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Ministero
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Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



SATELLITE DATA MANAGEMENT FOR ADVANCED ENVIRONMENTAL APPLICATIONS

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2nd ICSC Spoke2 meeting, Catania, 10-12 December 2024





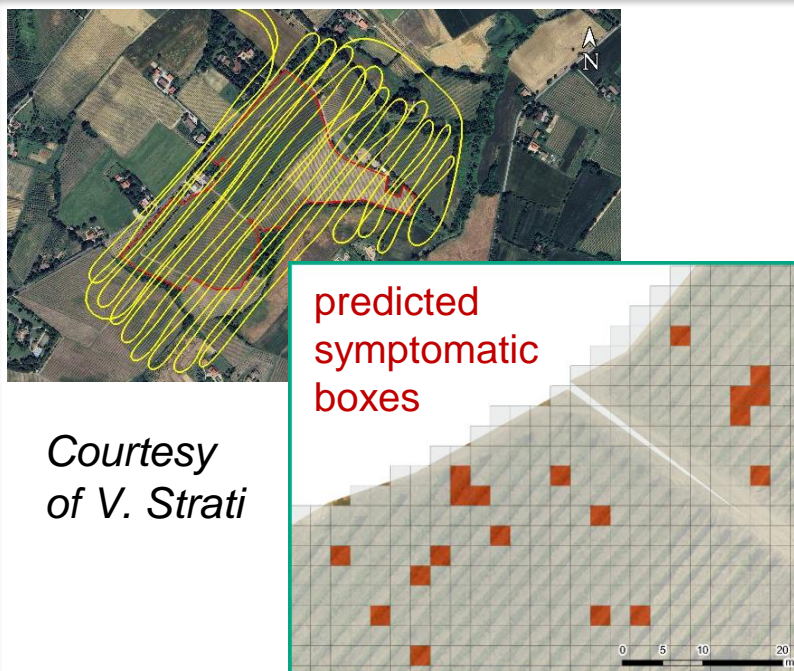
Space economy within the WP6

Activities are divided into **three distinct but interconnected** working groups.



Deterministic Learning algorithms for object identification of **photovoltaic panels in aerial images**.

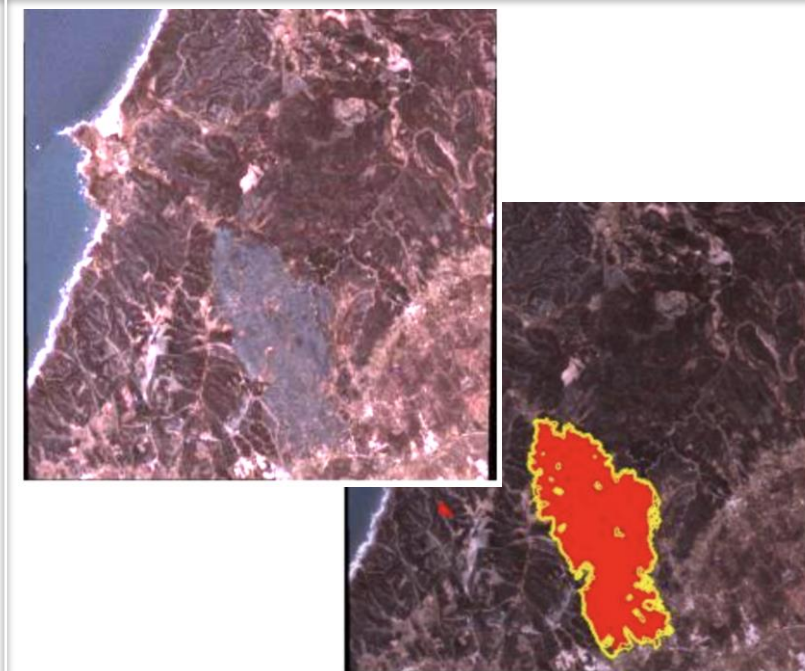
[Technologies 2023, 11, 174](#)



Courtesy of V. Strati

Disease detection in vineyards using high-resolution images collected by Unmanned Aerial Vehicles (UAVs).

[V. Strati, EGU24-10773 \(2024\)](#)



Analysis of satellite imagery using deep-learning **segmentation of wildfire-affected areas and the detection of vineyard disease**.



A custom library to download and manage satellite data

Within the project, a **python** library has been developed, currently including of 4 modules:

Download module

Download of satellite imagery using the [Sentinel-Hub API](#).
Currently implemented for Sentinel2-L2A products only.

DataManipulator module

Produce maps for single spectral band and vegetation indexes (currently 19 implemented) in TIFF format and as **numpy** arrays. Also combining downloaded data with **labels**.

Visualiser module

Printing the processed maps in standard formats (PDF, PNG, etc.)

DataHandling module

Pre-processing of data for training deep-learning applications.
Currently includes : dataset normalization, discrete mirroring/rotations & image splitting for data augmentation, storage in csv or numpy-native formats.

To be made publicly available as open-source library by the end of the project. Available [here](#) upon request



Wildfires: an increasing and critical problem

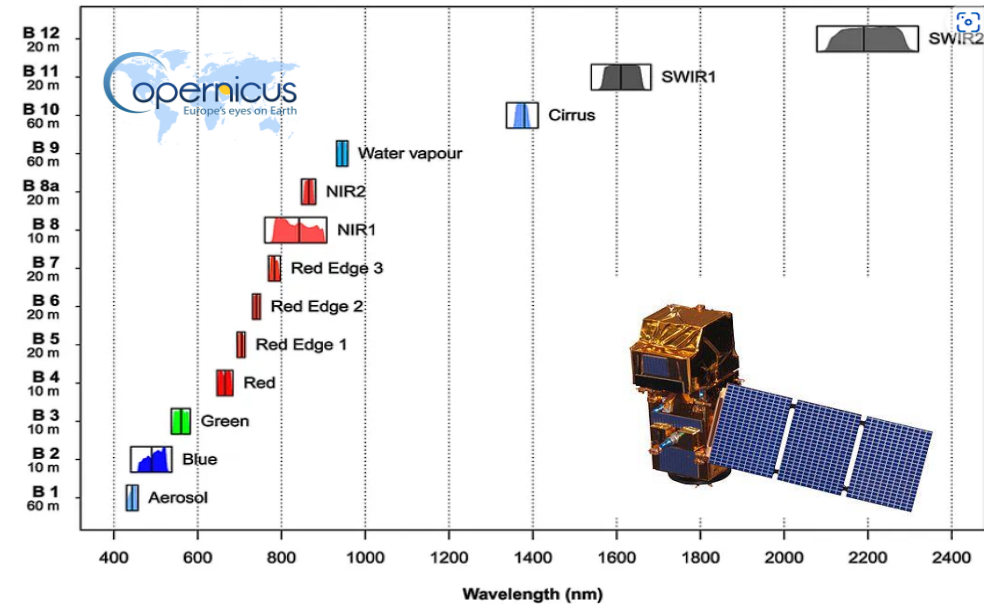
- In recent years, **forest fires have increased** significantly due to higher temperatures and prolonged periods of drought.
- In 2023, more than 4.1 million hectares will be burnt in Europe, an increase of 40 % compared to the average of the last ten years.
- Fires are often caused by a combination of factors: **extreme weather conditions, human activities and inadequate forest management.**
- Aerial data and machine learning can be used to extract useful information for wildfire identification, monitoring, prediction and **mapping of burned area.**





A dataset for the segmentation of burned area in sentinel-2 imagery

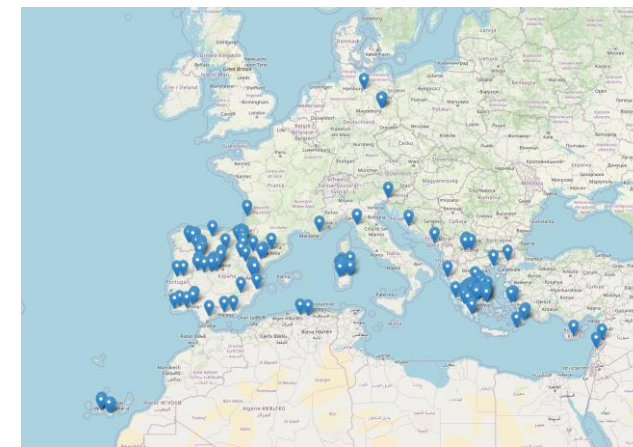
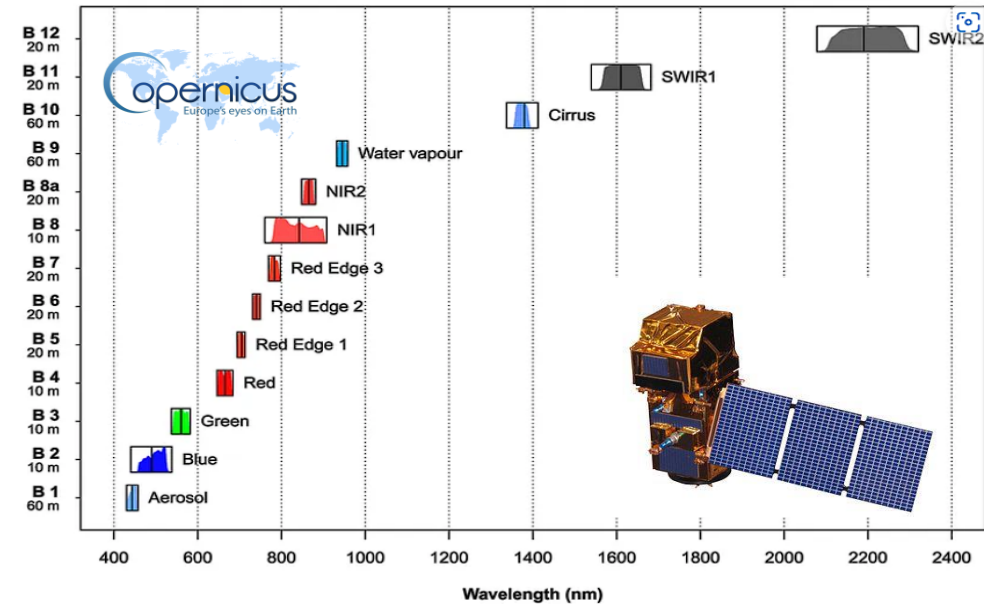
- [Sentinel-2 satellites](#) offer high-resolution multispectral imaging capabilities. These satellites provide data across a **wide range of wavelengths**, from the visible spectrum to shortwave infrared.
- The focus of the dataset is on **the detection and mapping of burnt areas** using multispectral satellite images from Sentinel-2.





A dataset for the segmentation of burned area in sentinel-2 imagery

- [Sentinel-2 satellites](#) offer high-resolution multispectral imaging capabilities. These satellites provide data across a **wide range of wavelengths**, from the visible spectrum to shortwave infrared.
- The focus of the dataset is on **the detection and mapping of burnt areas** using multispectral satellite images from Sentinel-2.
- The dataset used in the analysis comprises **114 multispectral 3-steps temporal series of images** (all the 12 Sentinel-2 bands), each with a size of 2048x2048 pixels and a spatial resolution of 10 meters.
- These images focus on **historical fires across Europe**, primarily in the Mediterranean area, sourced from the [Copernicus Emergency Management Service \(EMS\)](#).



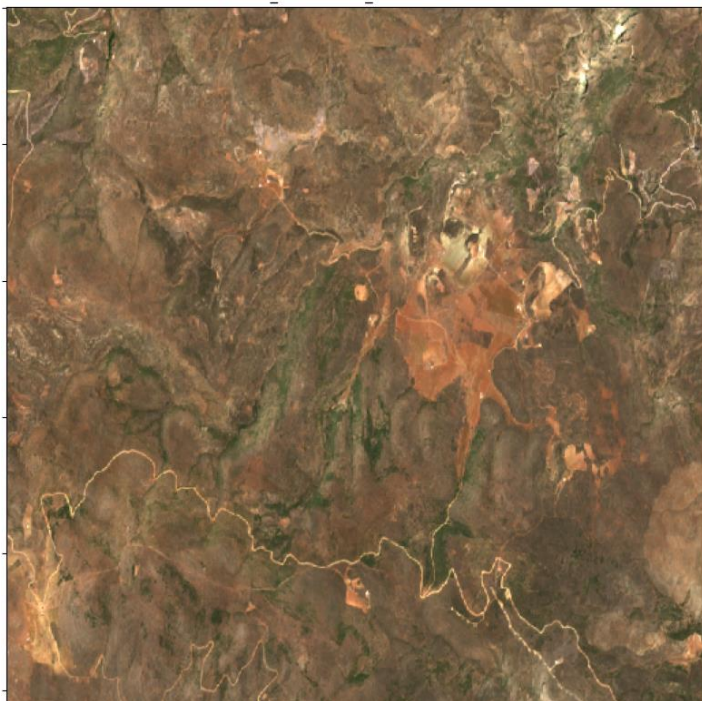


Download and manipulate Sentinel-2 data

DOWNLOAD TEMPORAL SERIES

BEFORE FIRE (RGB ONLY)

EMSR370AOI01_2019-06-13_2019-07-02 - RGB bands



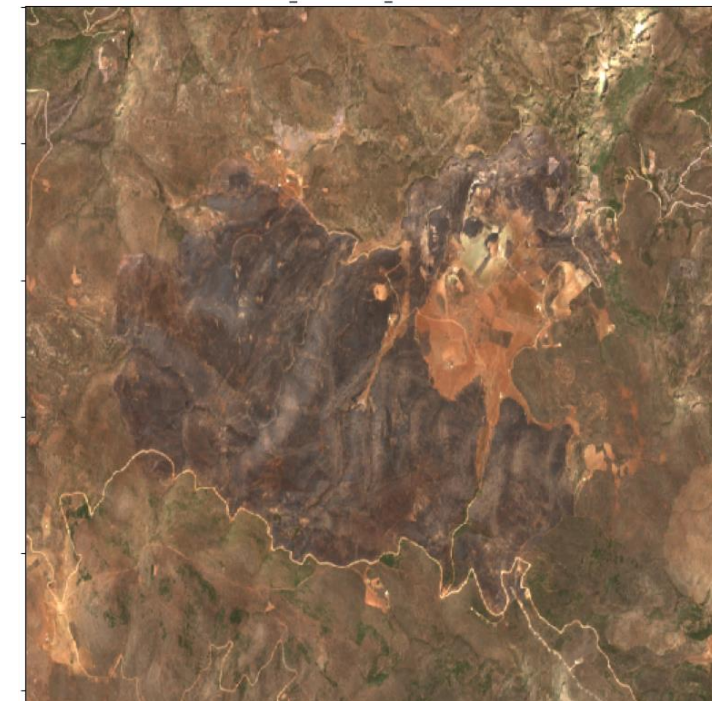
NEAR FIRE (RGB ONLY)

EMSR370AOI01_2019-07-03_2019-07-22 - RGB bands



AFTER FIRE (RGB ONLY)

EMSR370AOI01_2019-07-23_2019-08-11 - RGB bands

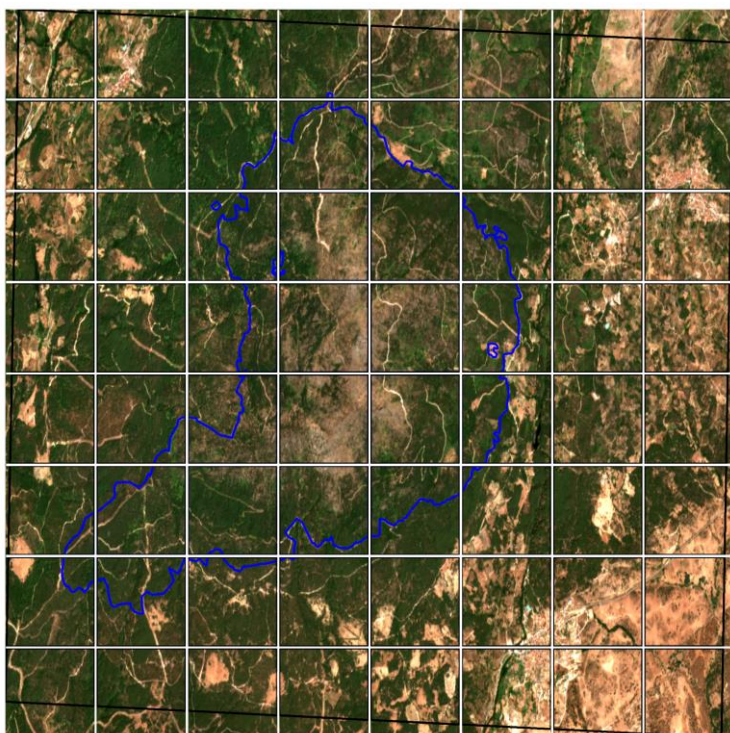




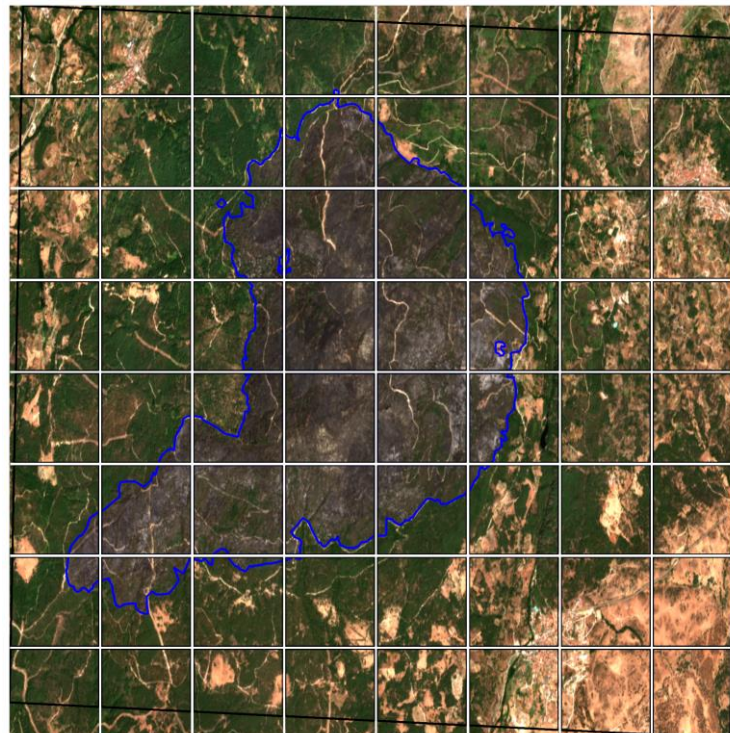
Download and manipulate Sentinel-2 data

LABELLING, CROPPING, AUGMENTING

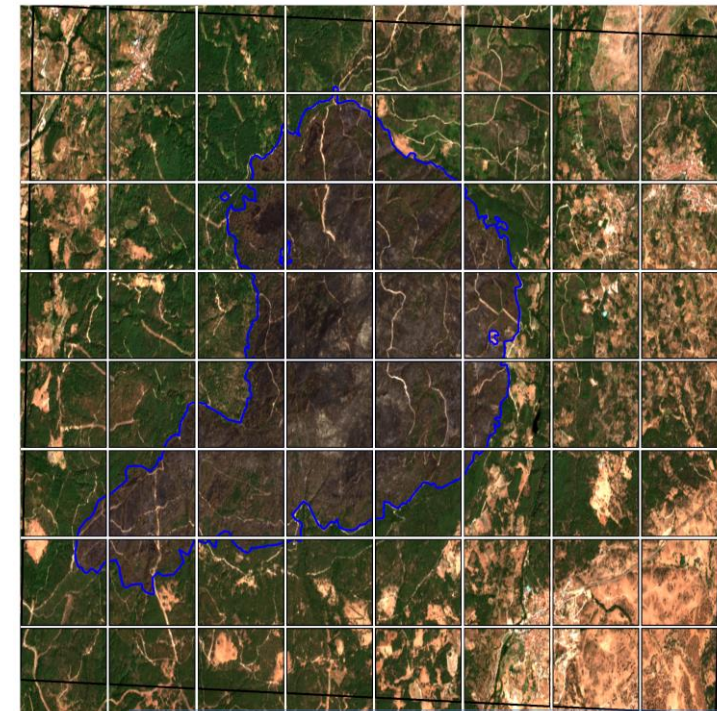
BEFORE FIRE (RGB ONLY)



NEAR FIRE (RGB ONLY)



AFTER FIRE (RGB ONLY)

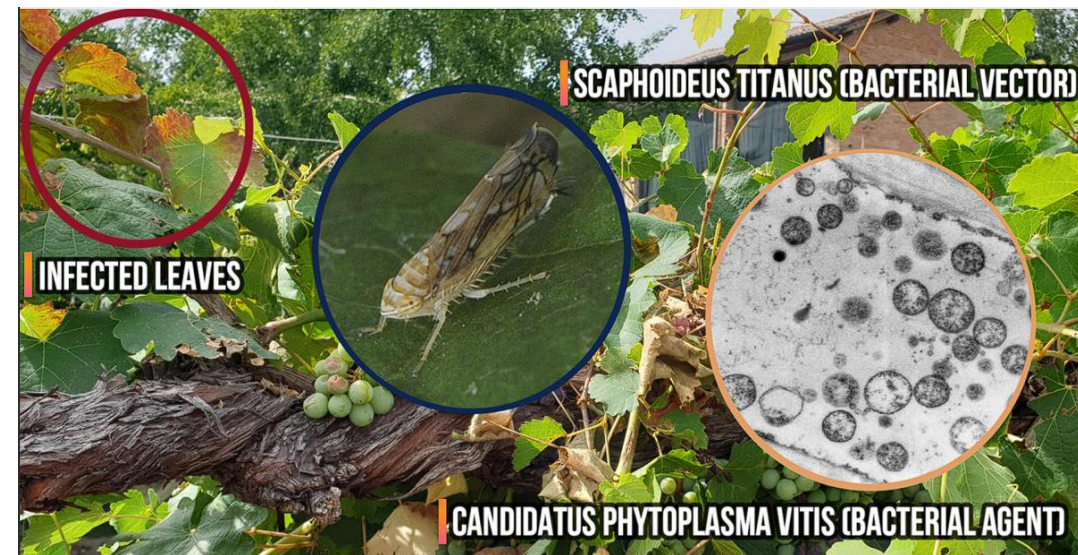


**see talk of G. A. Anastasi
on 12/12 for more details
on analysis!**



Flavescence dorée: a devastating vineyard disease

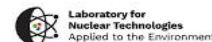
- Flavescence dorée is a vineyard disease caused by a phytoplasma that **is devastating crops across Europe** (reduction of yields by up to 50-60%).
- Main symptoms are downward rolling, interruption of the lignification, reduction in fruit production and leaf yellowing (white grapes) or **reddening (red grapes)**.
- Once infected **there are no possibilities to cure the plant**: insecticide sprays and immediate uprooting are mandatory to avoid the spread of the disease.
- Early detection of the symptoms **via remote sensing** represents a significant improvement over traditional ground-based surveys (highly time-consuming and inefficient).
- **This study aims to quantify the incidence of the disease using airborne images to identify the reddening of the leaves.**



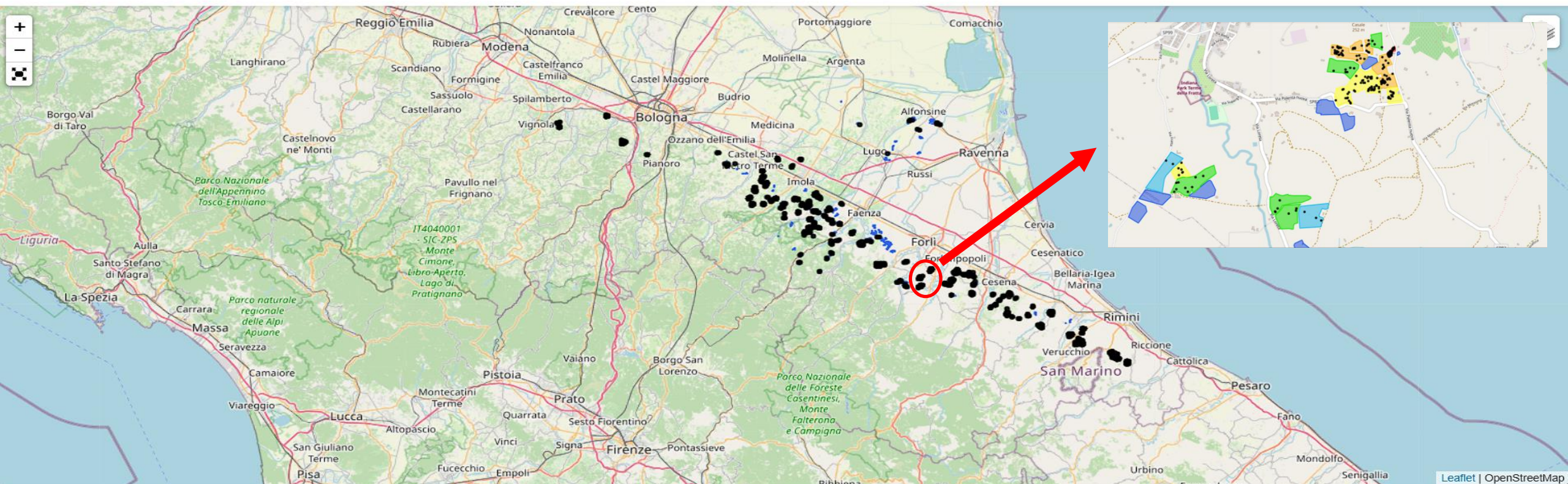


Early vineyard disease detection: The PERBACCO project

PERBACCO



Mapa di densità di casi sospetti di giallumi e mal dell'esca
Numero di casi sospetti per ettaro





Dataset for vineyard disease detection

Using the custom library, a dataset of Sentinel-2 images from 741 fields has been created :

- each image is a **multispectral 64x64 pixels map** with a resolution of 10 m;
- **disease severity stored as integer** from 0 (no cases) to 5 (>50 cases per hectare);
- **data augmentation** (random translations – rotations – mirroring) applied.

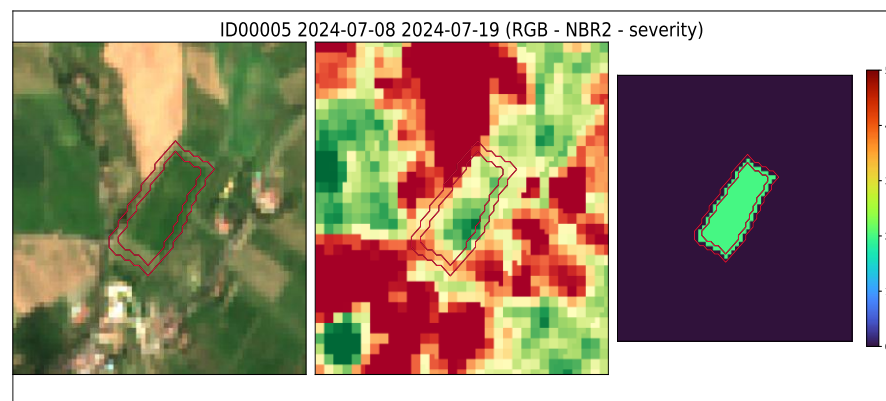
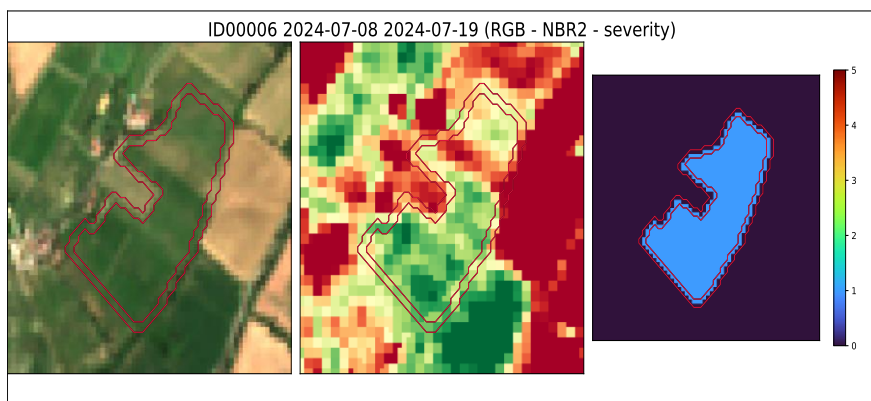
Currently studying machine learning applications for **classification under 2 labels** (0 → no cases, 1 → any disease severity).

Attempts at **regression** (i.e. reconstruction of the severity level) will be performed after classification is successfully developed.

see talk of G. A. Anastasi on 12/12 for more details on analysis!

Mappa di densità di casi sospetti di giallumi e mal dell'esca

Numero di casi sospetti per ettaro

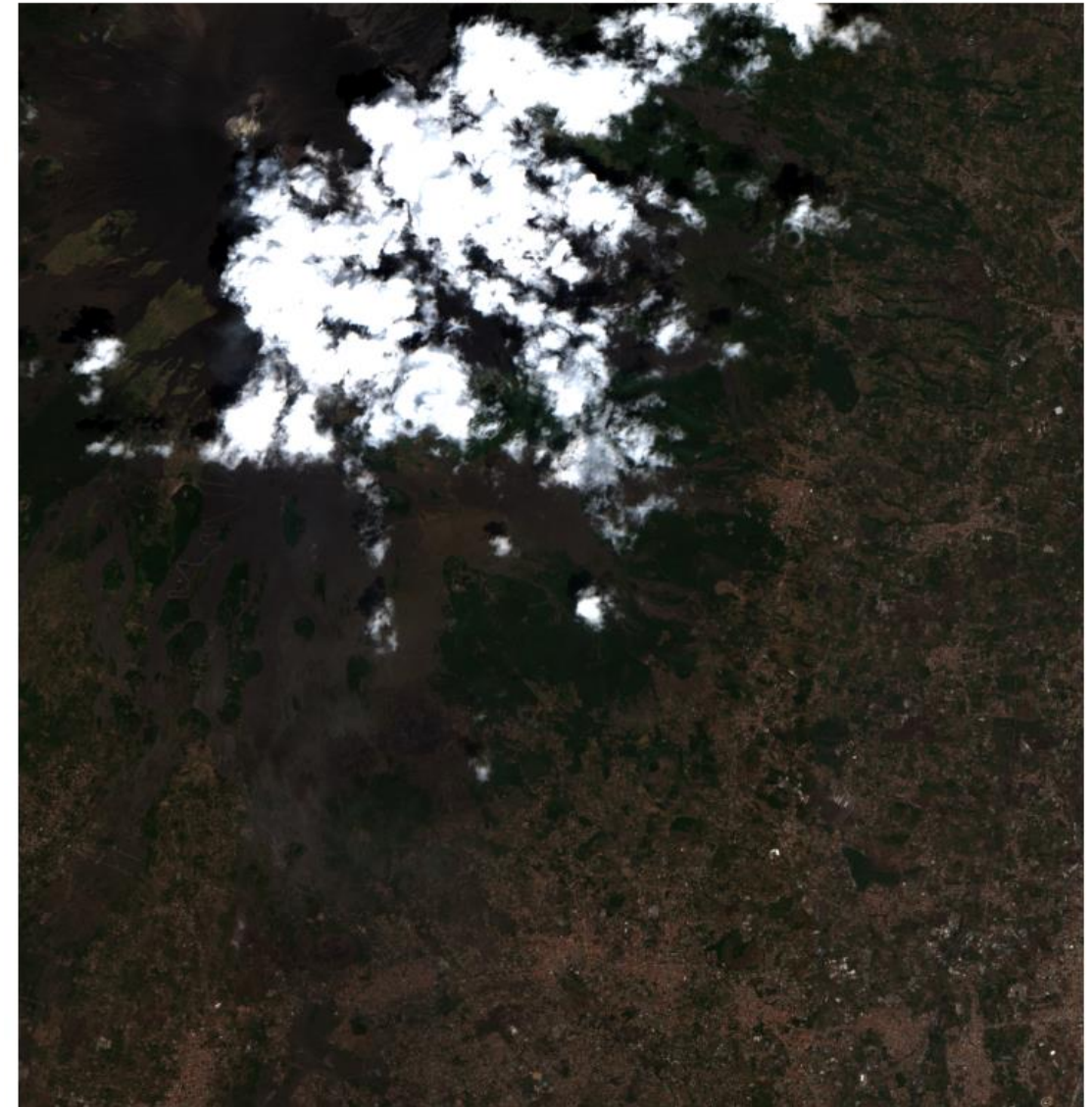




Next steps in the remaining year

- Increase available satellite data sources, starting with those of the **Copernicus constellation**.

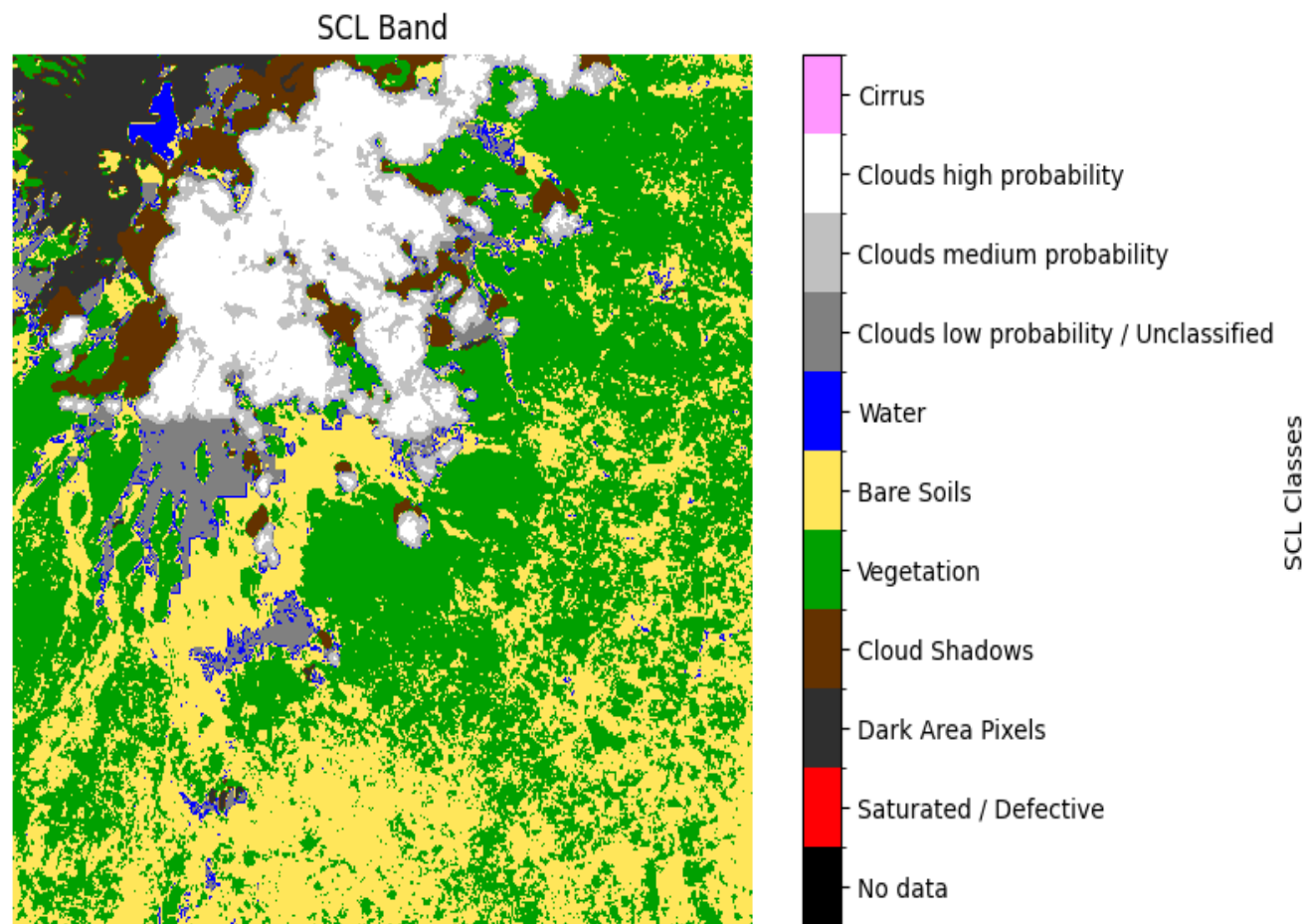
Sentinel-2 RGB Composite (B04: Red, B03: Green, B02: Blue)





Next steps in the remaining year

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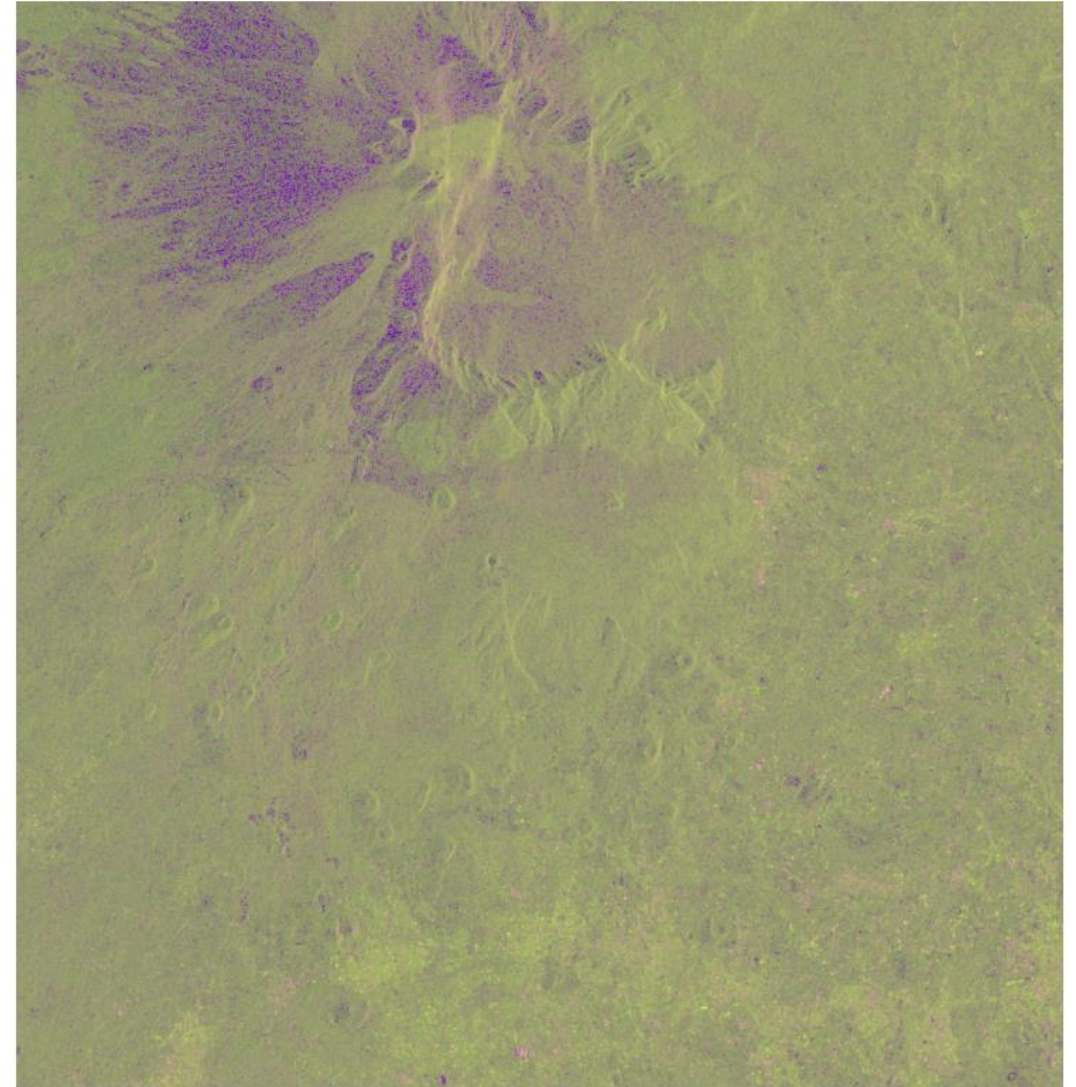




Next steps in the remaining year

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Sentinel-1 RGB Image [VV, 2 * VH, VV / VH / 100.0]





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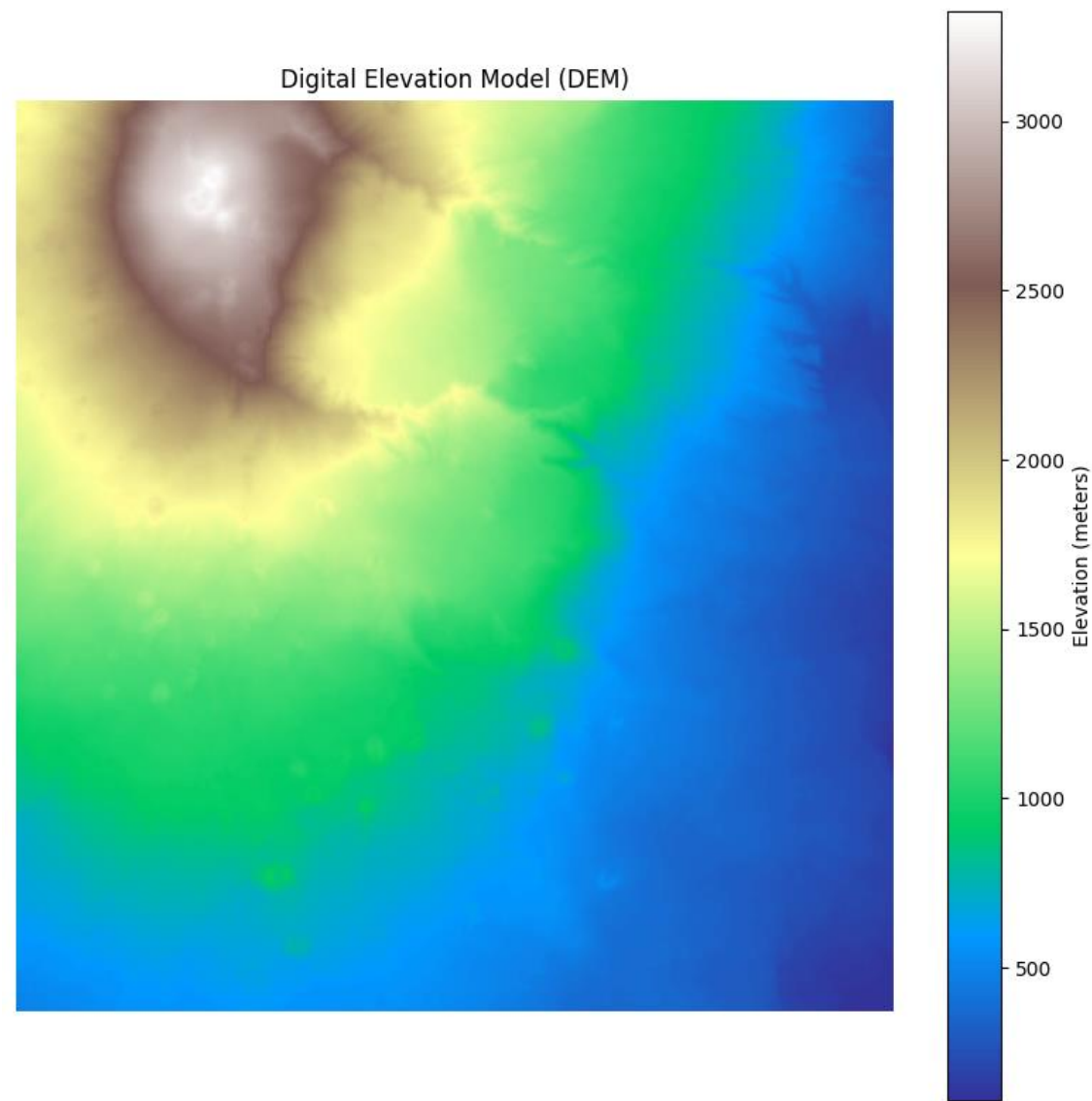
Sentinel-3 OLCI RGB Composite (B08: Red, B06: Green, B04: Blue)





Next steps in the remaining year

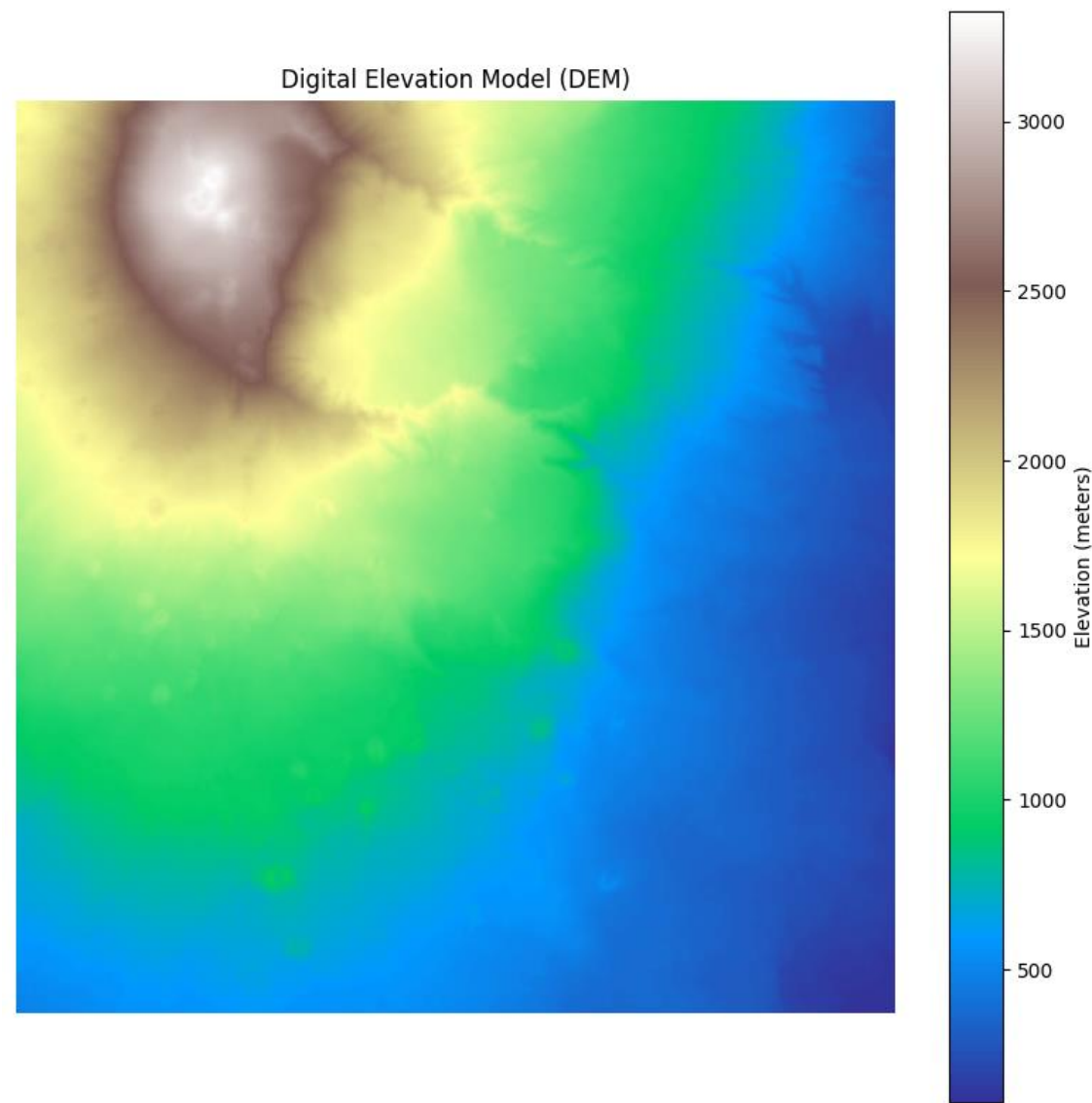
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- Improving the quality of the code to make it available to the community.





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- Improving the quality of the code to make it available to the community.
- Facilitating accessibility to satellite data, perhaps by creating a **user interface**.

Satellite Data Download Toggle Directory Browser

Authentication:
 Use existing configuration
 Configuration Name: New

Enter Client ID and Secret
 Client ID:
 Client Secret:
 Data Folder:
 GeoJSON File: Browse
 Start Date (YYYY-MM-DD):
 End Date (YYYY-MM-DD):
 Interval Days:
 Mosaicking Order:

Select Satellites:
 Sentinel-1 Sentinel-2 Sentinel-3-OLCI
 Sentinel-3-SLSTR-Optical Sentinel-3-SLSTR-Thermal DEM
 Perform Data Fusion:

Sentinel-1 Options:
 Data Collection:
 Polarizations:
 Backscatter Coefficient:
 Orthorectify:
 DEM Instance:
 Sample Type:

Sentinel-2 Options:
 Data Collection:
 Units:
 Sample Type:

Sentinel-3-OLCI Options:
 Sample Type:

Sentinel-3-SLSTR-Optical Options:
 Sample Type (Optical):

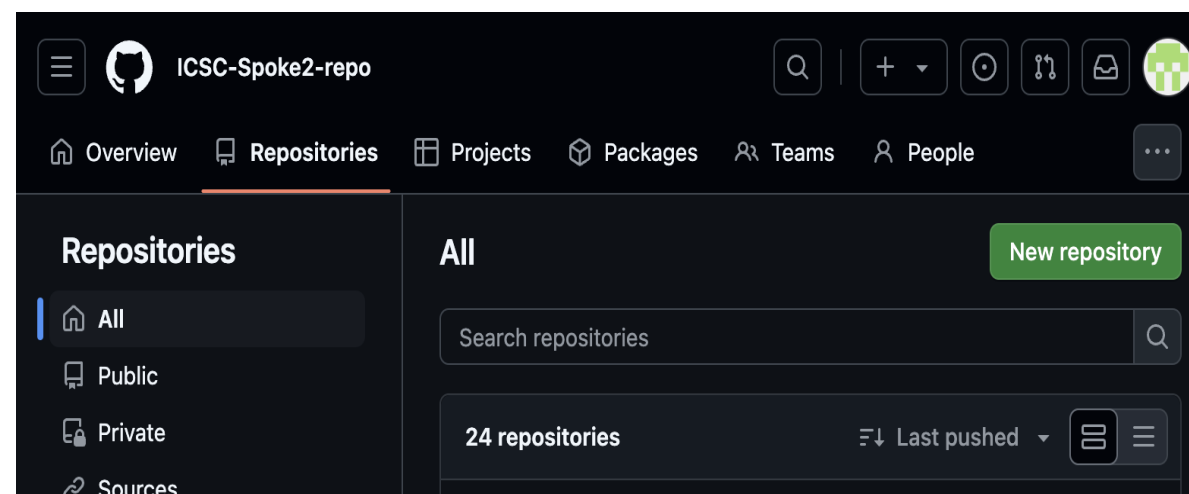
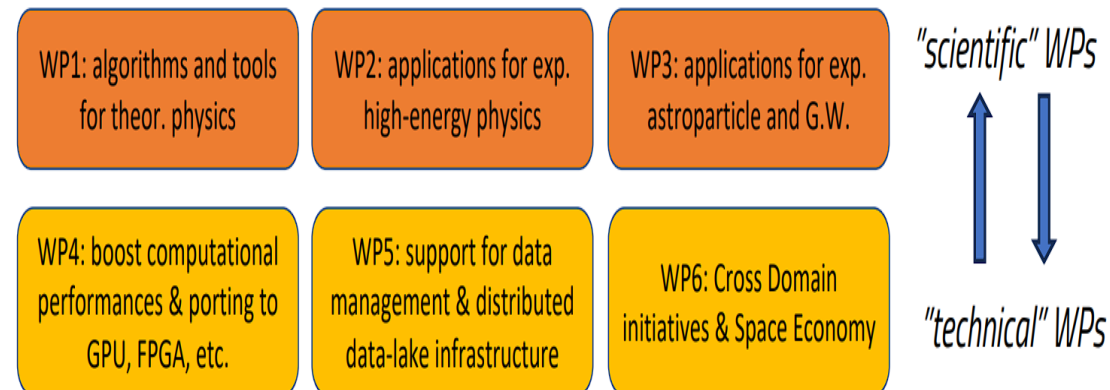
Sentinel-3-SLSTR-Thermal Options:
 Sample Type (Thermal):

DEM Options:
 DEM Instance:
 Sample Type:



Next steps in the remaining year

- Increase available satellite data sources, starting with those of the **Copernicus constellation**.
- Improving the quality of the code to make it available to the community.
- Facilitating accessibility to satellite data, perhaps by creating a **user interface**.
- Integrating the library with the CN **computational resources**, with a view to making it available to the EO community.
- **Publishing the repository under the Spoke 2 GitHub.**





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