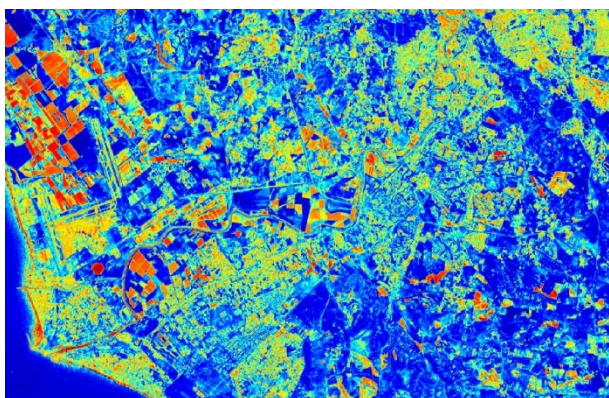




1 Rome-Ostia, 2022-03-21, Sentinel-2, true-colour image.



2 Rome-Ostia, 2022-03-21, Sentinel-2, Vegetation Index NDVI – from red to green the vegetation intensity increases.



3 Rome-Ostia, 2022-03-21, Sentinel-2, Soil Moisture Index NSMI – from blue to red the water content decreases.



4 Rome-Ostia, 2022-03-21, Sentinel-2, Water Index NDWI, allowing to clearly identify water bodies.

## Satellite Data Interpretation - Indices

Interpreting satellite data to derive insights about Earth's surface features and changes is a complex task. Index-based analysis has emerged as a powerful tool to extract information from satellite data. Examples of indices, derived from combinations of spectral bands, highlight specific features, patterns, and environmental conditions:

**Vegetation:** Vegetation indices are fundamental in monitoring plant health, biomass, and land cover changes. Indices like the Normalised Difference Vegetation Index (NDVI) use the contrast between the reflectance in the red and near-infrared bands to quantify vegetation density. High NDVI values typically indicate healthy and dense vegetation, while lower values suggest stressed or sparse vegetation. These indices are crucial for applications ranging from agriculture monitoring to ecosystem health assessments (Fig. 2).

**Soil:** The Normalised Soil Moisture Index (NSMI, Fig. 3) gives insight into the water balance of the soils, important information e.g. for agricultural activities.

**Urbanisation:** Urbanisation indices help analyse and monitor the extent and characteristics of urban areas within satellite imagery. The Urban Heat Island Index (UHII), for example, compares the temperature of urban and rural areas, highlighting the increased heat in urban environments. Other indices, like the Normalised Difference Built-Up Index (NDBI), focus on the built-up areas within the landscape, aiding in urban planning and infrastructure development studies.

**Water:** Satellite data are used to assess water quality through specific indices. The Normalised Difference Water Index (NDWI, Fig. 4) is used to identify surface water bodies, while indices like the Water Quality Index (WQI) use multiple bands to assess parameters such as chlorophyll concentration and sediment loads, offering insights into aquatic ecosystems and water resource management.

**Burned Area:** Monitoring and assessing burned areas and wildfires are critical applications of satellite data. Indices like the Normalised Burn Ratio (NBR) highlight changes in vegetation cover after a fire. With them, analysts can quantify the severity and extent of the burned area, aiding in post-fire recovery planning and ecological restoration.



### Exercises

- Look at the NDVI (normalised difference vegetation index) derived from the Sentinel-2 data and compare with the true colour image.
- Find features with low/high NDVI and identify the respective land cover using the true colour image. Where is the NDVI low, where is it high? Do your findings fit with your expectations?
- Look at the NSMI (normalised soil moisture index) and repeat what you did with the NDVI.
- Take a special look at agricultural land, both with and without vegetation. Which parts appear to be driest (red colours in the NSMI)?
- Look at built-up areas. The colours differ between yellow and red, i.e. between low and very low soil moisture. What does this tell us about the density of settlements?
- Look at the NDWI (normalised water index) showing water bodies in blue and compare with the true colour image. Are the water bodies identified correctly?

### Links and Sources

- [https://www.esa.int/Education/1.\\_Introduction](https://www.esa.int/Education/1._Introduction) - ESA's Earth observation course for secondary schools.
- <https://eos.com/make-an-analysis/ndvi/> - basic description of NDVI and its use in agriculture
- <http://www.eo4geo.eu/training/sentinel-2-data-and-vegetation-indices/> - EO4GEO lecture on Sentinel-2 and Vegetation Indices

