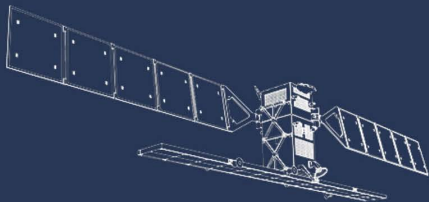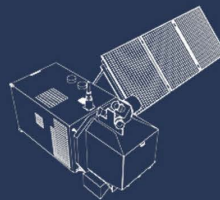# TUTORIAL FOR EXERCISE 1
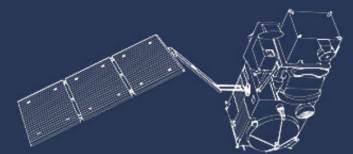
Open Access to Sentinel Missions Data

sentinel-1

sentinel-2

sentinel-3

Table of Content

1 Exercise outline

In this exercise, we will:

- learn how to retrieve satellite imagery from ESA and third-party missions

- set up access to the ESA Hub account and the EO browser

- perform selected analyses using the EO Browser

- learn advanced forms of search

- install ESA SNAP and perform basic image operations

- view the spectral curve of some surface types

- how to use third-party data
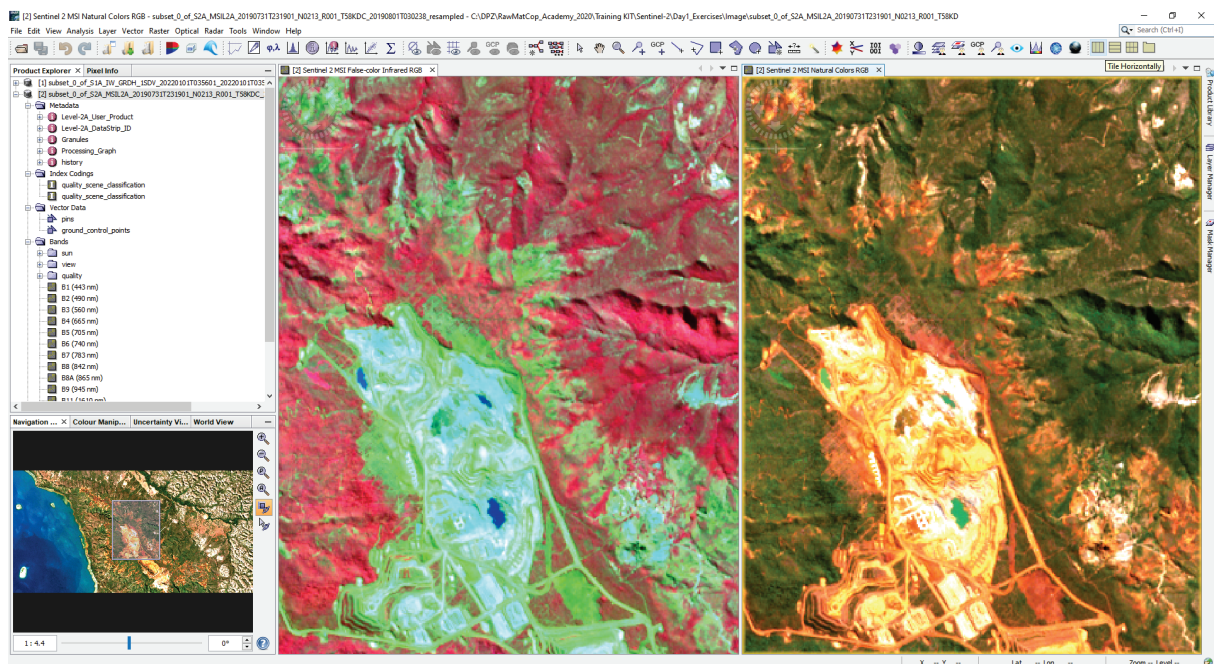
2 Background

The Copernicus Open Access Hub (formerly known as the Sentinels Scientific Data Hub) provides full, free and open access to Sentinel-1, Sentinel-2, Sentinel-3, and Sentinel-5p user products, starting with the In-Orbit Commissioning Review (IOCR). Sentinel data is also available through Copernicus Data and Information Access Services (DIAS) via several platforms. The option to register online through self-registration is available to any interested party. The self-registration process is automatic and instantaneous. Registration grants access rights to search and download Sentinel products. Sentinel products are available free of charge to anyone. The data available through the Data Center is governed by the Copernicus Sentinel Data and Information Use Legal Notice, which the user has consented to by using Sentinel data.

The ESA Hub allows checking searches online by browsing and viewing product metadata and measurements without downloading them. Sentinel products are provided for download over HTTP in *.ZIP archive file format.

In addition to providing satellite data to users from its own Earth Observation (EO) satellite resources, ESA provides users with access to a number of non-ESA EO missions - so-called Third Party Missions (TPMs). In the scientific use of data, it is necessary to combine satellite resources to increase the sustainability of their services, extend the range of parameters monitored, maximize the use of ESA and TPM data, and stimulate the development of science. Third-party data can be requested by anyone, subject to licensing conditions for users from some countries with respect to national legislation in data provision.

3 Copernicus Open Access Hub

Copernicus Open Access Hub provides open access to the current ESA EO satellite missions Sentinel-1, Sentinel-2, and Sentinel-3. It is available at:
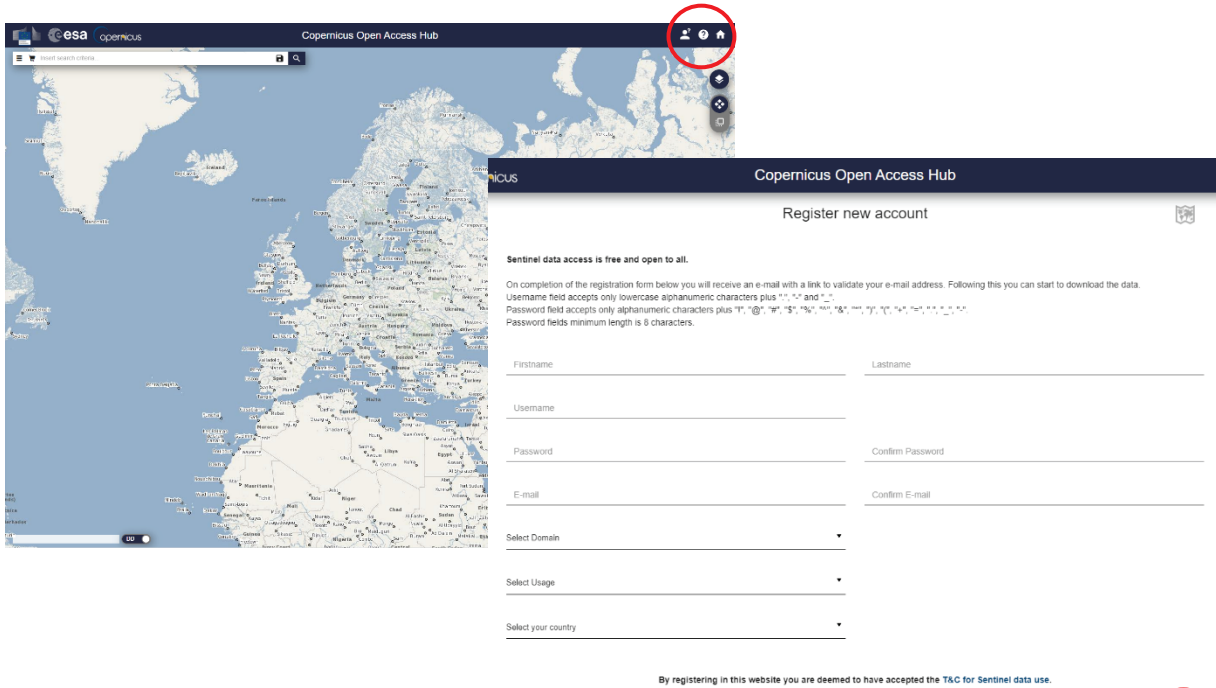
https://scihub.copernicus.eu/

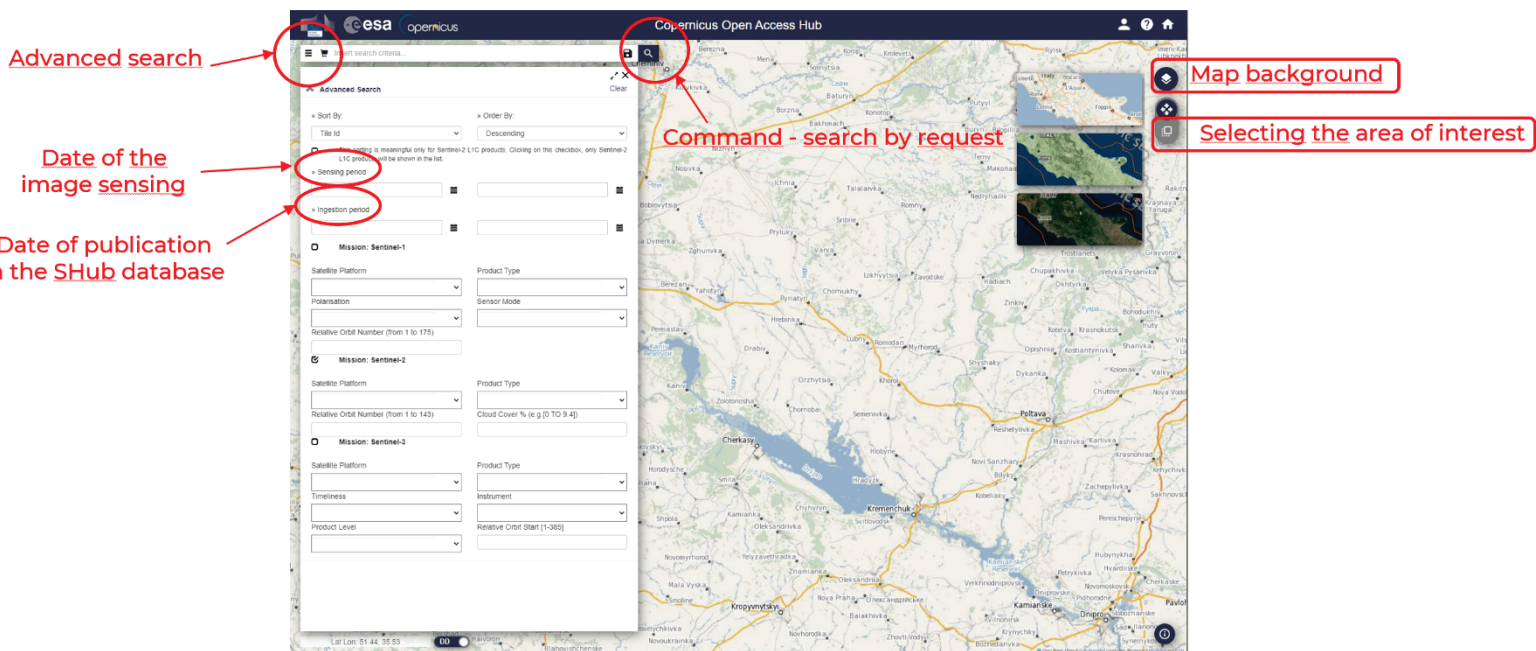
3.1. Registration and login

We can register a new user or log in as an existing user to the portal.

The ESA HUB system allows us to browse satellite images freely, but we need to register and fill in the details in the form to download them.

After registration and login, the portal looks as:

Advanced search

Date of the image sensing

Date of publication in the SHub database

Command - search by request

Map background

Selecting the area of interest

We can choose various satellite platforms, product types, polarizations, and sensing modes for individual satellites in the advanced search.

Platform selection A or B

☑ **Mission: Sentinel-1**

Satellite Platform

S1A_*
S1B_*

Relative Orbit Number (from 1 to 175)

Levels of product types

Level - 0 unprocessed raw data

Level - 1 SLC (Single Look Complex) contains complex images with amplitude and phase

Level - 1 GRD (Ground Range Detected)

Level - 2 OCN (Ocean) provide data on geophysical parameters of the ocean

Product Type

SLC
GRD
OCN
RAW

Polarization selection

☑ **Mission: Sentinel-1**

Satellite Platform

Polarisation

HH
VV
HV
VH
HH+HV
VV+VH

Sensing modes

Interferometric Wide Swath Mode (IW)

Extra Wide Swath Mode (EW)

Stripmap (SM)

Wave (WV)

Product Type

Sensor Mode

SM
IW
EW
WV

3.2. Search results

After defining the search criteria, we get the results that can be further analysed.

Image preview

Image preview

Image download

4 EO Browser

The EO Browser is a powerful tool for viewing and processing full-resolution satellite imagery from the provided datasets. It contains a large number of additional features. The browser will display the resulting data by selecting your area of interest and the desired time span and cloud coverage. It is possible to create different visualizations or download high-resolution images with time series creation. EO Browser provides free usage to make these features available to almost everyone. At the same time, it allows instant visualization of satellite data from many satellites and data collections. A background process takes care of selecting suitable scenes, downloading and processing the data, as well as creating mosaics. Satellite images in the EO browser can be visualized based on the user's desired configuration and according to ready-made visualizations with legends and descriptions such as true color, false color, NDVI, EVI, etc. An advantage is the possibility to create your own indices from combinations of spectral bands. In addition, the EO browser allows you to create your own script as a powerful tool for visualizing satellite data.

EO Browser can be accessed at:

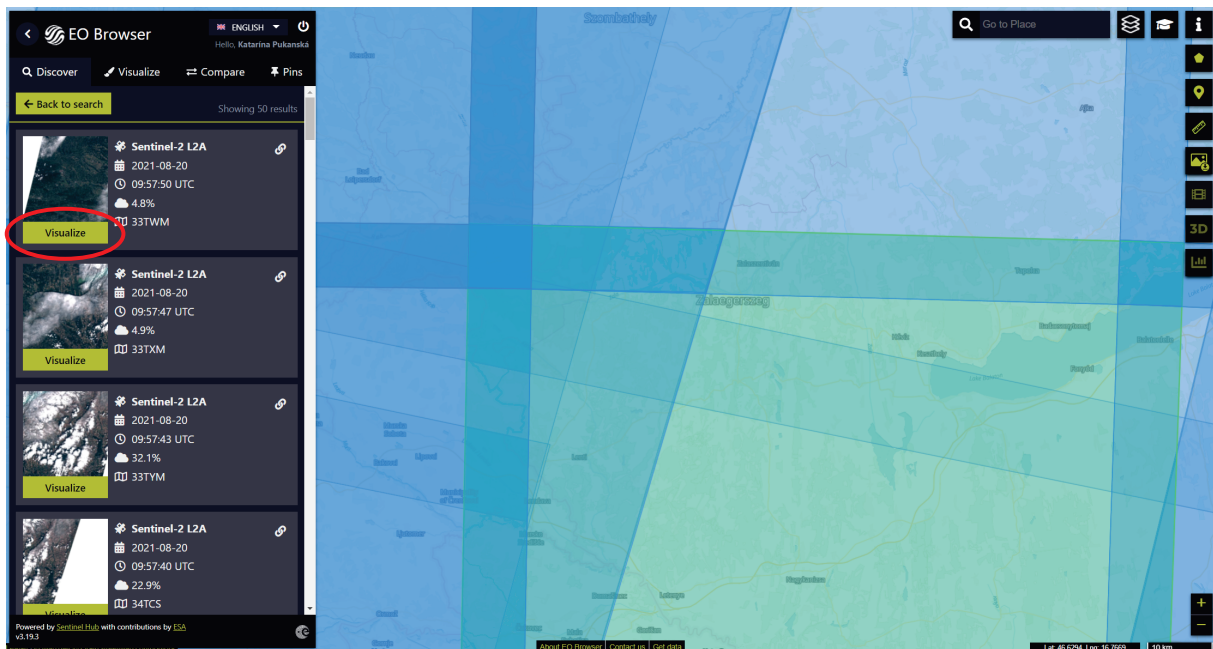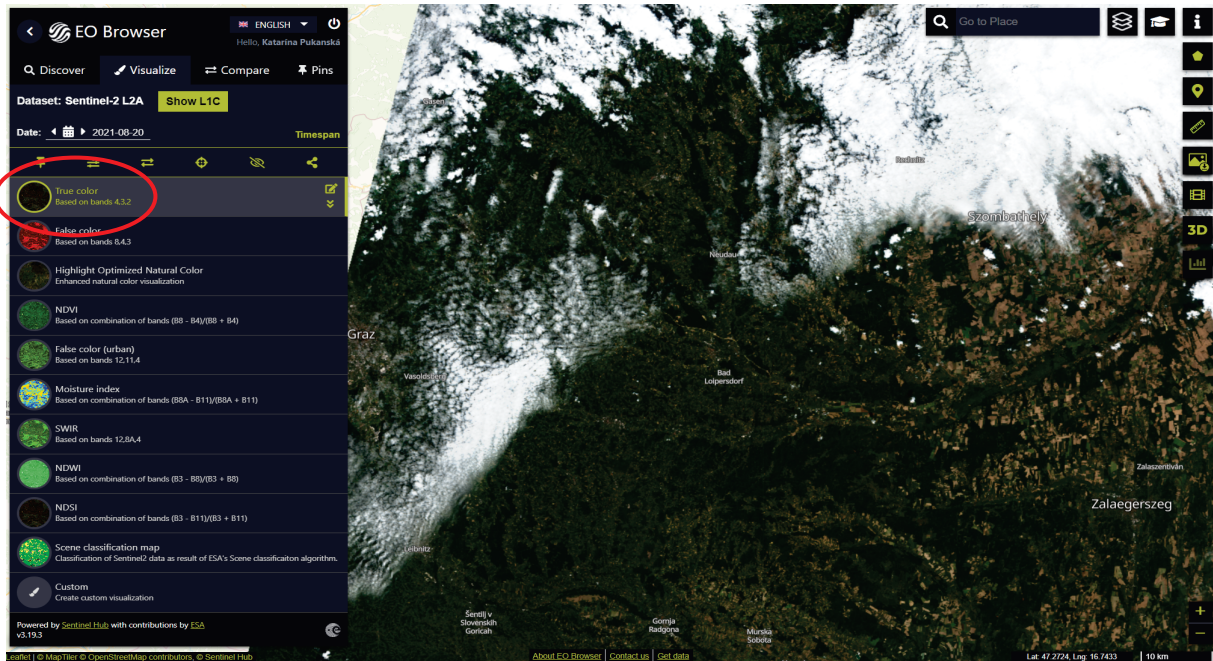https://apps.sentinel-hub.com/eo-browser/

Registration / Log In
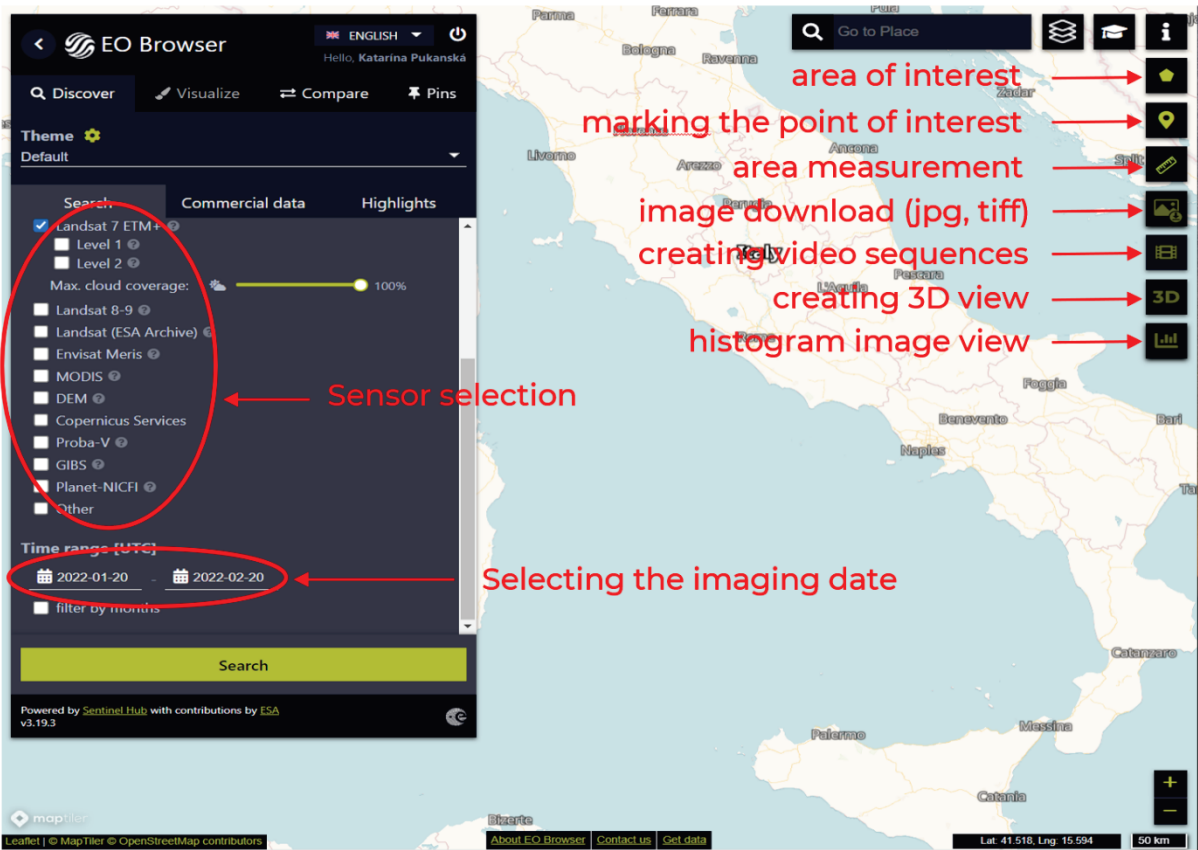
After the search, the selected image can be visualised in the browser.

4.1. Optical data

In the visualisation tab, we can change the view mode (true colour, false colour, NDVI, etc.).

True colour

False colour
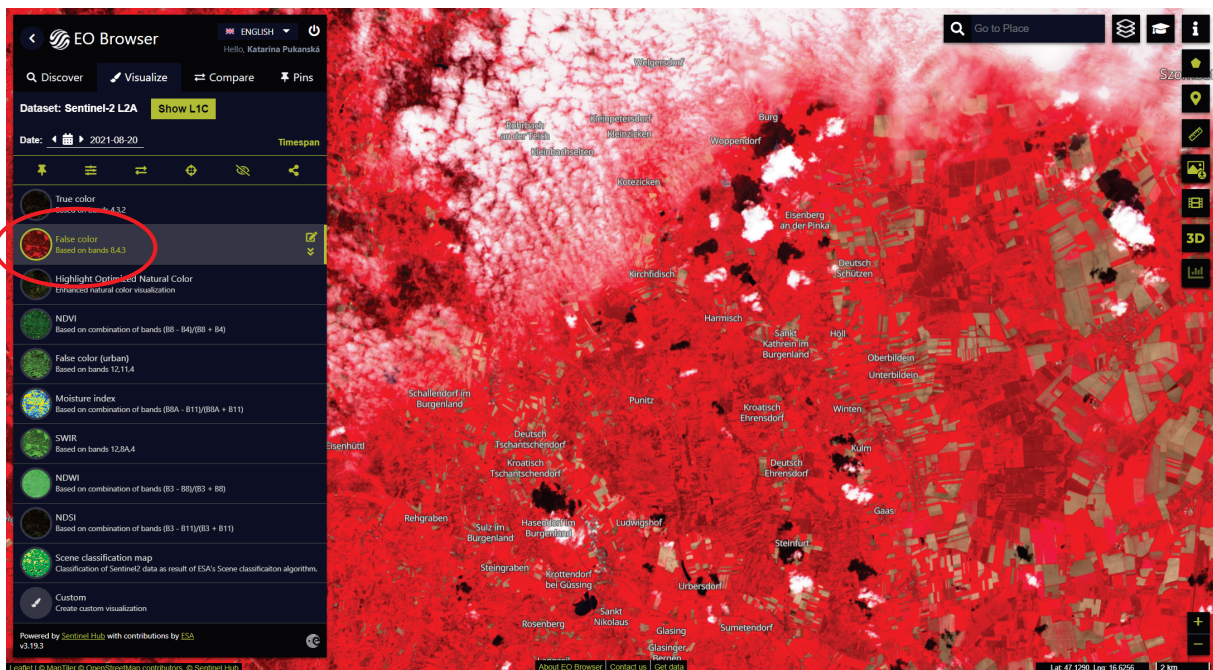
Other options of visualisations

True colour display (RGB composition)

False colour display (NIR, Red, Green)

Display in enhanced true colours

Display of NDVI index for vegetation monitoring

False colour display by bands 12, 11, 4

Display of soil moisture index

SWIR display by bands 12, 8A, 4

Display of NDWI index for water monitoring

Display of NDSI index for snow monitoring

Classification display based on ESA algorithms

User visualizations for custom band combinations

We can also use a visualisation for custom combinations of default bands or the scripting tool.

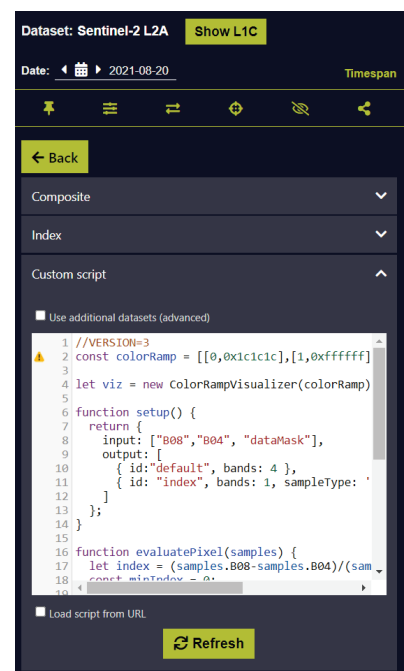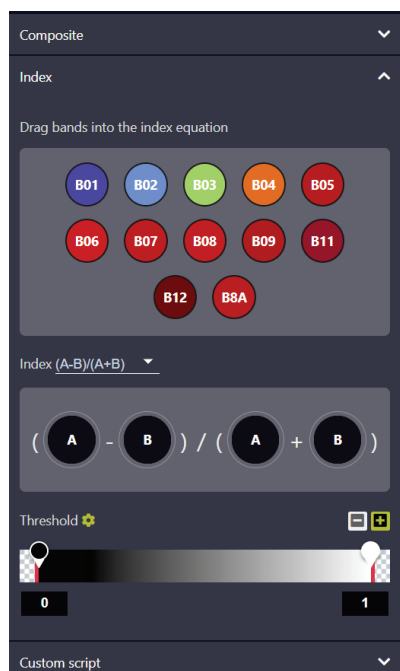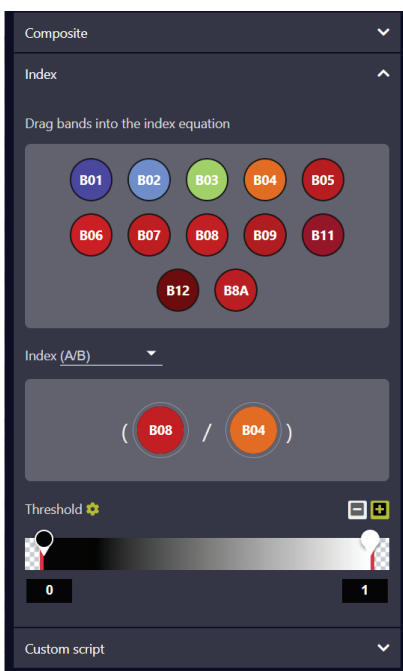An important visualisation tool of EO Browser is the *Timelapse* function. We can choose multiple images filtered by date and select one image per orbit, day, week, month, or year. Then we can play or download the timelapse visualisation.
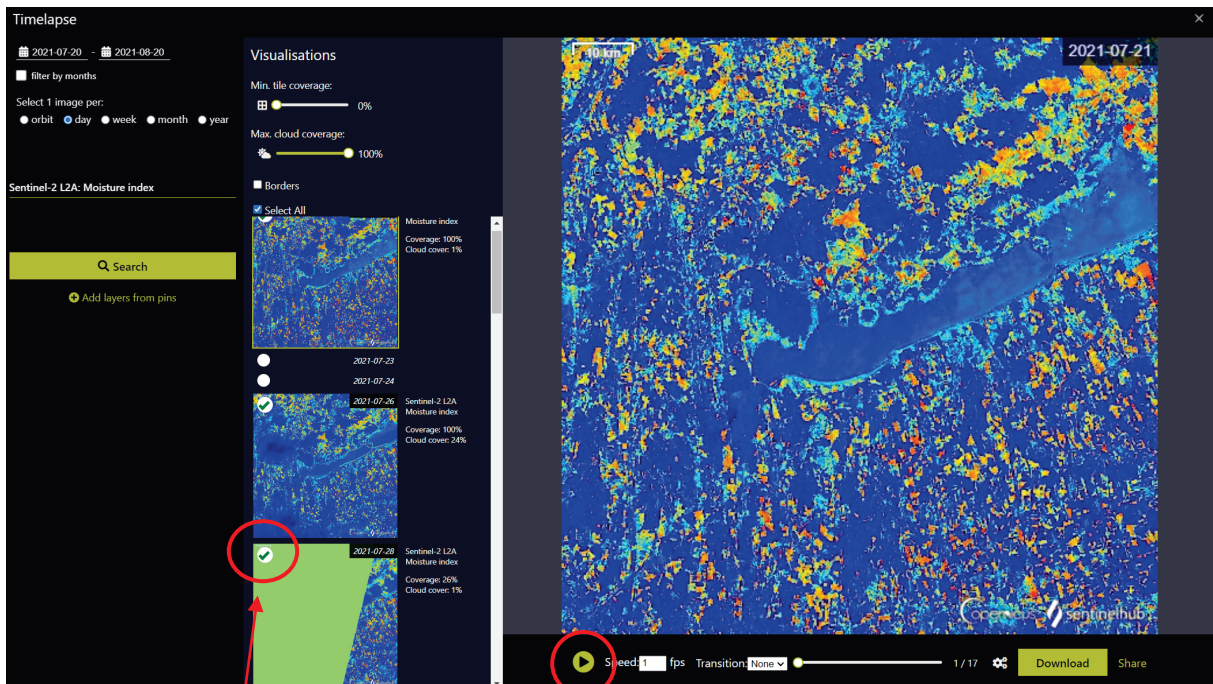
Select / deselect image

Starting a video, display parameter settings

For image analysis purposes, we can use the *Measure* function. Using this function, we are able to measure, for instance, the area of Zemplínska Šírava.
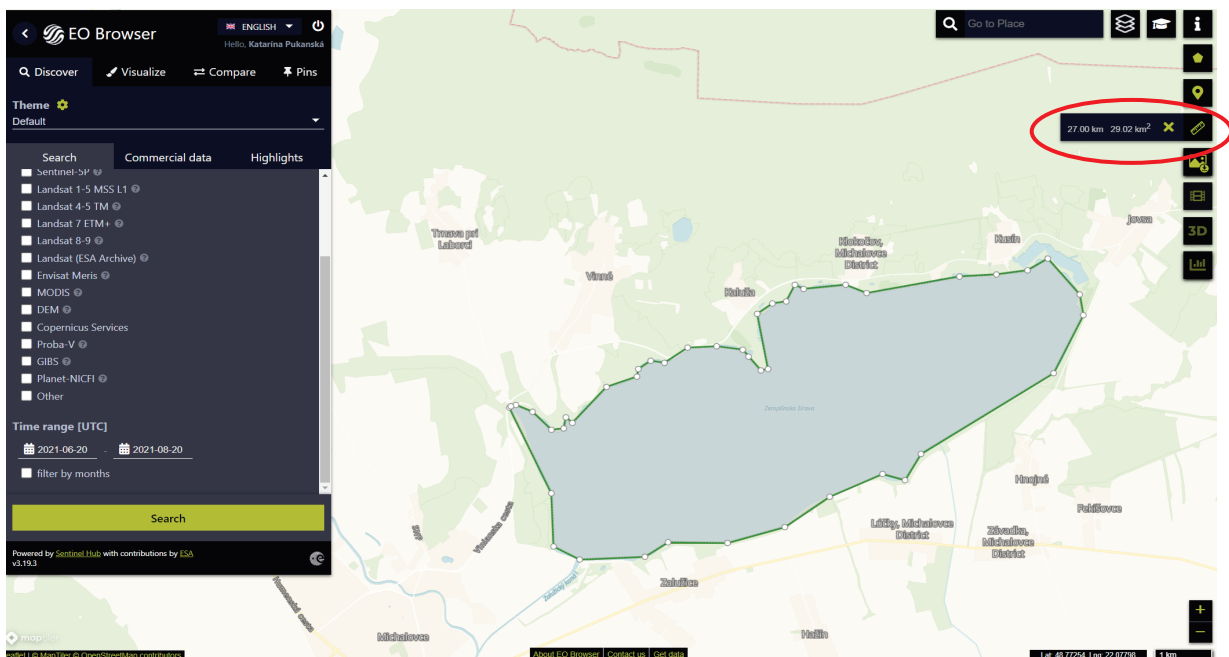
4.2. Radar data

When displaying radar data, we can also choose from various types of visualisations.

As required, the terrain can be displayed in different polarizations, cross-polarizations, and corrections.

5 ESA SeNtinel Application Platform

ESA Sentinel Application Platform (ESA SNAP) - is a freely downloadable tool developed by the European Space Agency specifically for satellite image processing. The software makes it easy to import and process data from all Copernicus satellites as well as other commercial satellites.

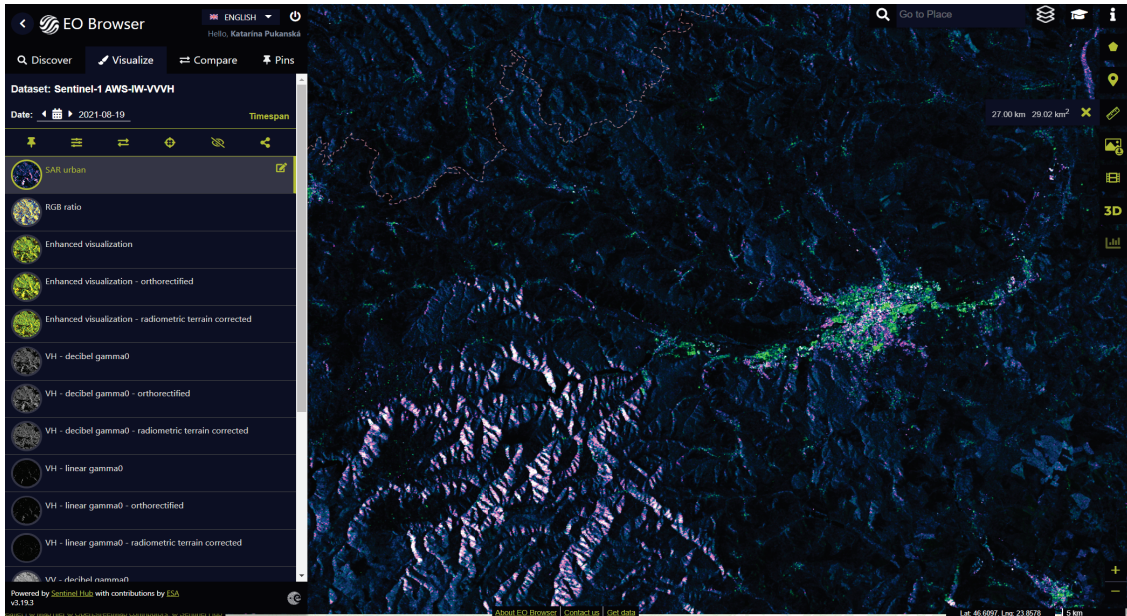The ESA SNAP tool can be downloaded from the ESA STEP website:

https://step.esa.int/main/download/snap-download/

Here you can download the latest installers for SNAP and the Sentinel Toolboxes.

Data provision is available to all users via the **Sentinel Data Hub**.

Current Version

The current version is **8.0.0** (19.10.2020 **15:00 UTC**).

For detailed information about changes made for this release please have a look at the release notes of the different projects: SNAP, S1TBX, S2TBX, S3TBX, SMOS Box, PROBA-V Toolbox.

We offer three different installers for your convenience. Choose the one from the following table which suits your needs. During the installation process, each toolbox can be excluded from the installation. Toolboxes which are not initially installed via the installer can be later downloaded and installed using the plugin manager. Please note that SNAP and the individual Sentinel Toolboxes also support numerous sensors other than Sentinel.

	Windows 64-Bit	Windows 32-Bit	Mac OS X	Unix 64-bit
Sentinel Toolboxes	These installers contain the **Sentinel-1**, **Sentinel-2**, **Sentinel-3** Toolboxes, download size is close to 900MB.			
	Main Download	Main Download	Main Download	Main Download
	Mirror Download	Mirror Download	Mirror Download	Mirror Download
SMOS Toolbox	These installers contain only the **SMOS Toolbox**, download size is close to 500MB. Download also the Format Conversion Tool (Earth Explorer to NetCDF) and the user manual.			
	Main Download	Main Download	Main Download	Main Download
	Mirror Download	Mirror Download	Mirror Download	Mirror Download
All Toolboxes	These installers contain the **Sentinel-1**, **Sentinel-2**, **Sentinel-3** Toolboxes, **SMOS** and **PROBA-V** Toolbox, download size is close to 1GB.			
	Main Download	Main Download	Main Download	Main Download
	Mirror Download	Mirror Download	Mirror Download	Mirror Download

The SNAP architecture is ideal for Earth observation (EO) processing and analysis due to the following technological innovations: extensibility, portability, modular rich client platform, generic EO data abstraction, tiled memory management, and a graph processing framework.
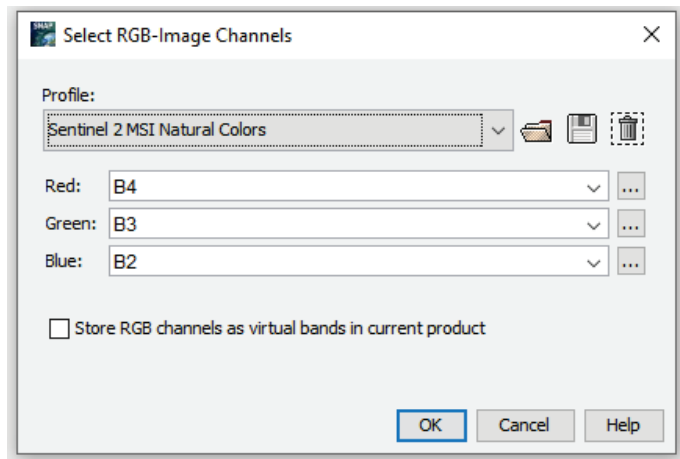
SNAP and the individual Sentinel Toolboxes support numerous sensors other than Sentinel sensors.

ESA/ESRIN is providing the SNAP user tool free of charge to the Earth Observation Community.
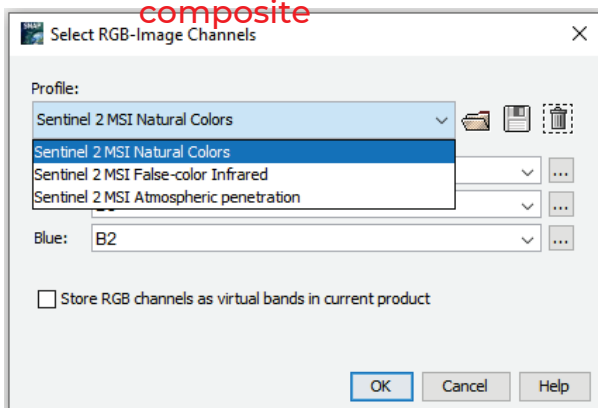
After installing the software, we can open an image.
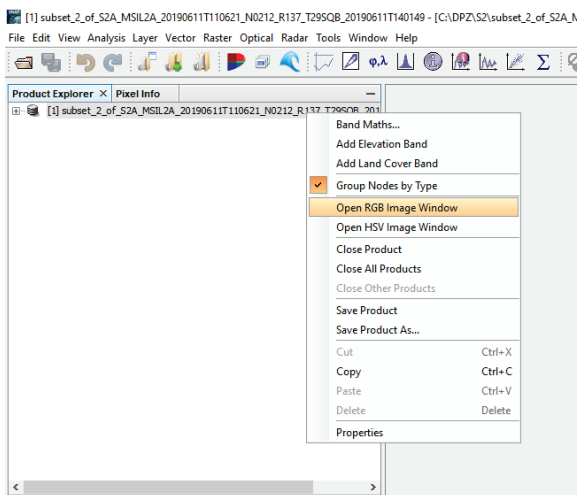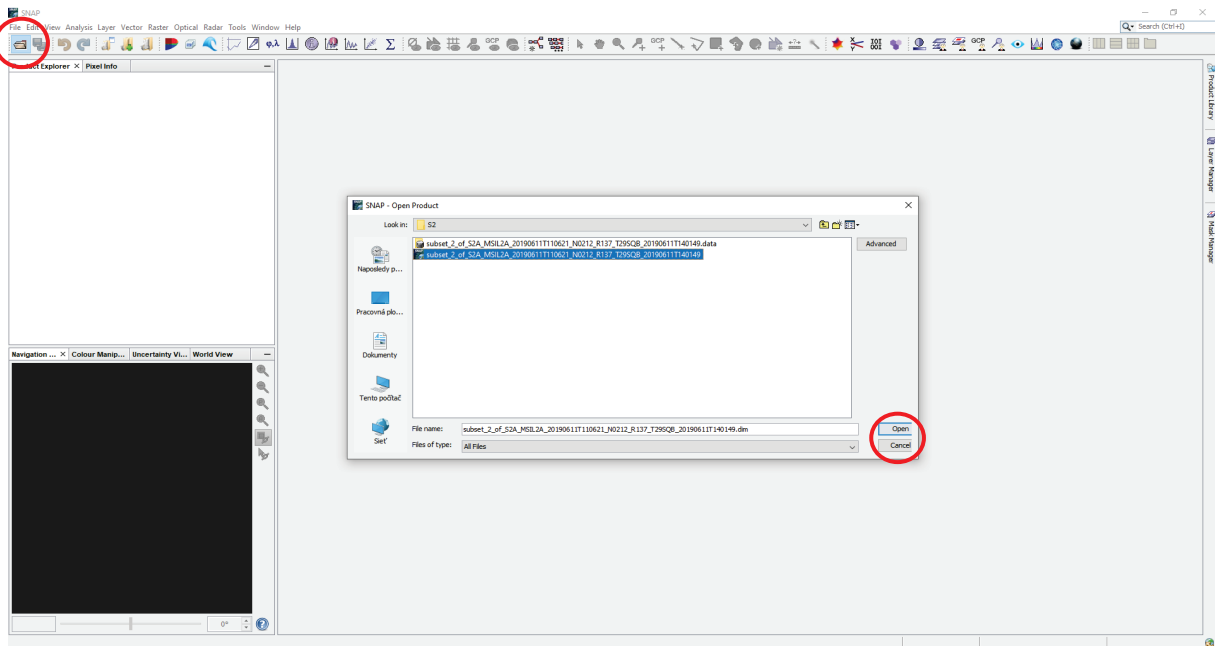
Open image in RGB colour composite

Display in natural colours; Bands selection

Open image in false colour infrared RGB composite;
Or opening image displaying atmospheric penetration.

When we open an image, we can browse the image data in the Product Explorer window, open RGB composite image, browse metadata, spectral bands, or image masks.

For radar images, we can display amplitude or intensity in various polarisations.
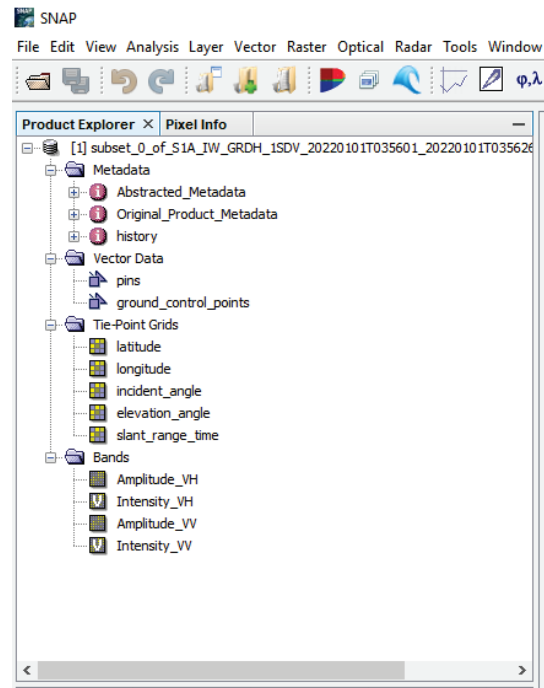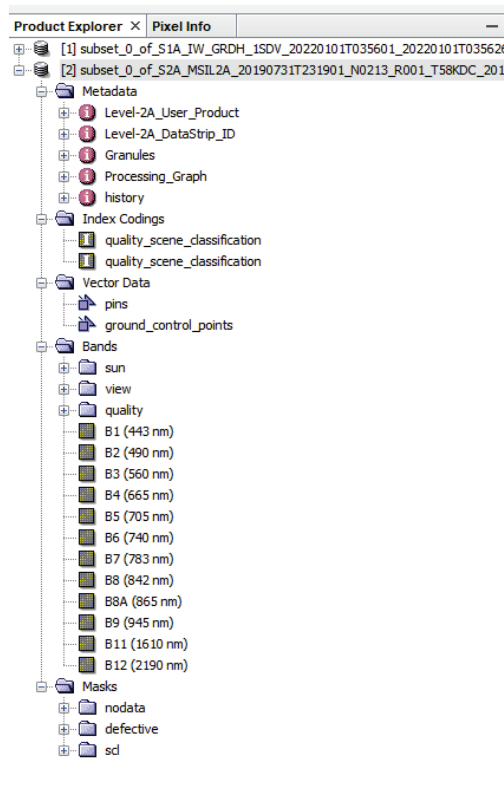
- Opening MS image in RGB colour composite;
- Metadata;
- Spectral bands;
- Masks.

- Opening radar image;
- Metadata;
- Displaying the amplitude in VV, VH polarisation;
- Displaying intensity in VV, VH polarisation.

In the *Colour Manipulation* tool, we can see the histogram for the opened image. We can manipulate individual channels or assign new colours or colour palettes to the image.

You can explore the individual functions of this tool on your own.
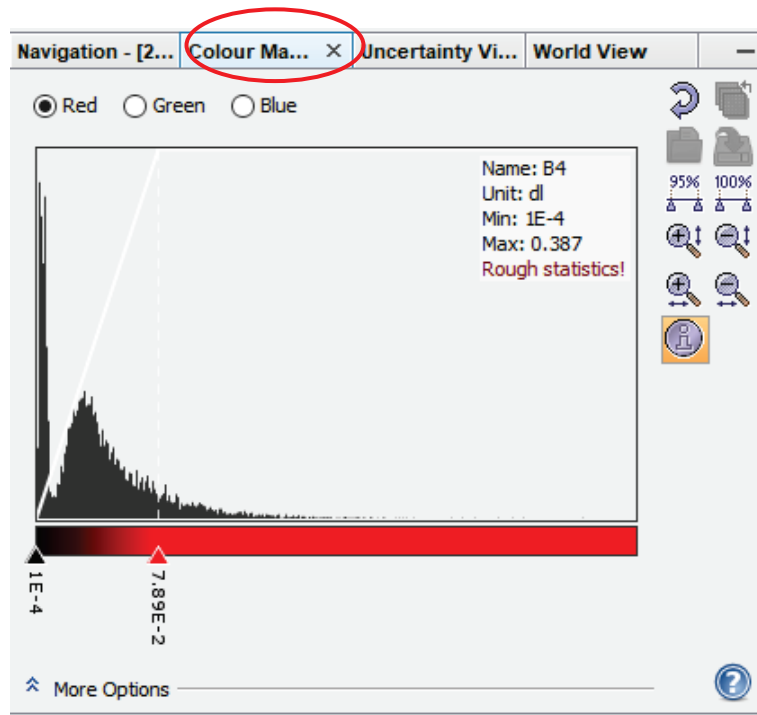
Another useful tab is the *World View* tab. Here we can see the position of our selected image.
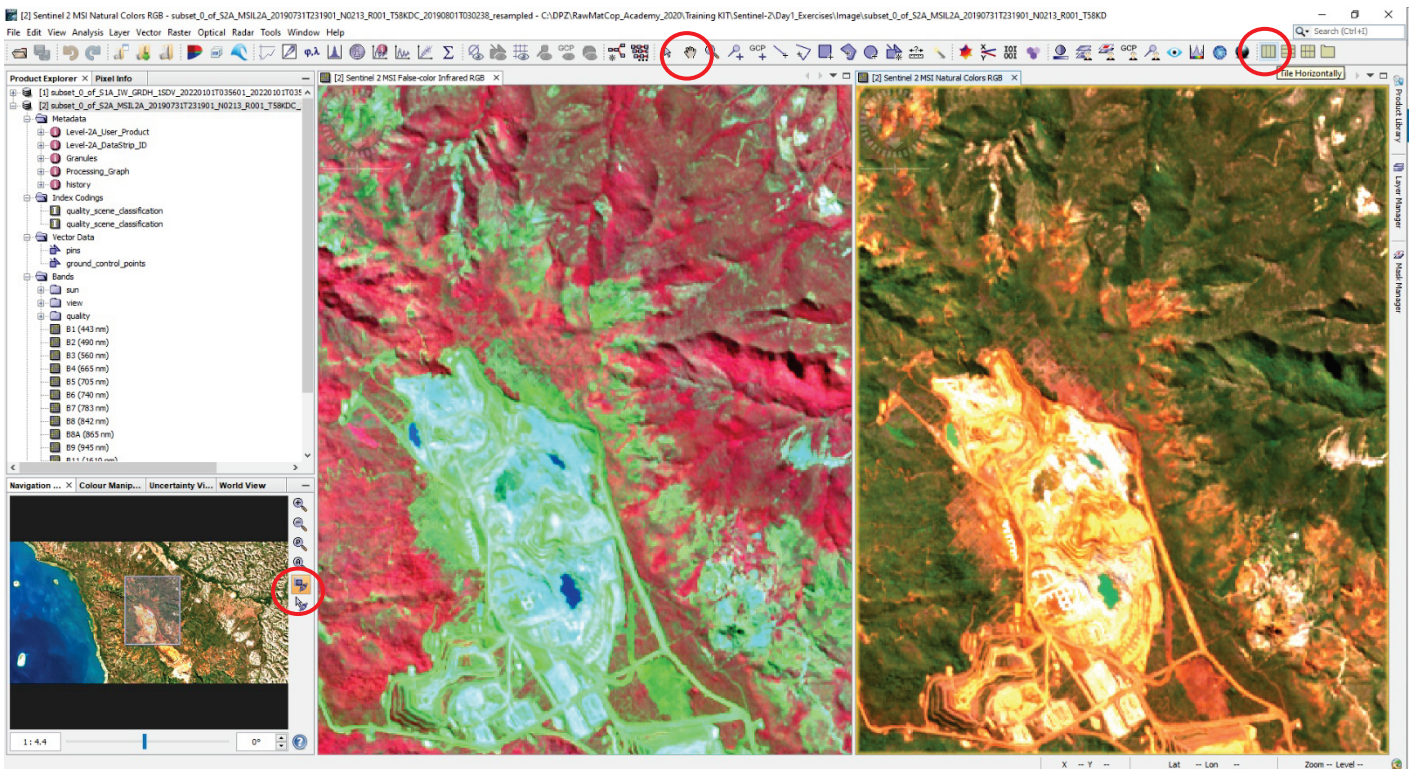
If we want to see multiple opened images at once and compare them, we can use the function *Tile Horizontally*.

To see the cursor and manipulate all images simultaneously, go to the Navigation tab and make sure that the following is checked:

synchronises views across multiple image windows

synchronises cursor positions across multiple image windows

One of the basic tools for image analysis in ESA SNAP is the *Optical/Spectrum View* tool.

With this tool, we can display spectral curves of, for instance, water, soil, and vegetation. Here we can see that vegetation has the highest intensity of reflectance in the NIR band, while water is absorbed in the NIR band – with no reflectance.
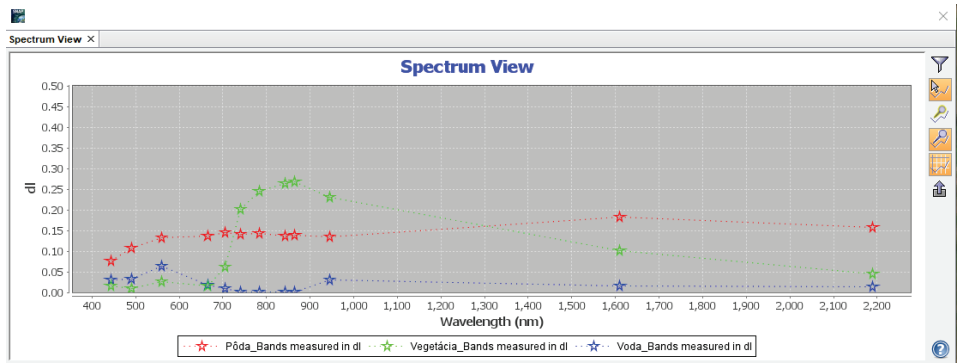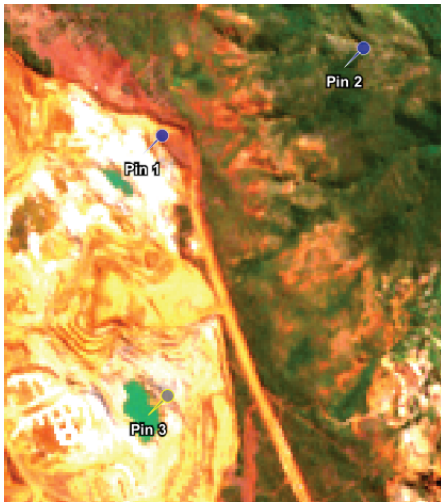
For easier manipulation, you can add various pins to different pixels and add the description to them (*View – Tool Window – Pin Manager*).

X	Y	Lon	Lat	Color	Label
851.500	428.500	164.203968	-20.444343	🟥	Pôda
920.500	398.500	164.210596	-20.441662	🟩	Vegetácia
853.500	517.500	164.204118	-20.452385	🟦	Voda

6 Third-Party Missions

Web access via the ESA website homepage is set up to retrieve data from third-party satellite missions:

http://earth.esa.int
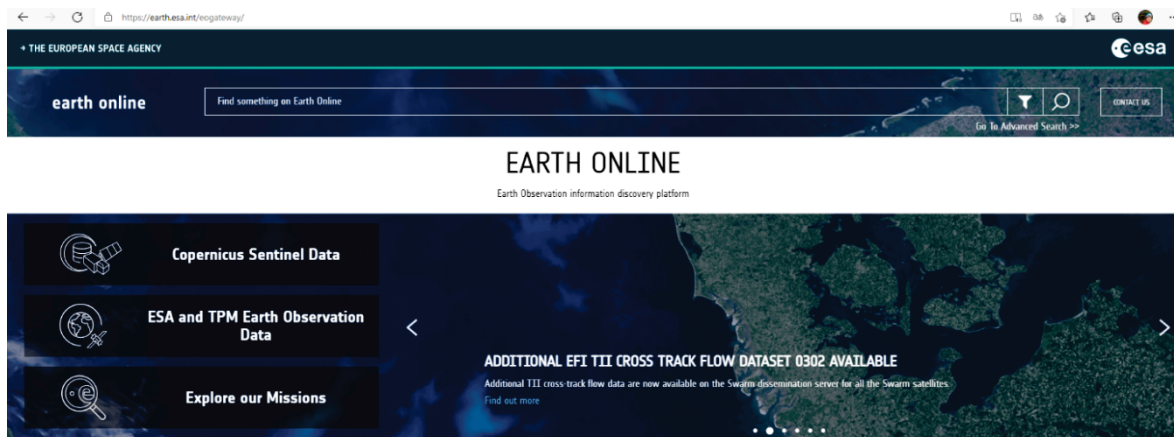
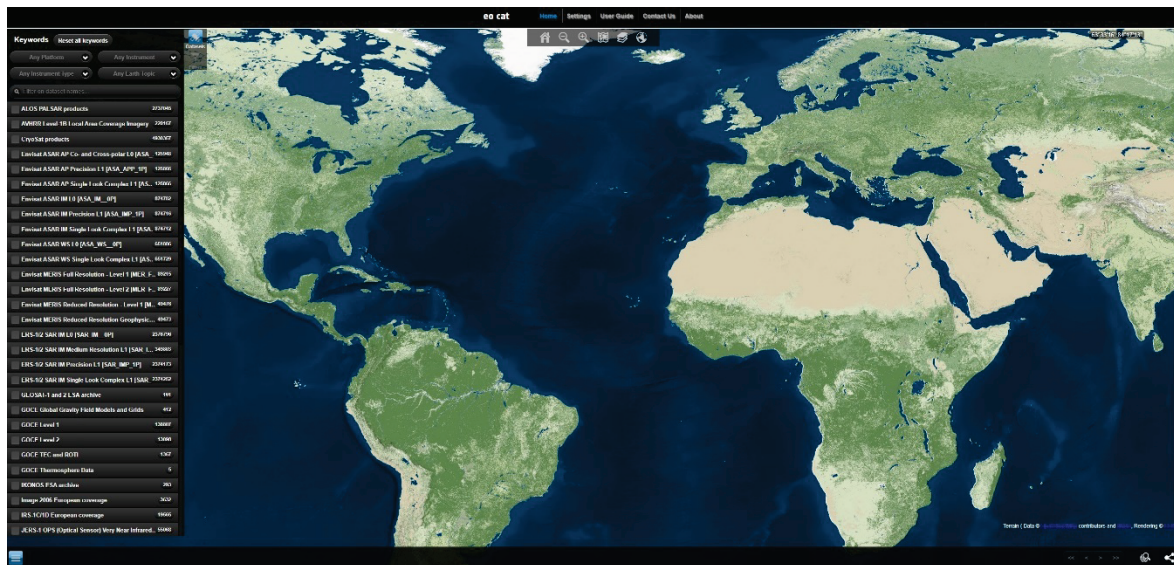The ESA and TPM Earth Observation Data link redirects us to a page with a selection of available satellites:

https://eocat.esa.int/sec/#data-services-area

We can find here:

- news and descriptions of missions and their instruments;

- descriptions of collections;

- technical product descriptions;

- links to access the data;

- information on selected Earth or environmental topics and satellite data applications.

The *Data Access/Browse Data Products* menu allows users to browse by satellite type, instrument, application, processing level, and product type.

6.1. Data access

We can request the access to data in three ways:

1. Instant access via *MyEarthNet*:

   https://earth.esa.int/web/guest/pi-community/myearthnet

2. By submitting a proposal where data requests are subject to specific solicitation or dissemination restriction. The proposal is evaluated over a 6-8 week period, and if accepted, the applicant is allocated a quota of products for the project. Submission of a proposal can be made at:
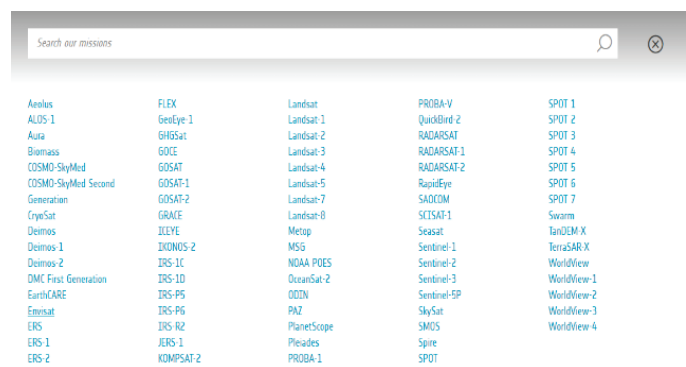
https://earth.esa.int/webiguest/pi-community/

3. An *Announcement of Opportunity* (AO) means that ESA will issue an announcement for a specific mission or research topic. If the requested data fall within a specific subject covered by a specific opportunity announcement, once the request has been received and accepted, an acknowledgement will be received within a few weeks. Information on current notified opportunities can be found at:

https://earth.esa.int/webiguest/pi-community/apply-for-data/ao-s

Access to archived data and historical ESA missions can be found at:

https://earth.esa.int/eogateway

How to access these data, as well as their availability, can change over time. Therefore, feel free to explore it on your own.

THANK YOU FOR FOLLOWING THE EXERCISE!