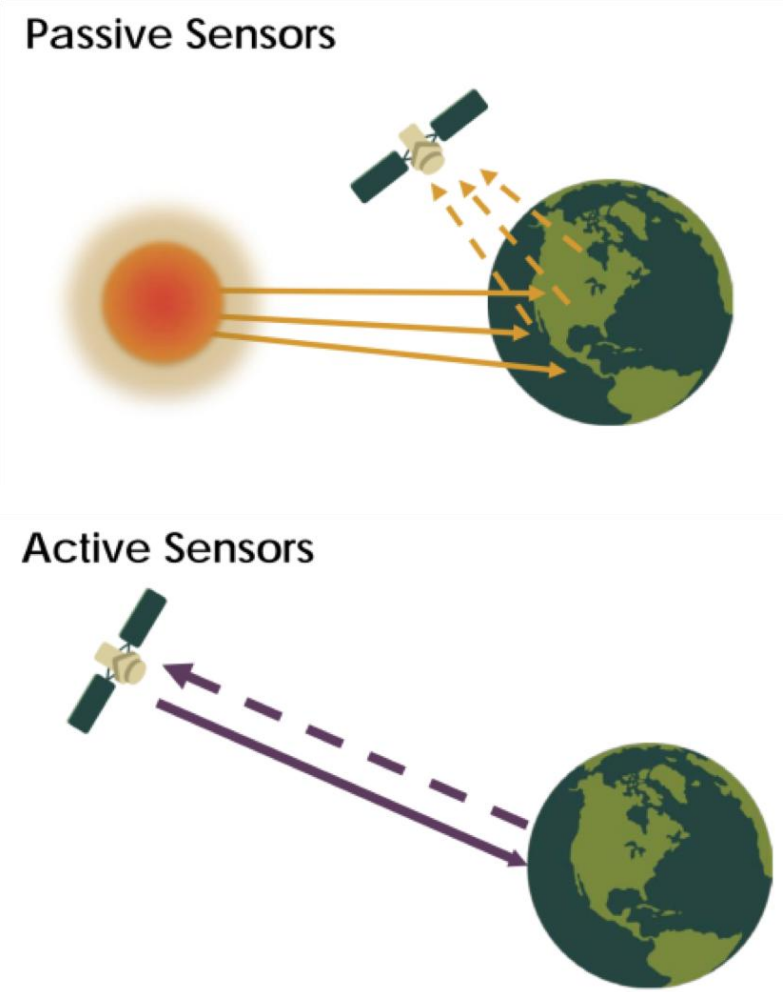
Electromagnetic spectrum

- Radiation travels as waves, each with a specific wavelength and frequency
- The human eye can only see a small portion of the EM spectrum, while satellites can detect many other wavelengths invisible to us
- Different frequencies are useful for different applications
- Remote sensing uses these 'invisible' wavelengths to study the Earth's surface and atmosphere



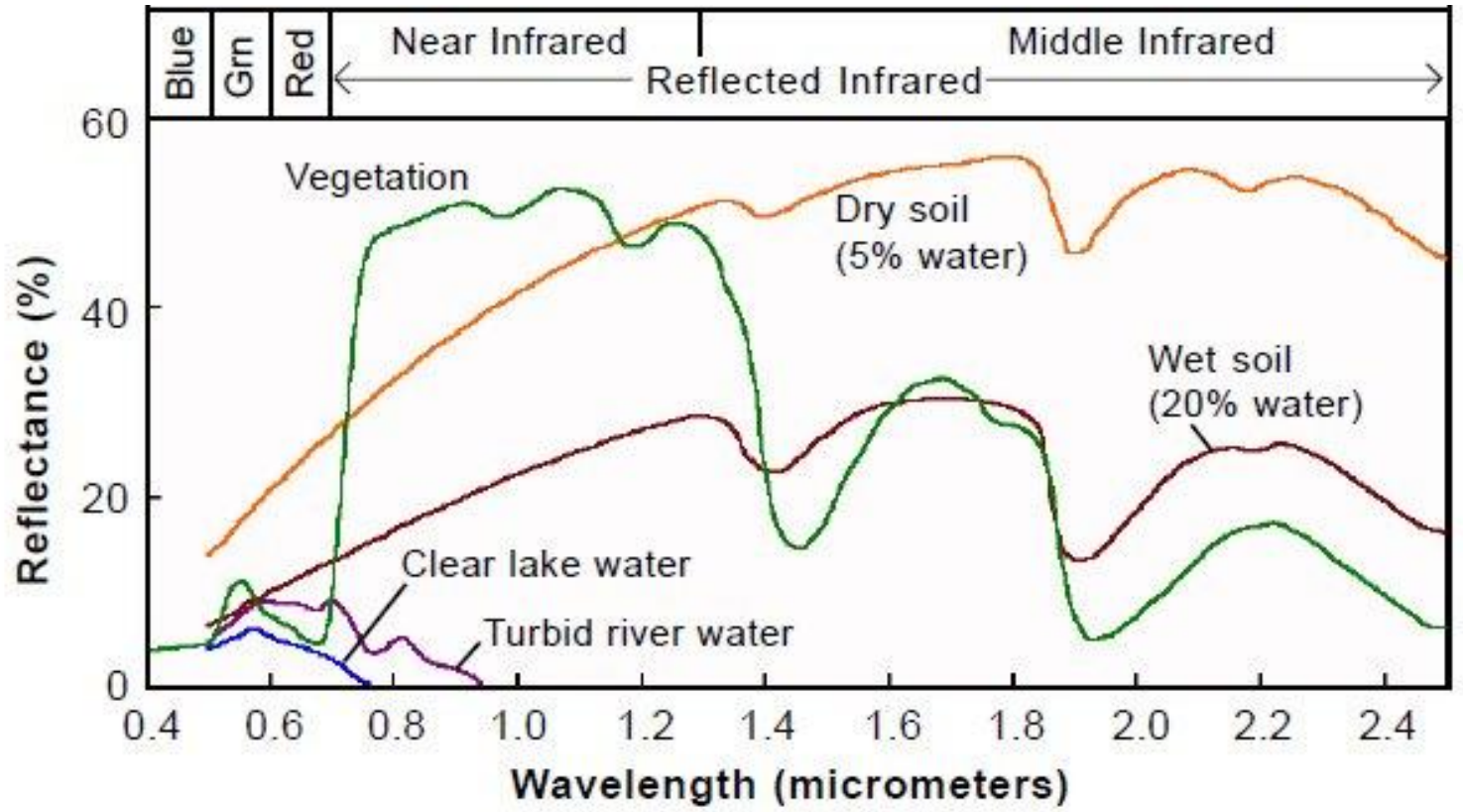
Passive vs. active sensors

- **Passive:** rely on reflected or emitted light from external source (sun or earth)
- **Active:** use their own source of radiation and measures the amount reflected back
  - Day and night
  - Can see through clouds (radar → longer wavelengths)
- Today mostly about passive

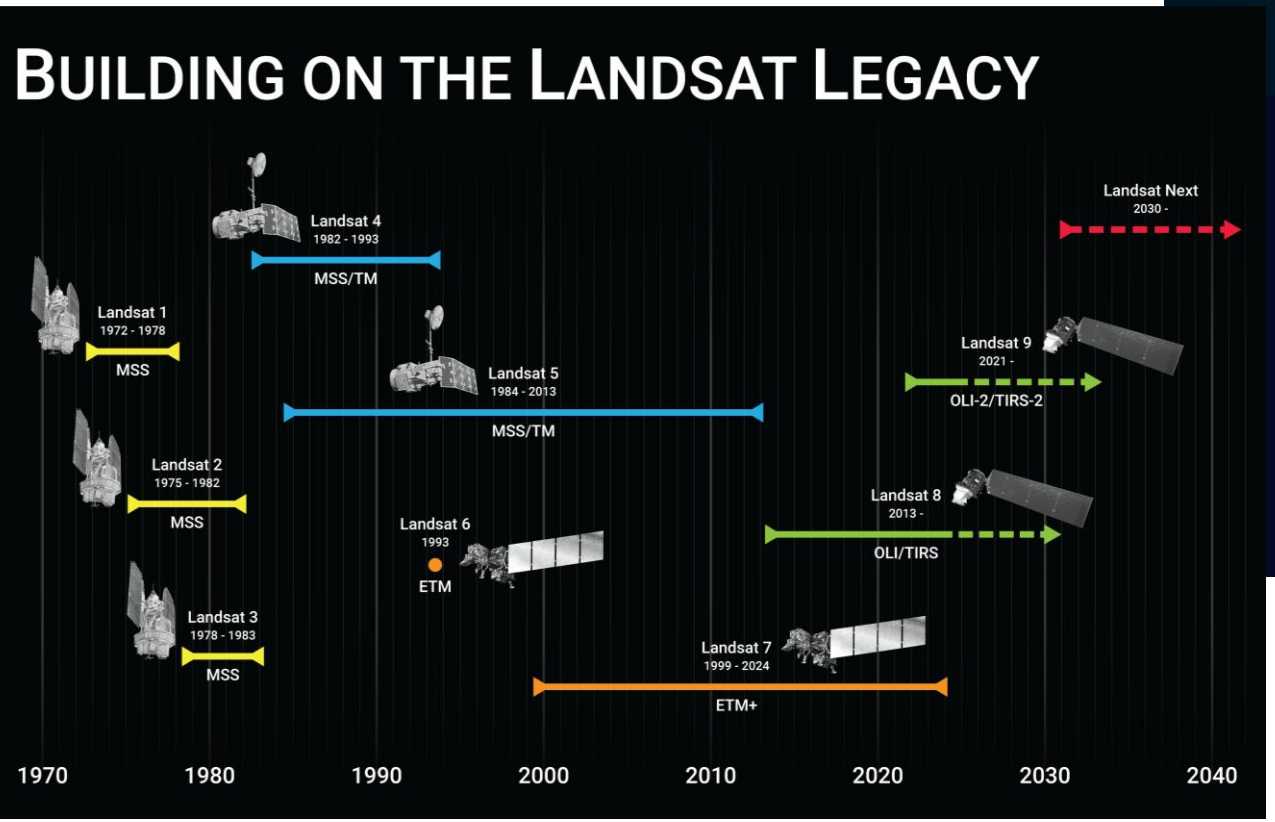


Reflectance

- Reflectance is the ratio of light reflected off a surface relative to the amount of light striking that surface
- Depends on type of surface and wavelength
- For example, water reflects very little light at all wavelengths, vegetation reflects little in blue but a lot in NIR



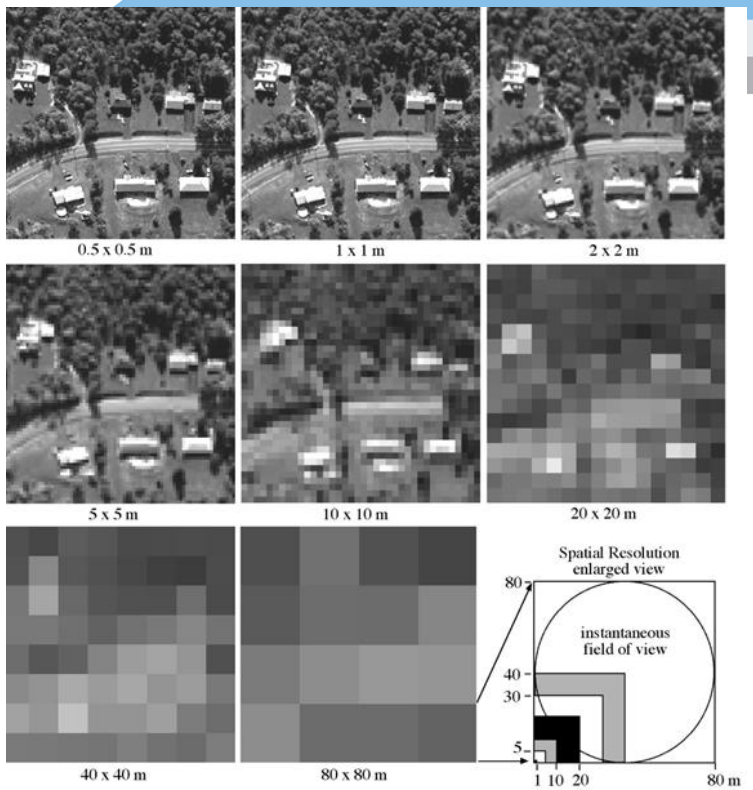
Many EO satellites



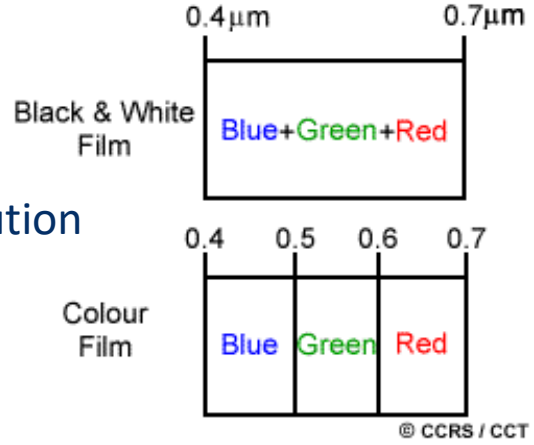
Resolution

- Spatial
  - Size of a single pixel of image
- Spectral
  - Wavelength range for particular band
- Radiometric
  - Ability to detect small differences in energy
- Temporal
  - Revisit period, i.e. time before a satellite passes over de same spot

Spatial resolution

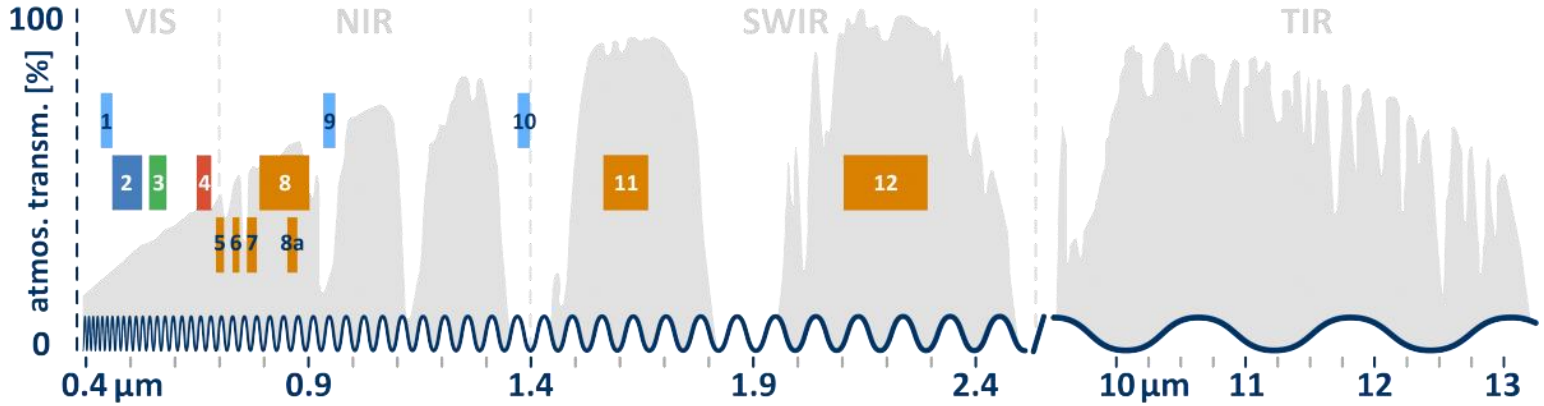


Spectral resolution



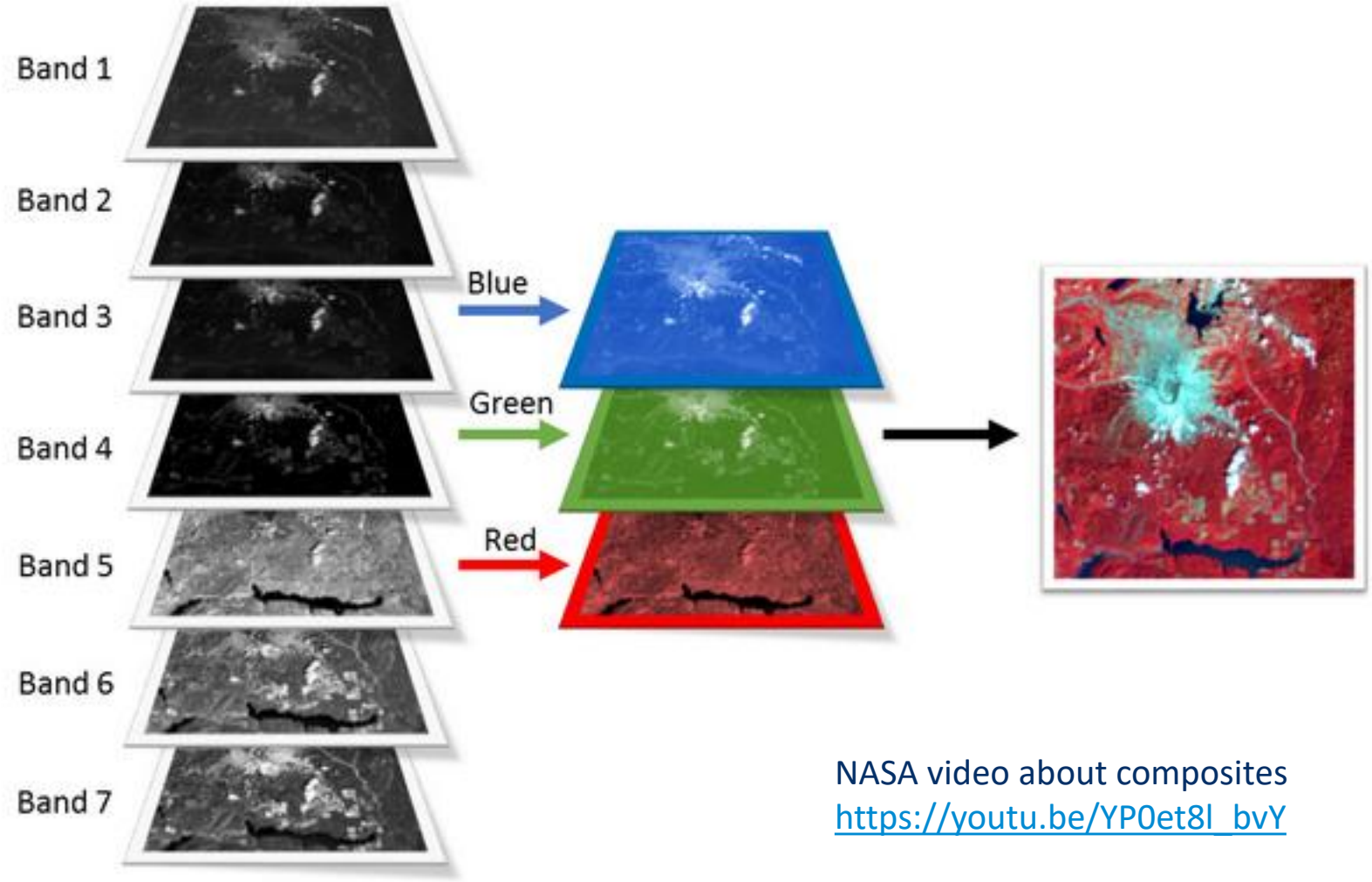
Example Sentinel-2

- **Revisit time:** 5 days
- **Bands:** 13 spectral bands
- **Spatial resolution:** 10, 20, or 60 m
- **Radiometric resolution:** 4096 levels of brightness



Multispectral imagery

- Each band measures a different range of wavelength
- If satellites measure multiple bands (a few) → multispectral imagery
- E.g. Red/Green/Blue
- Near infrared (NIR) → vegetation mapping



NASA video about composites
https://youtu.be/YP0et8l_bvY

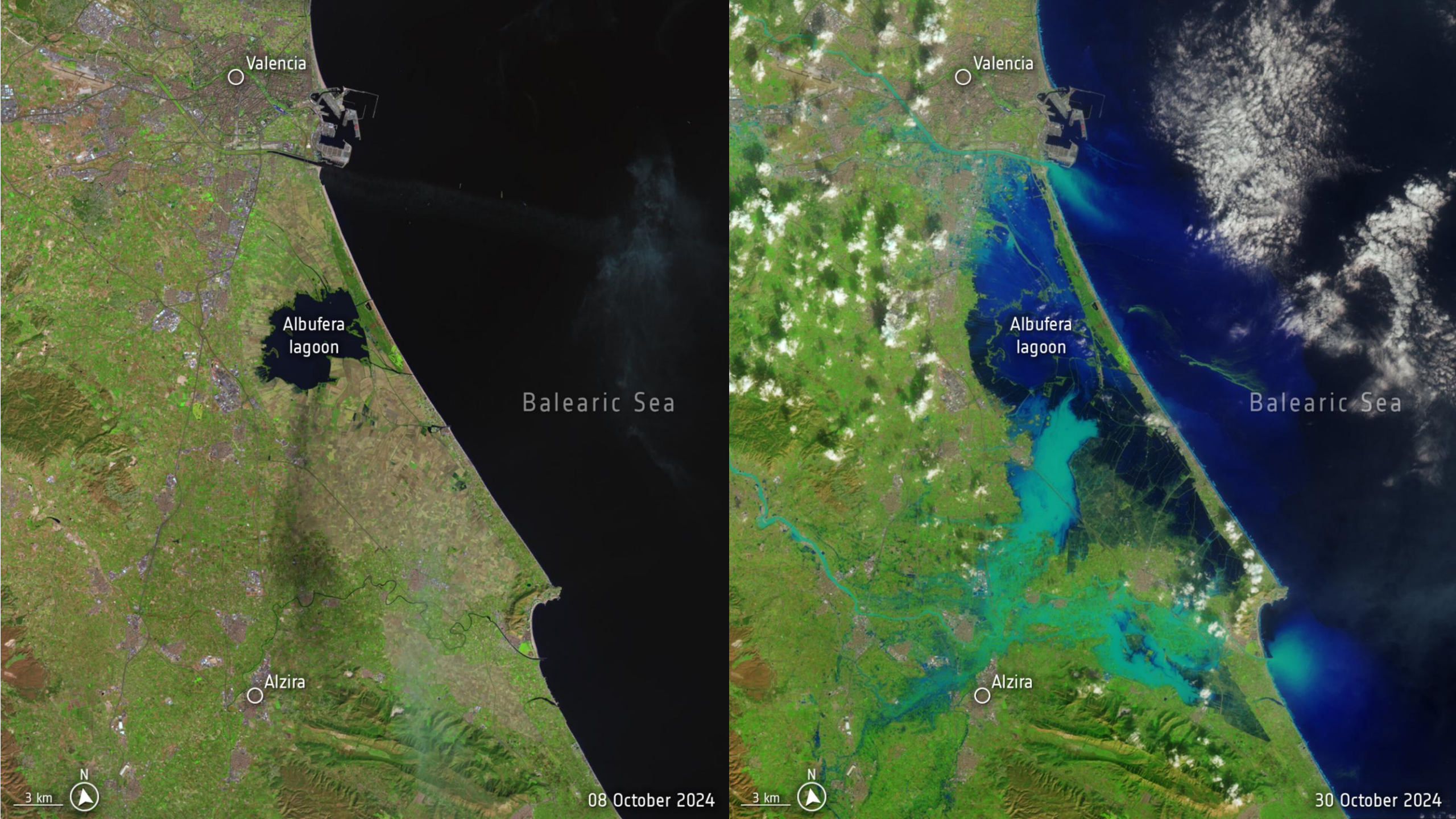
Band ratios and combinations

- Selection of specific bands to enhance specific features of interest
- There are many other indices that provide insight into different properties/surfaces:

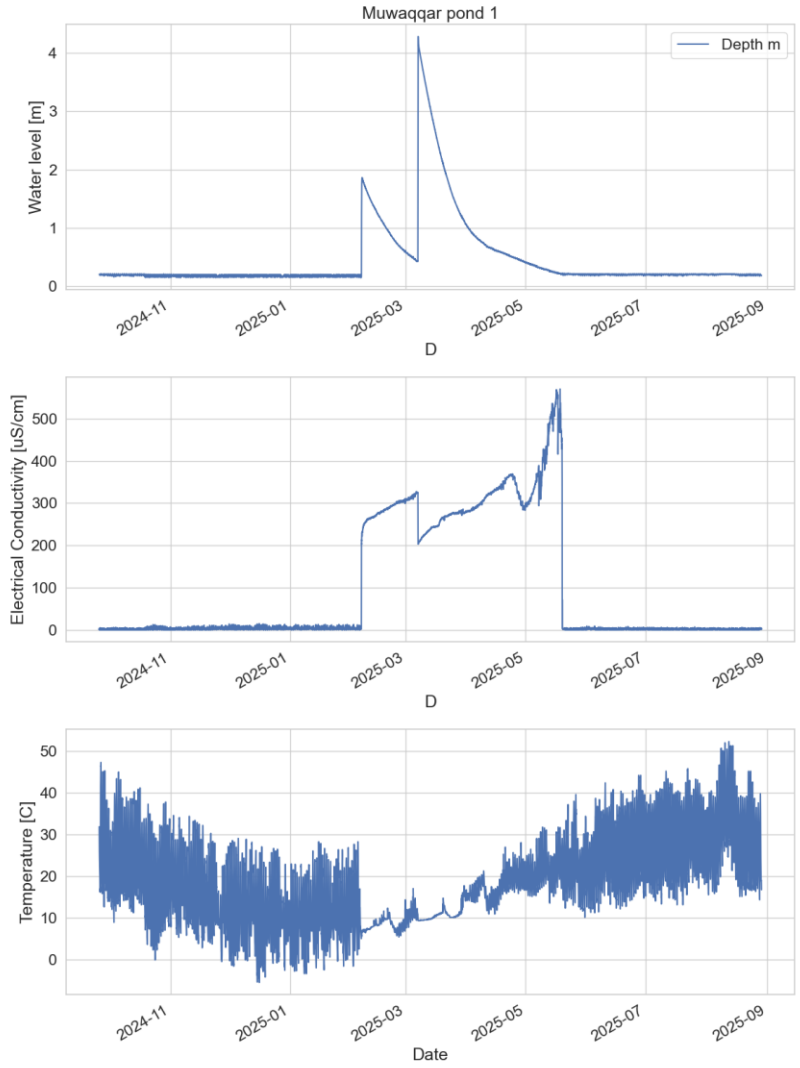
Theme	Landsat-8	Sentinel-2
Traditional false color	6,5,4	11,8,4
False Color Urban	7,6,4	12,11,4
Agriculture	10,6,3	-
Normalized difference vegetation index (NDVI)	(5-4)/(5+4)	(8-4)/(8+4)
Normalized difference water index (NDWI)	(3-6)/(3+6)	(3-8)/(3+8)
Land/water	6,10,5	-
Urban	7,10,5	-
Bare earth	10,4,3	-
Sultan	(6/7, 6/2, 6/5*4/5)	
Lithology	7/4, 6/5, 5/3	

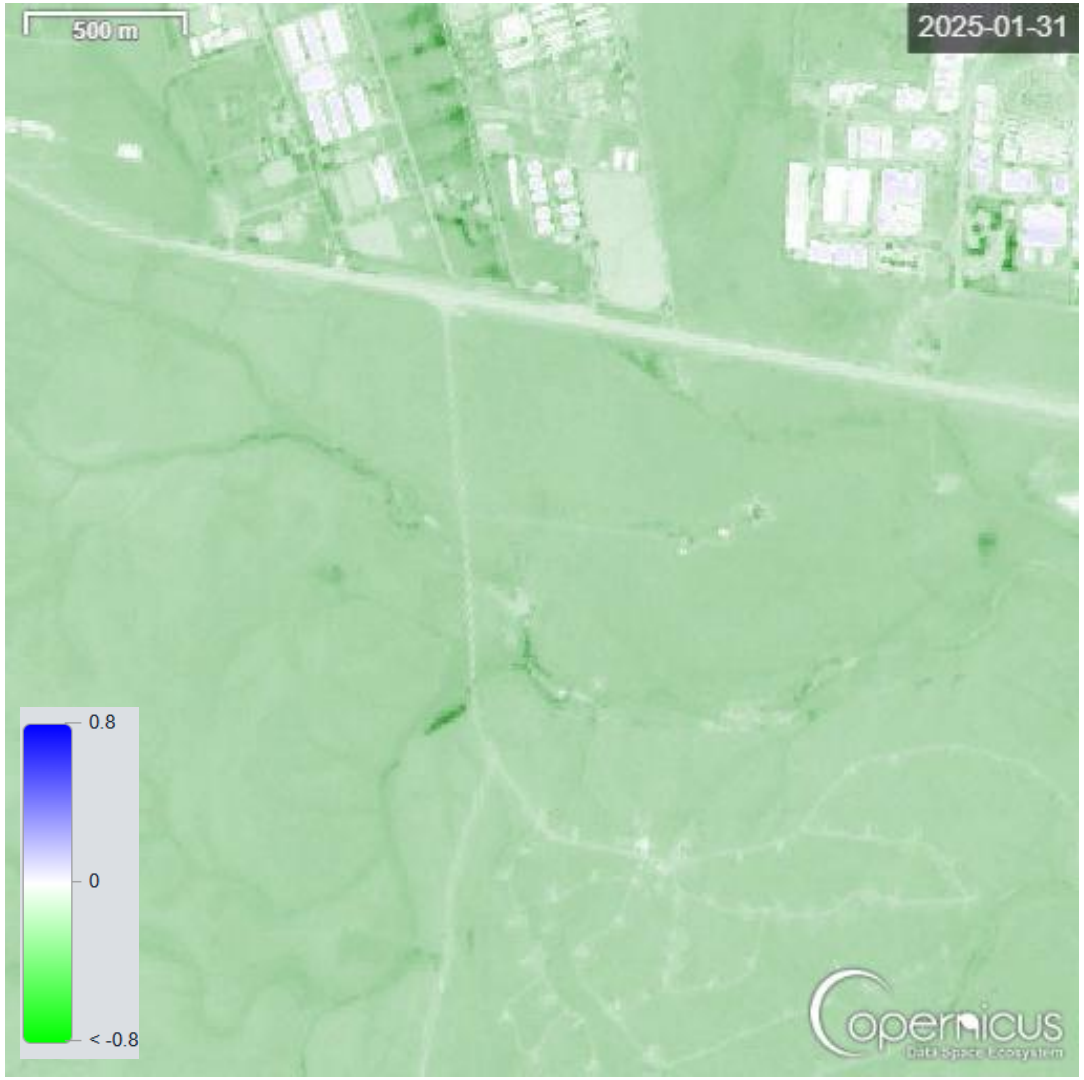
Some applications

- Vegetation mapping: e.g. crop/forest health, deforestation
- Disaster management: e.g. flood mapping, wildfire damage
- Land-cover classification
- Water quality monitoring: e.g. algal blooms, sediment loads
- And more..


Valencia
Albufera lagoon
Balearic Sea
Alzira
N
3 km
08 October 2024
Valencia
Albufera lagoon
Balearic Sea
Alzira
N
3 km
30 October 2024

Physical measurements vs. RS





Advantages and disadvantages

Advantages of RS:

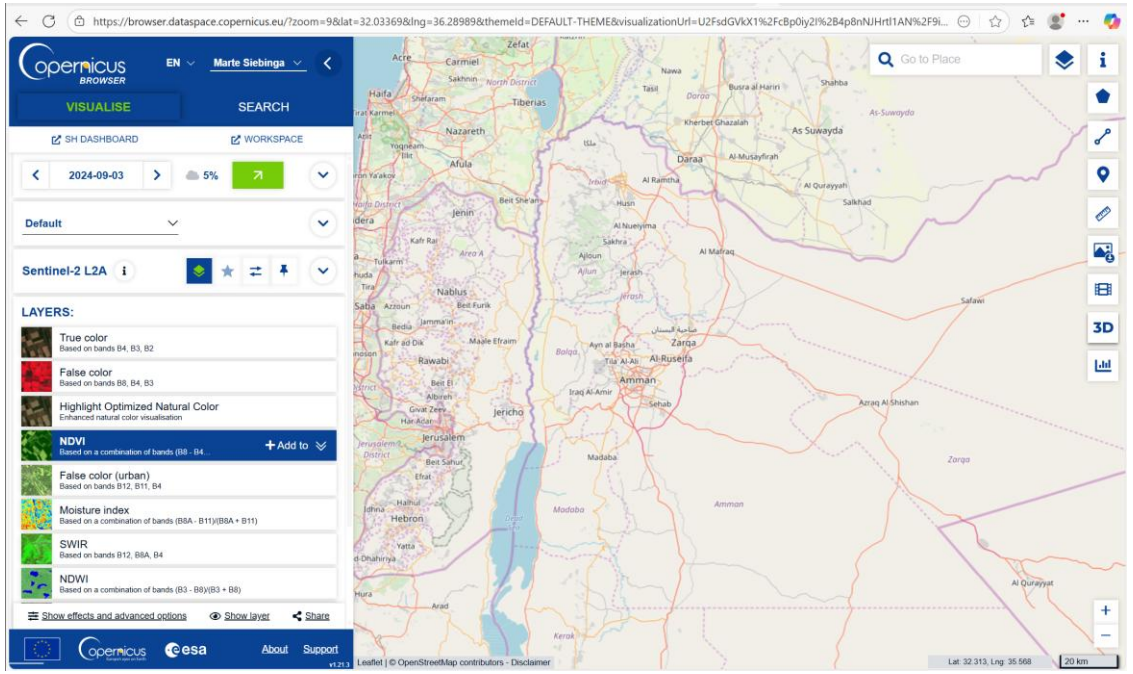
- Global (or regional) coverage
- Regular time interval
- Many datasets are free to use

Disadvantages of RS:

- **Indirect measurements, no absolute values,** some kind of index or model is needed to convert the reflectances into information
- Spatial resolution can be (too) coarse, depending on application

Assignment: exploration of RS data

- Go to https://browser.dataspace.copernicus.eu
- Create a free account with you email
- Pick your own ‘area of interest’
- What do you observe?
- Can you observe any interesting changes over time?
  - e.g. by creating timelapse or using compare panel
- Are there spatial differences within the area?



Other data links

Multispectral imagery

- USGS Earth Explorer: https://earthexplorer.usgs.gov/
- Copernicus Open Acces Hub: https://scihub.copernicus.eu/
- NASA Earth Data: https://search.earthdata.nasa.gov/
- EOS Landviewer: https://eos.com/landviewer

WaPOR (ET product)

- data.apps.fao.org/wapor/?lang=en

Learn at your own pace

IHE Open Courseware: https://ocw.un-ihe.org/

- Water Productivity and Water Accounting using WaPOR (also available in Arabic)
  https://ocw.un-ihe.org/enrol/index.php?id=92
- WaPOR introduction (version 3)
  (including automated download through script)
  https://ocw.un-ihe.org/enrol/index.php?id=263

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