Sentinel-2 Analyzer Plugin for QGIS

Application Examples

18/05/25

Overview

Sentinel-2 Analyzer is a modular plugin for QGIS developed to simplify the processing and analysis of Sentinel-2 satellite imagery. It supports key remote sensing tasks through a user-friendly interface, with no coding required.

Key Features**:**

- **Band Stacking**: Create custom stacks from S2 SAFE folders, multi-band rasters, or single-layer inputs.
- **Spectral Indices**: Compute predefined (NDVI, NDWI, NBR, etc.) or custom indices across thematic categories.
- **Masking & Statistics**: Generate masks (discrete or threshold-based) and statistical reports per layer or by class.
- **Change Detection**: Apply simple distance measures to detect changes between two different scenes.

Optimized for Sentinel-2 Level-2A products and for environmental monitoring.

The case studies hereby presented are carried out in QGIS LTR v 3.34

Case Study 1 – Venice and *“l’Acqua Granda”*

Background:

In November 2019, Venice experienced one of its most severe flooding events in recent history.
On November 12, the city recorded a sea level rise of 187 cm, the highest since the catastrophic flood of 1966. This event was the result of a combination of meteorological factors, including a high astronomical tide, elevated mean sea levels in the Mediterranean, and a deep atmospheric depression over the Adriatic Sea, leading to strong winds and storm surges.

Objective:

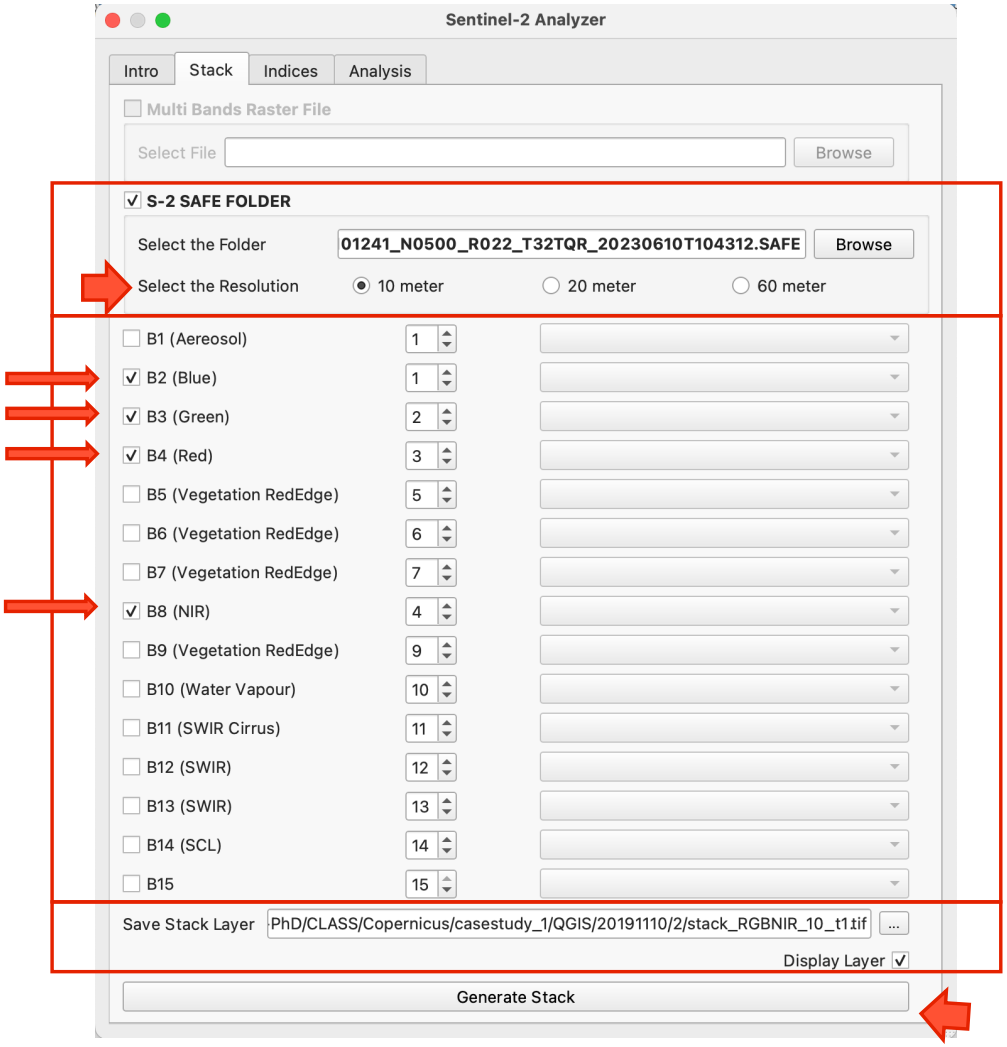
Visualize the extent of flooding during the "Acqua Alta" event by comparing Sentinel-2 satellite images captured before and after the peak flooding.

Data Acquisition:

Sentinel-2 Level-2A images from Copernicus Browser (cloud cover < 30%)

- Pre-flood: November 10, 2019
- Post-flood: December 5, 2019

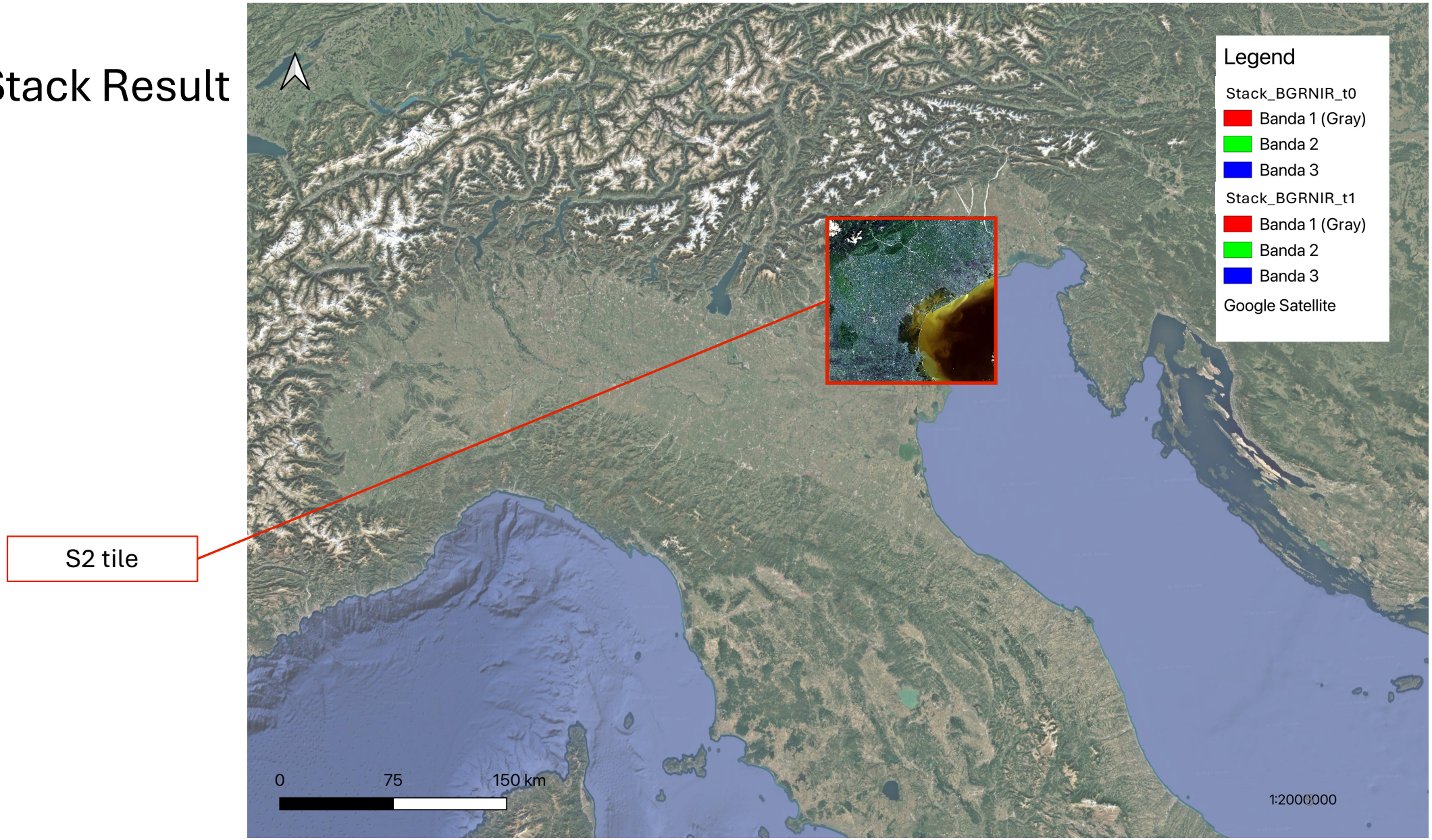
Step 1 – Stacking Sentinel-2 bands

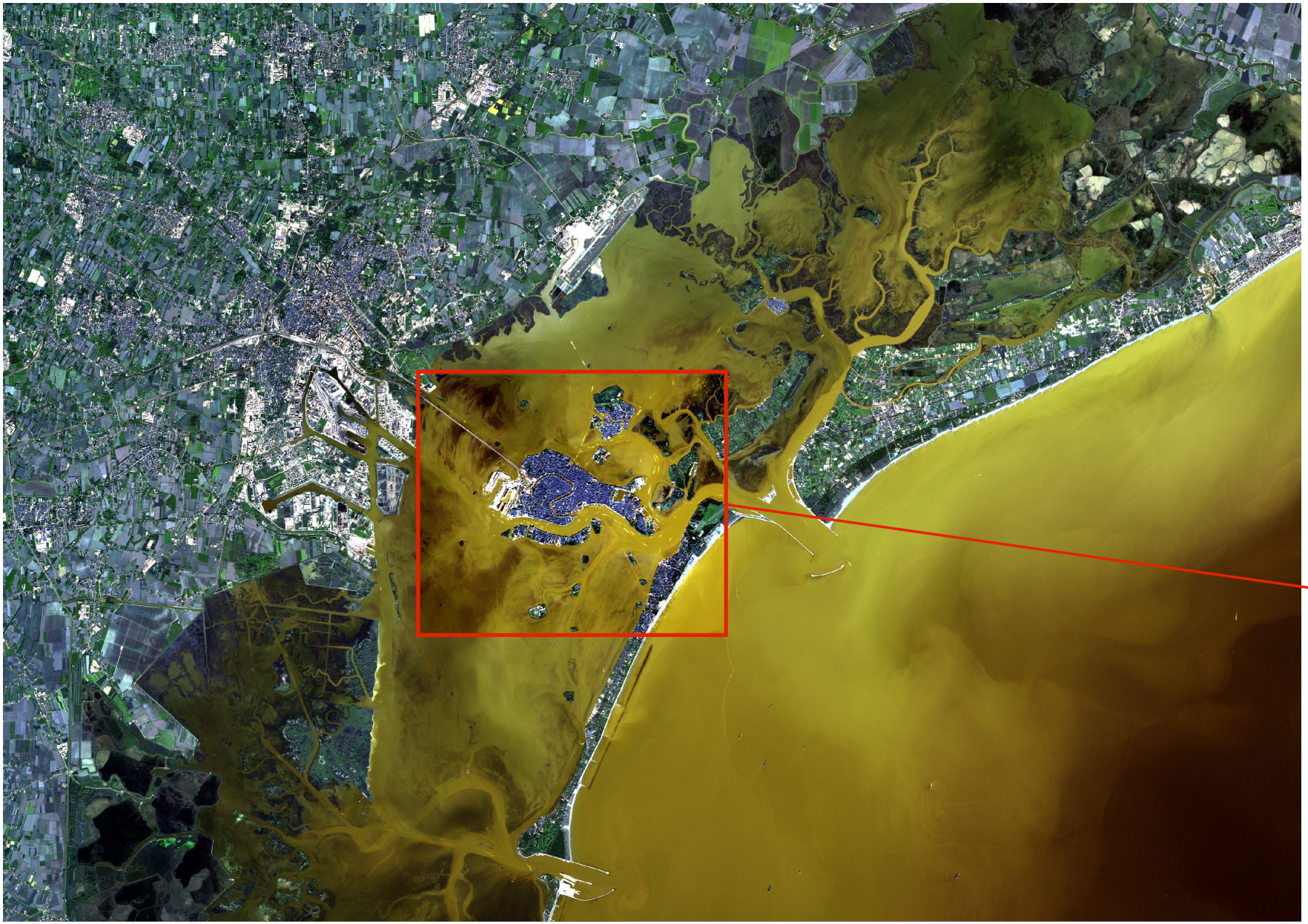


1. Path directory of S2 SAFE folder downloaded from Copernicus Browser
2. Selecting the desired resolution
3. Define the bands order -> B-G-R-NIR
4. Path directory to save the output stacked layer
5. Press Generate Stack

All steps were done both for t0 and t1 images

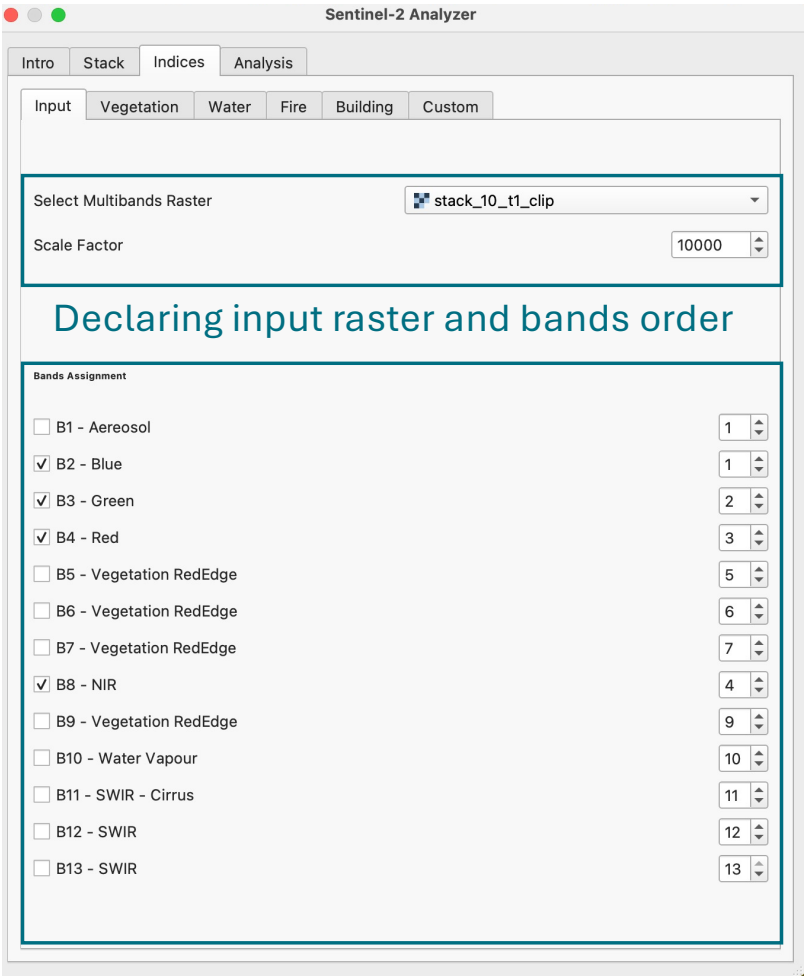
Stack Result



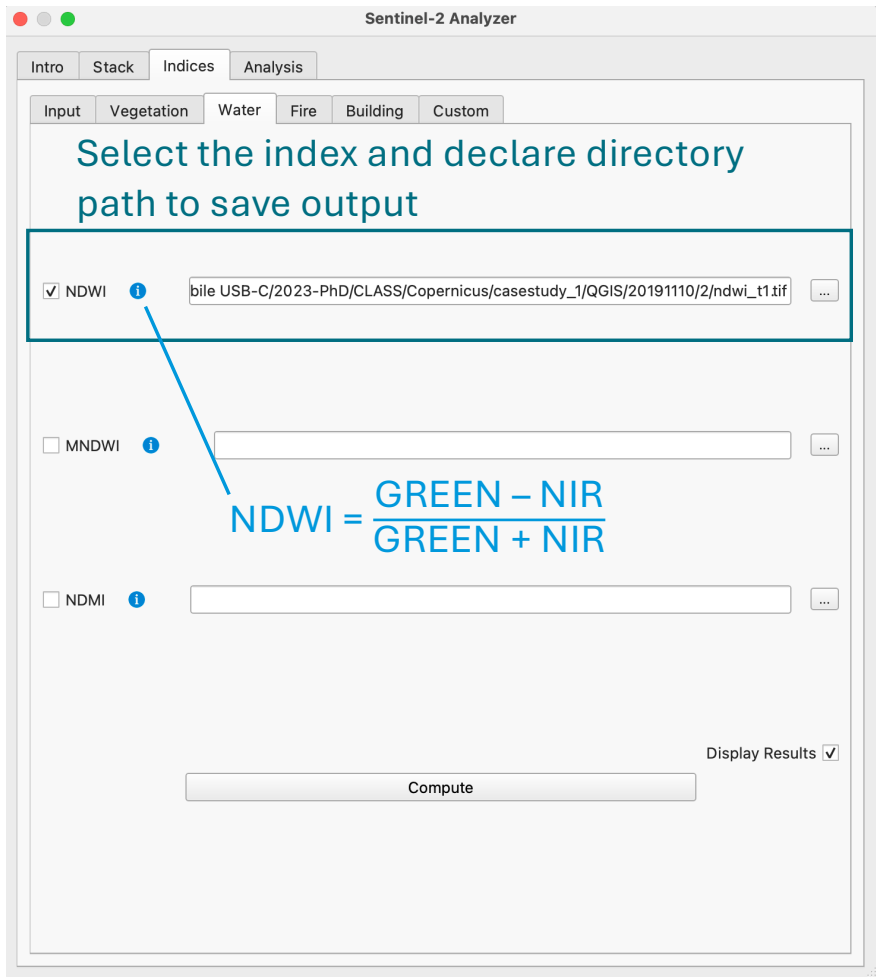

Area of Study

Step 2 – Spectral Indices – Normalized Difference Water Index

1



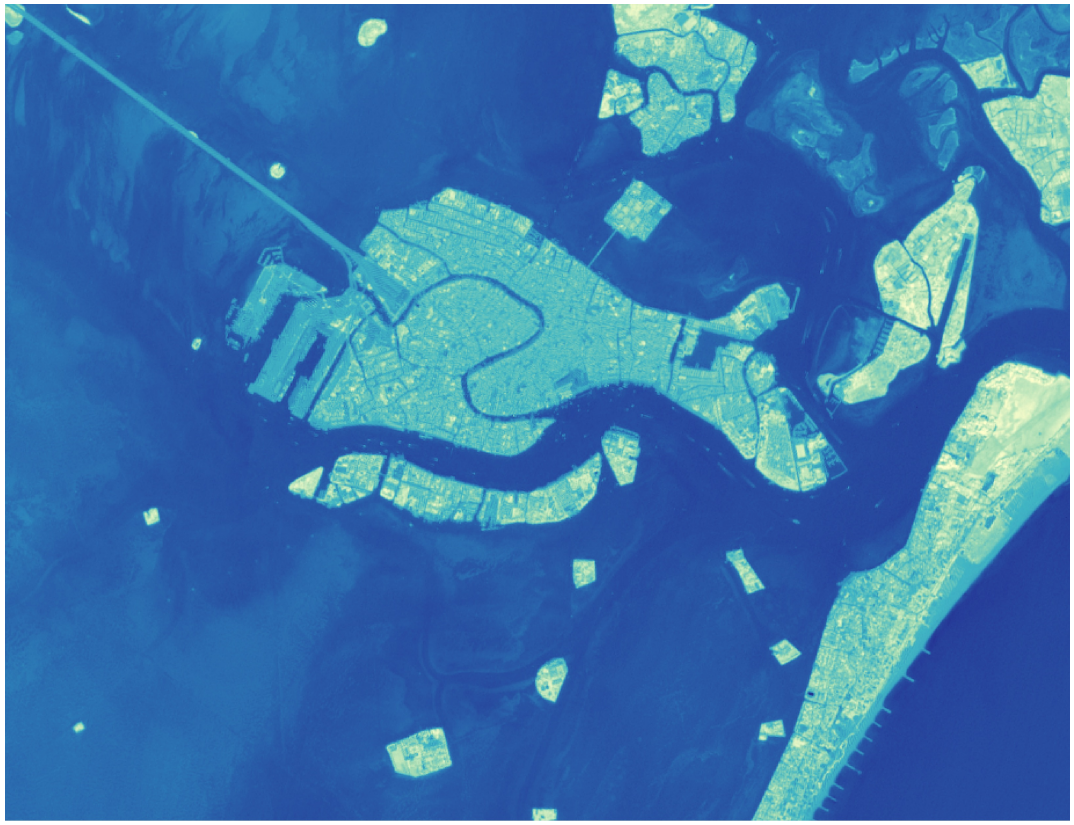
2



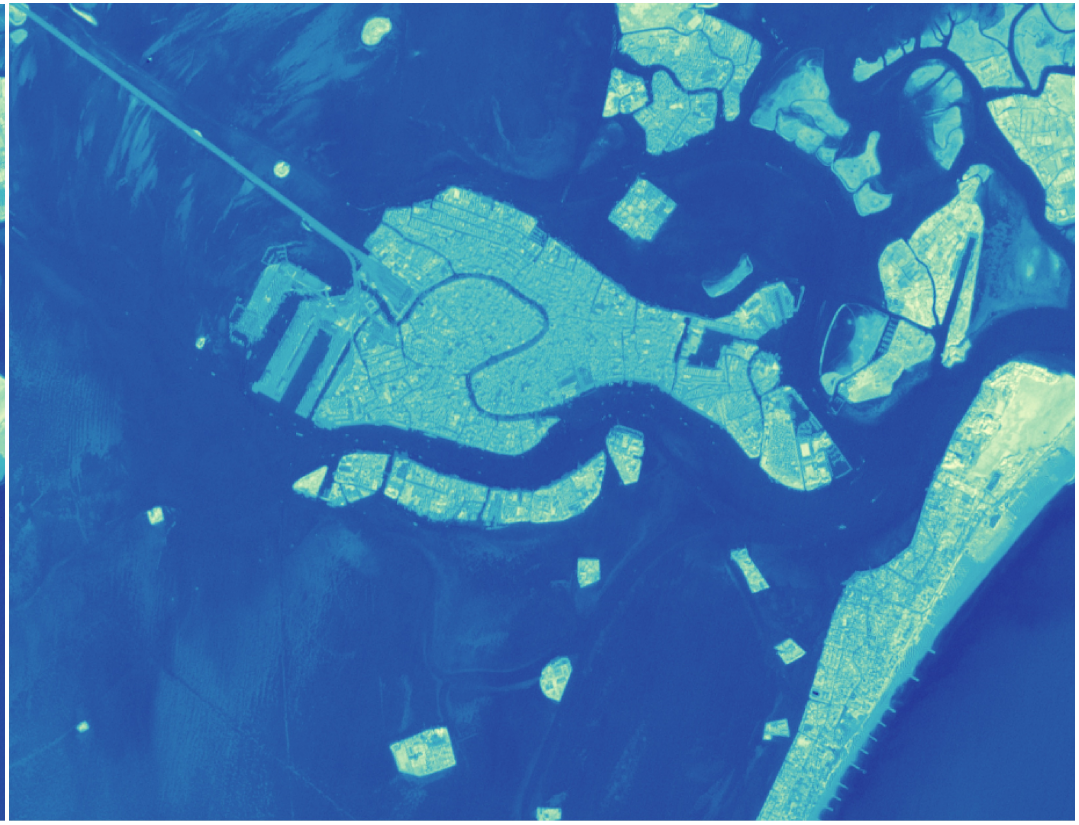
$$NDWI = \frac{GREEN - NIR}{GREEN + NIR}$$

NDWI Result

Water absence -0,6 0,38 Water presence



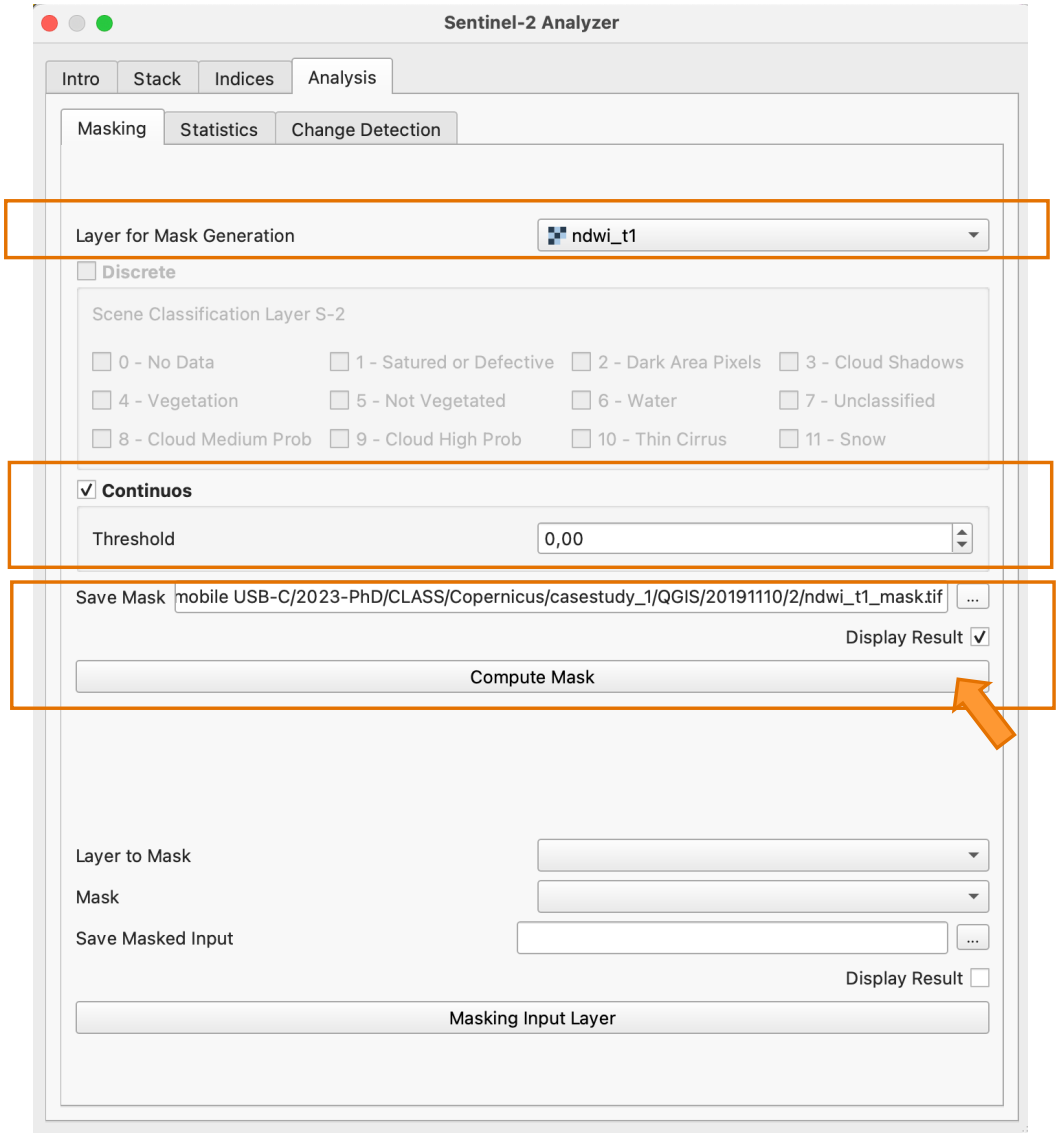
t0



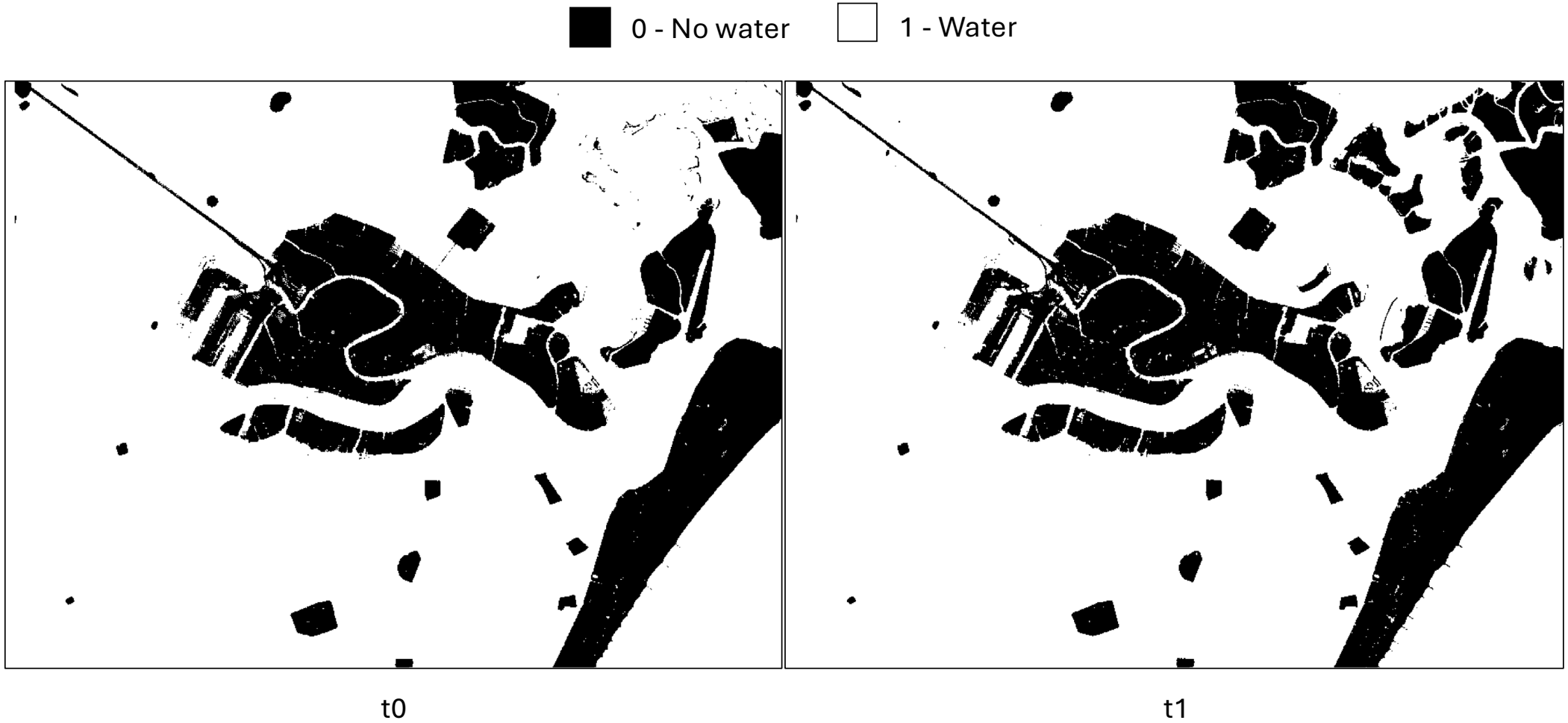
t1

Step 3 – Masking

1. Select layer for mask generation from those loaded in QGIS
2. Choose between discrete (class) or continuous (threshold) masking
3. Set a threshold
4. Save output directory path
5. Compute mask



Masking Results

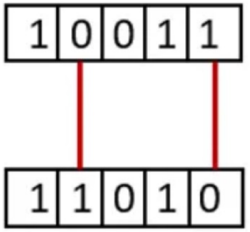


Step 4 – Change Detection

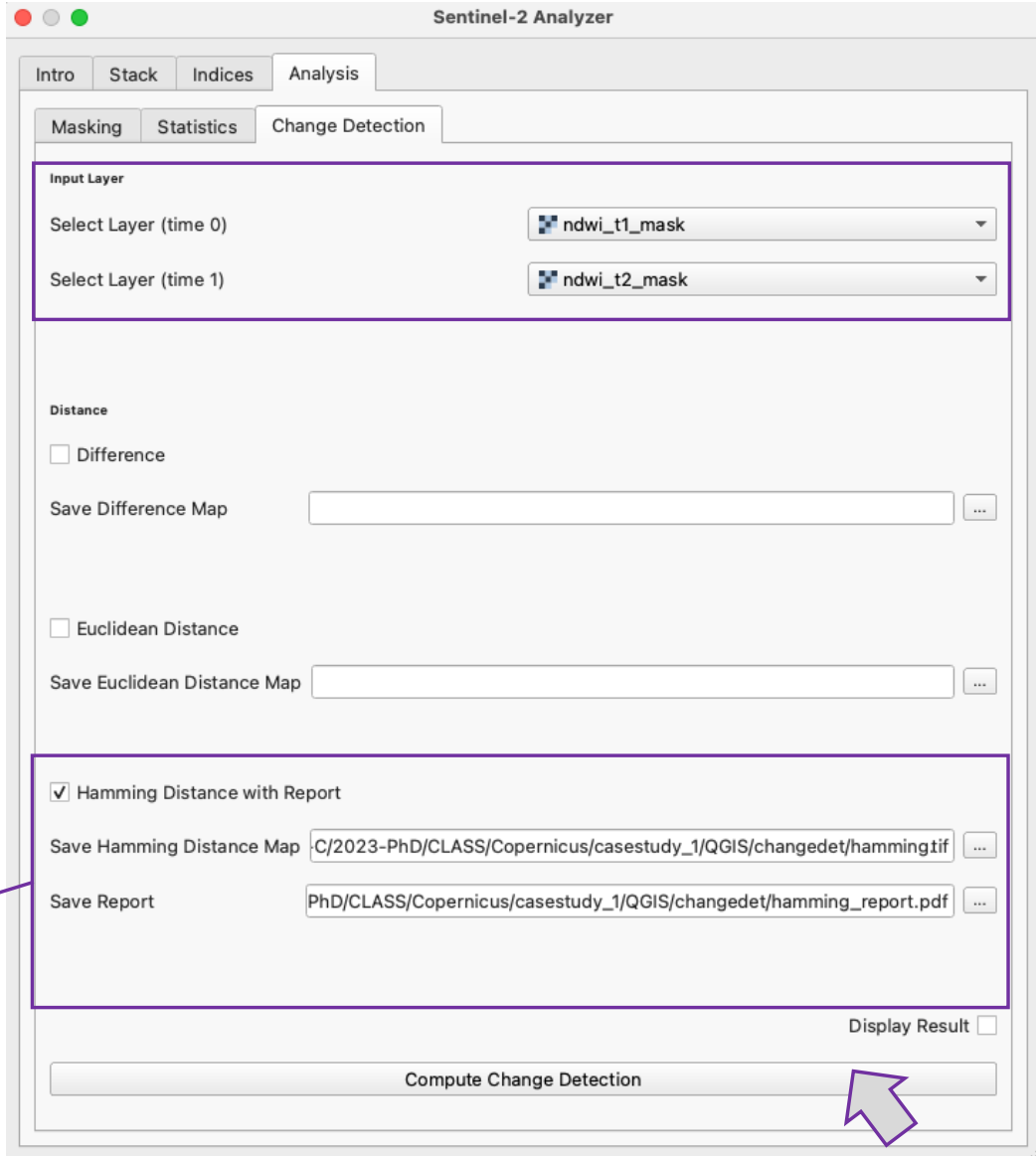
1. Select t0 and t1 layers between which to detect scene differences
2. Choose the distance metric

Change detection between binary rasters (masks) -> **Hamming distance**

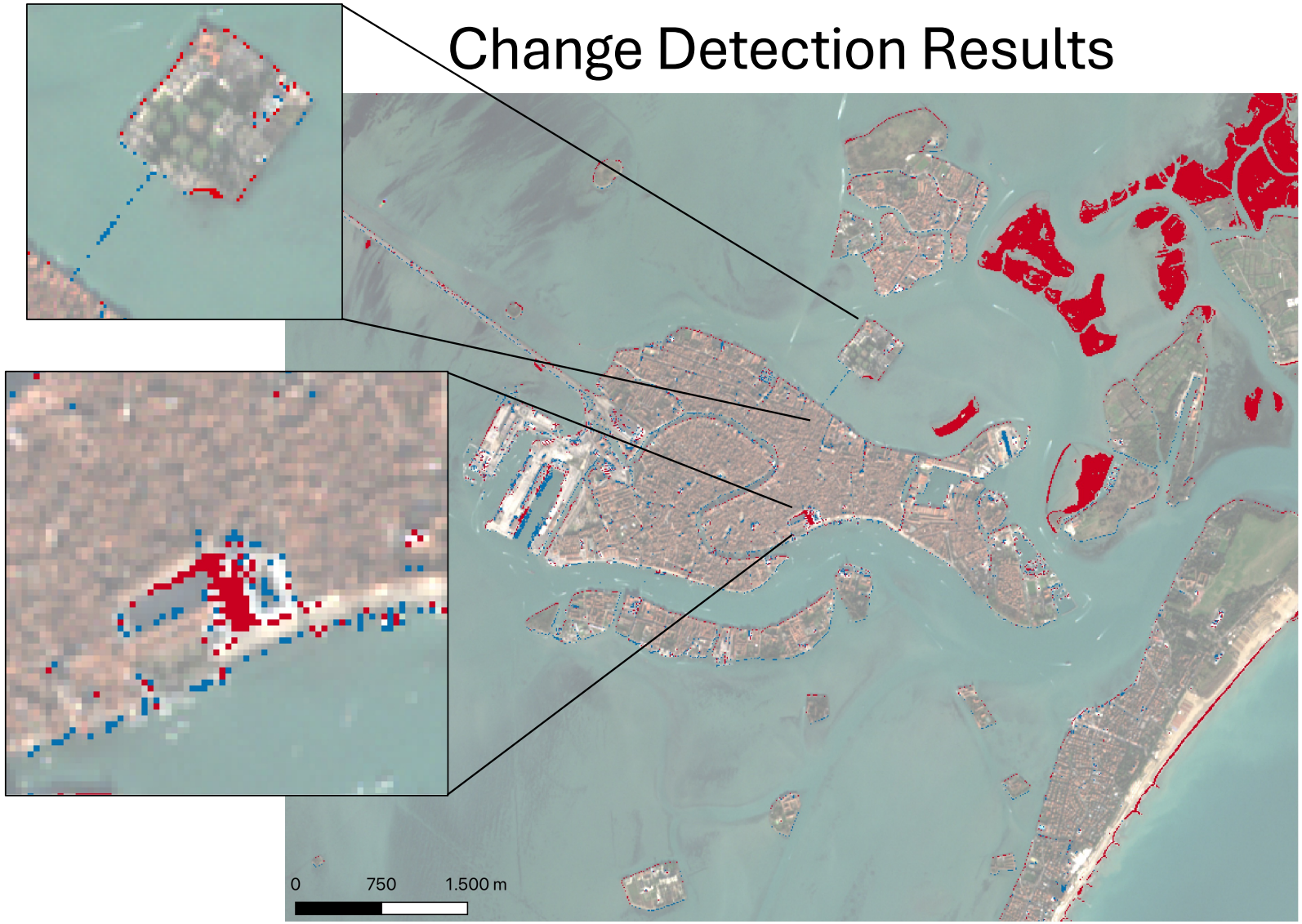
It measures the number of pixel-wise differences



The plugin generates the output raster image and a report



Change Detection Results



Legend

Changes t0– t1

Banda 1 (Gray)
-1 Water Loss
0 No Change
+1 Water Gain

True Color Image (TCI) t1
Banda 1 (Red)
Banda 2 (Green)
Banda 3 (Blue)

1:250000

Change Detection Result

```
Report Hamming Distance

Geographic Information:

CRS: EPSG 32632

Resolution: 10.0 m

Distance:

Hamming Distance: 3.05 %
Value -1.0: 18406, Percentage: 2.57, Area: 1840600.00 m²
Value 0.0: 693680, Percentage: 96.95, Area: 69368000.00 m²
Value 1.0: 3386, Percentage: 0.47, Area: 338600.00 m²
```

3 % of the scene changed

An area of 1.8 Km^2 was covered with water at t0 which then receded at t1

An area of 0.3 Km^2 was covered with water at t1 but not at t0

Case Study 2 – Wildfires in west Sardinia

Background:
In late July 2021, Sardinia experienced one of its most devastating wildfire events in recent history. The fires, particularly intense between July 23 and July 30, ravaged the Montiferru region in the Oristano province. Approximately 20,000 hectares of land were burned, leading to the evacuation of around 1,500 residents. The fires destroyed homes, agricultural lands, and centuries-old olive trees, including the millennial olive tree of Sa Tanca Manna in Cuglieri.

Objective:
To analyze and visualize the severity and the extent of the wildfires by comparing Sentinel-2 satellite images captured before and after the fire events.

Data Acquisition :

Sentinel-2 Level-2A images downloaded from Google Earth Engine

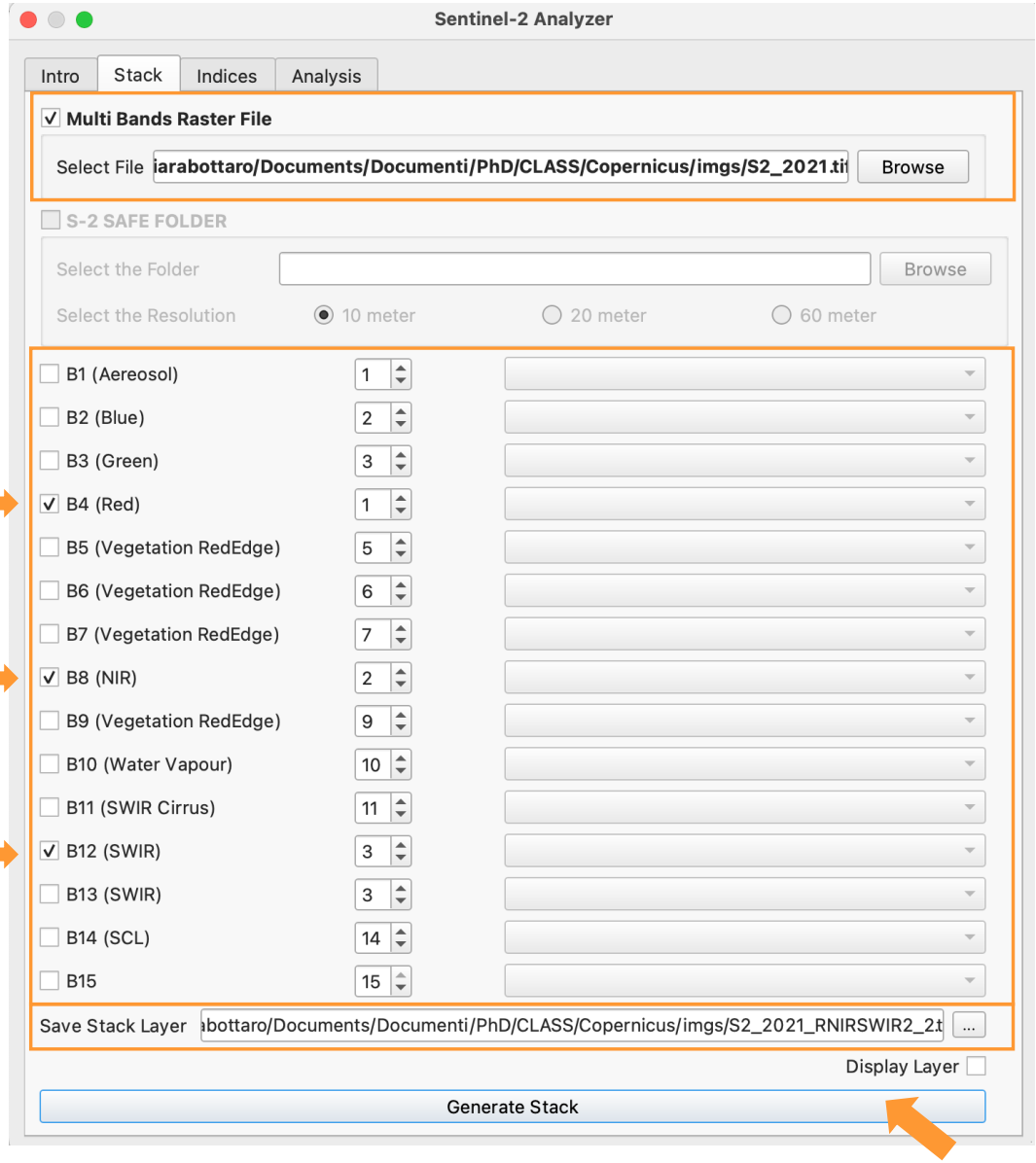
- Pre-fire**:** median composite image for September 2020
- Post-fire: median composite image for September 2021

Step 1 – Stack

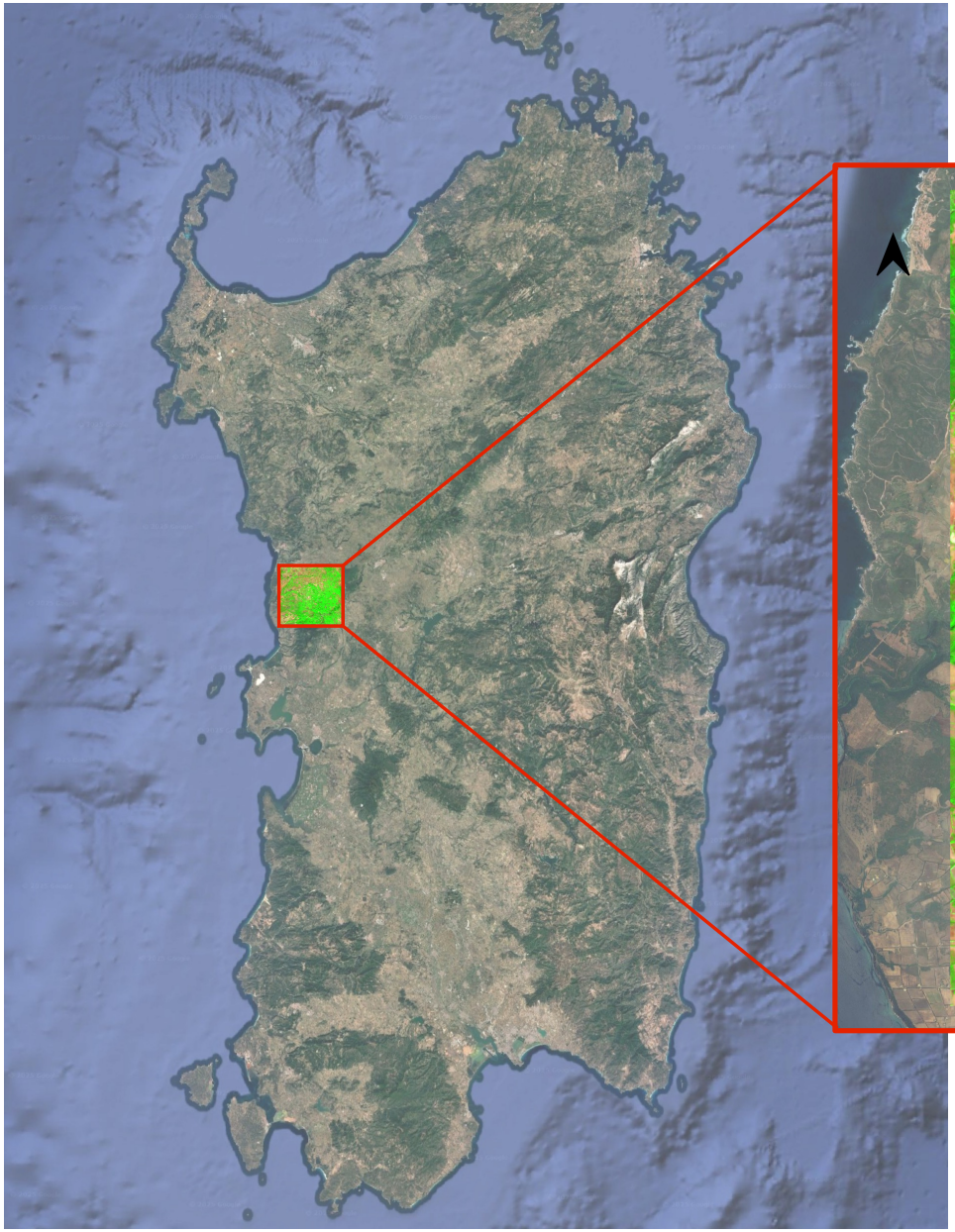
1. Path directory of a multi-band raster file
2. Define the bands order -> R-NIR-SWIR2
3. Path directory to save the output stacked layer
4. Press Generate Stack

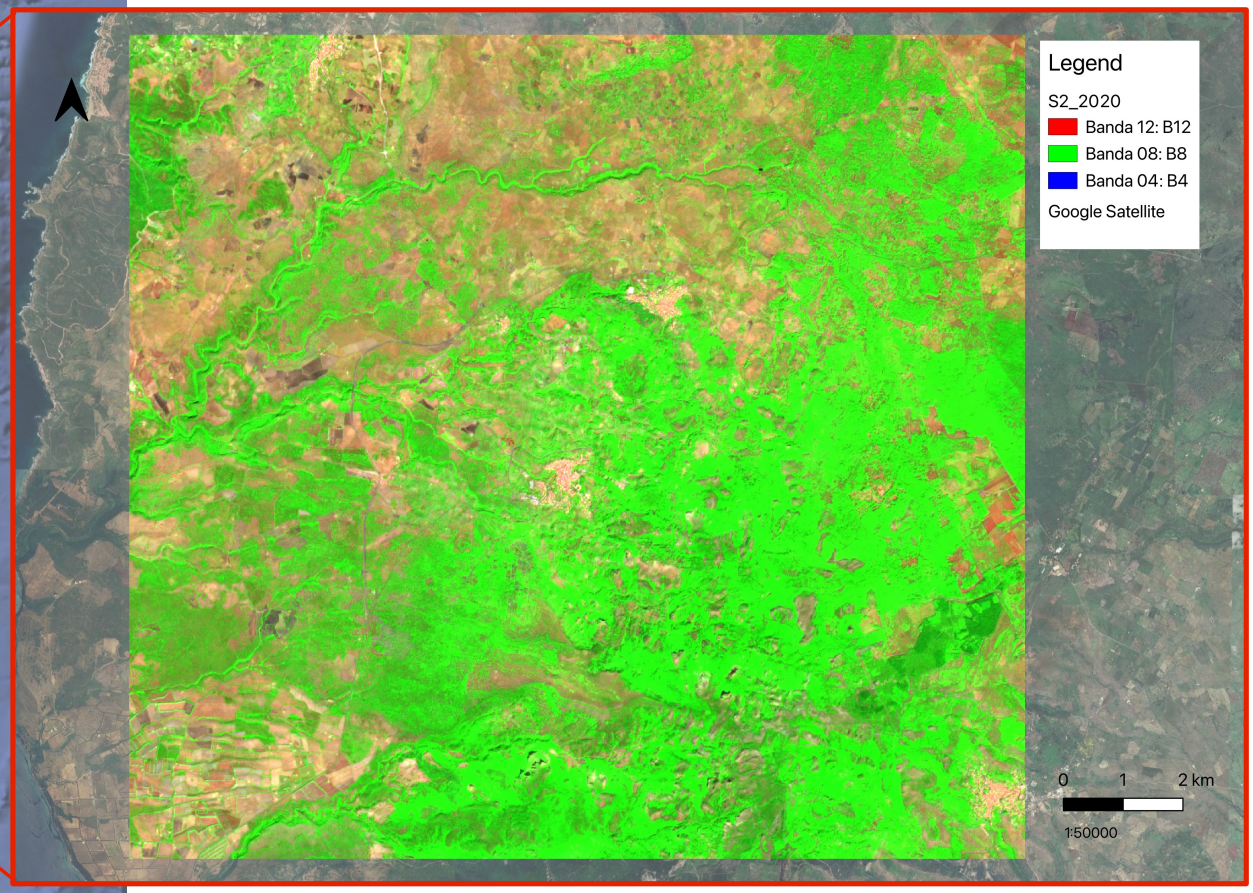
In this way it is possible to reduce the size of a multiband raster by selecting only the bands of interest

All steps were done both for t0 (2020) and t1 (2021) images



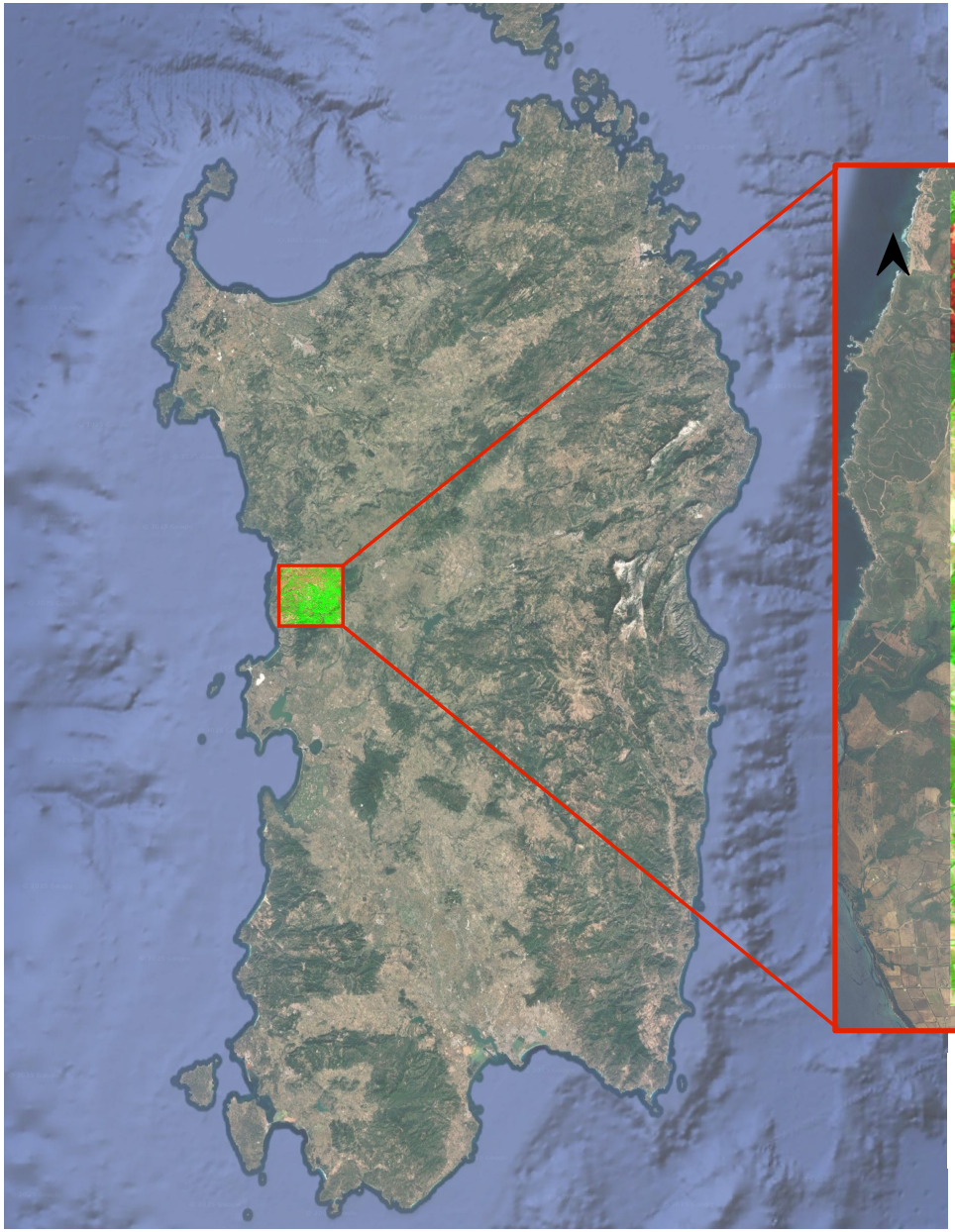
Stack Result - Area of Study

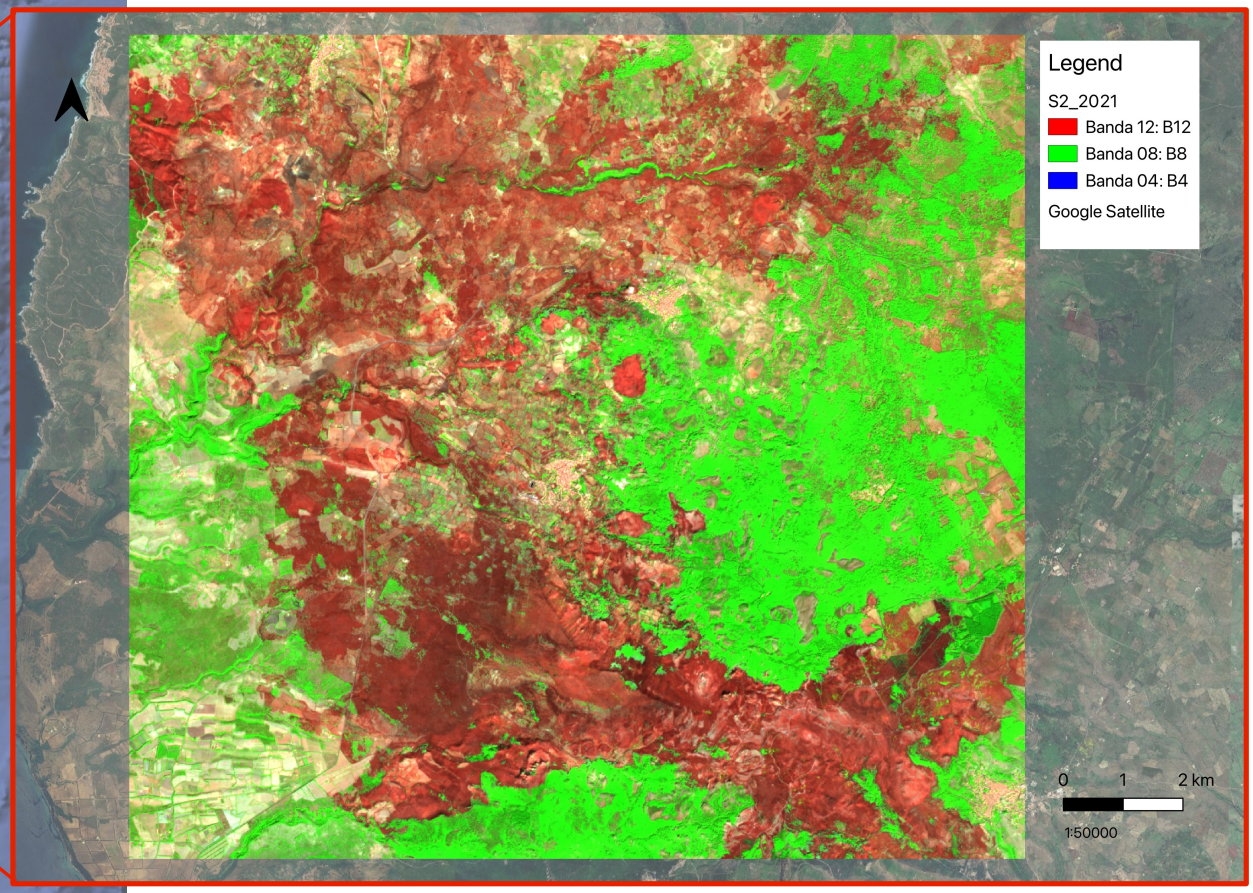




Pre-fire image - Visualization in short-wave infrared band combination (SWIR 2, NIR, RED)

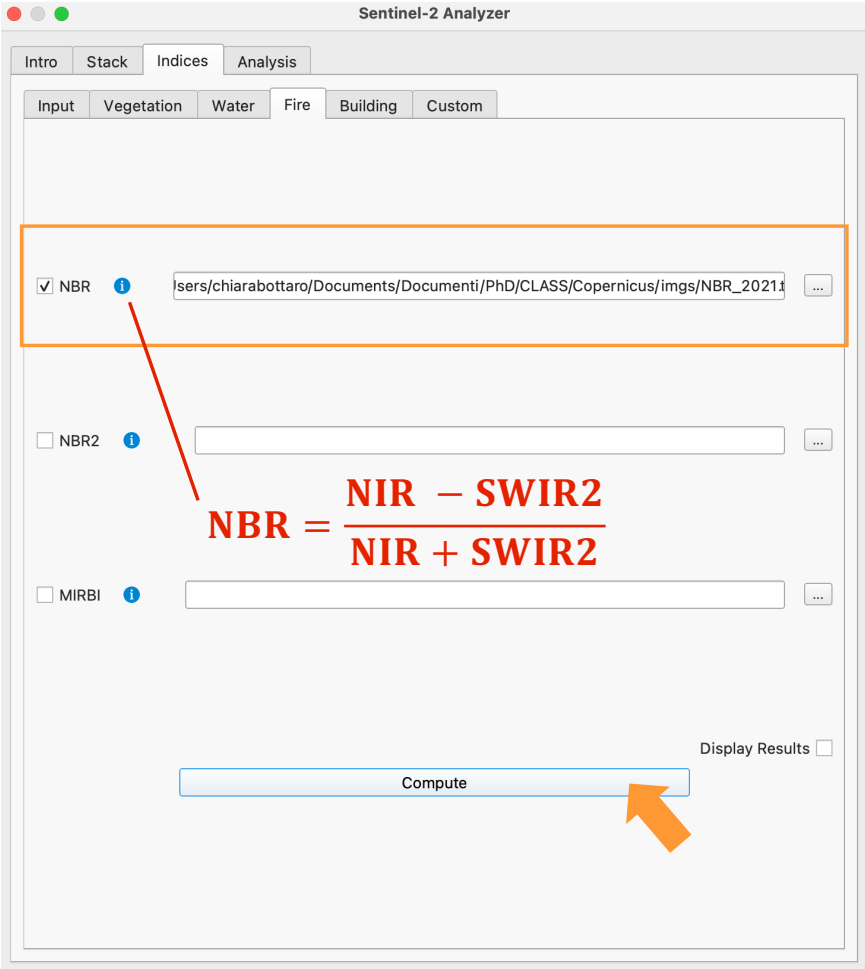
Stack Result - Area of Study





Post-fire image - Visualization in short-wave infrared band combination (SWIR 2, NIR, RED)

Step 2 – Spectral Indices – Normalized Burned Ratio Index

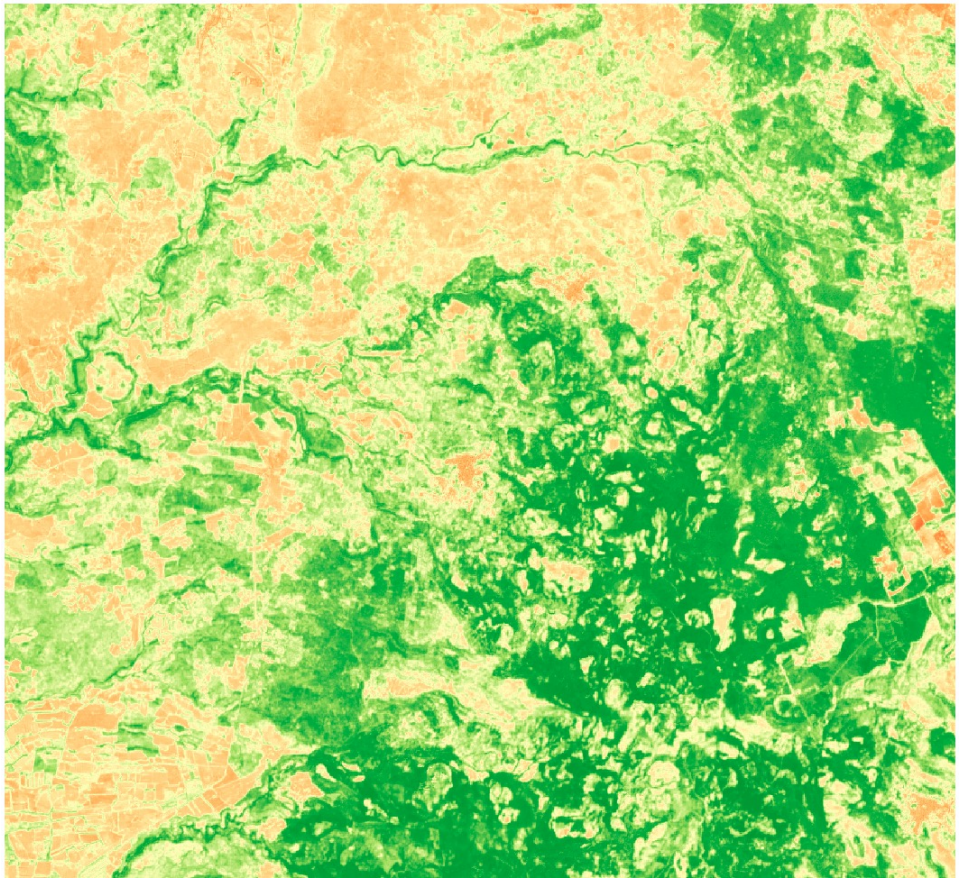


$$NBR = \frac{NIR - SWIR2}{NIR + SWIR2}$$

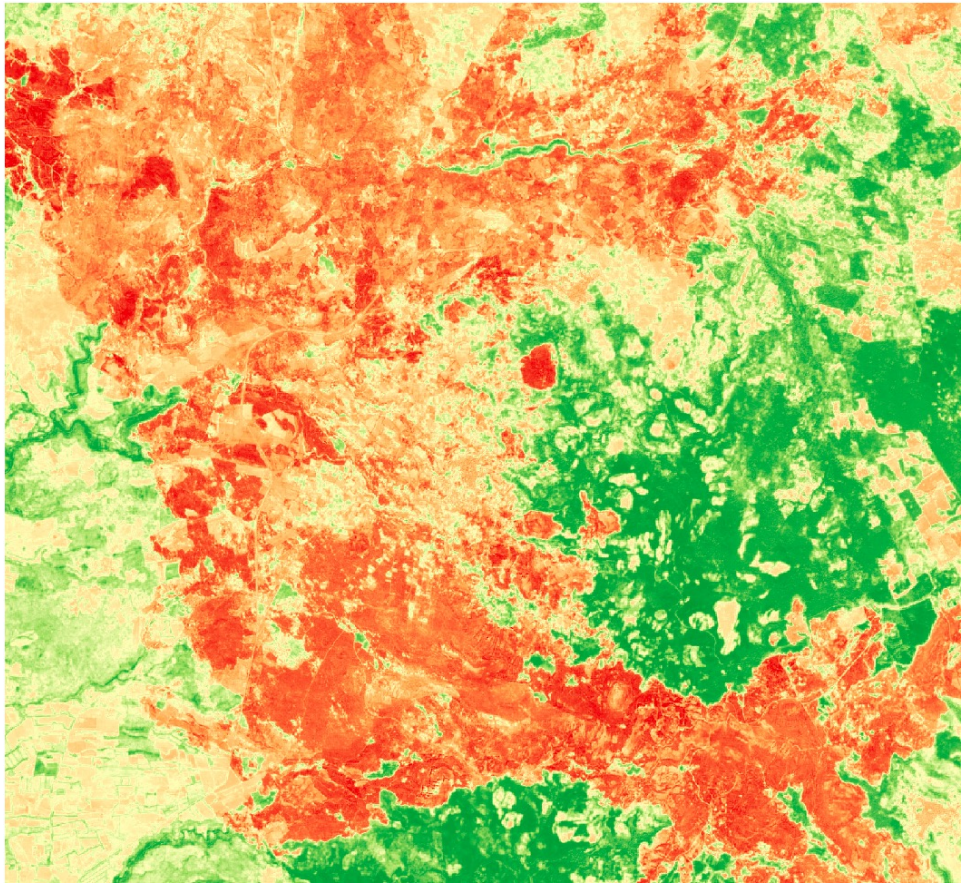
1. Declare input raster and bands order in the input box
2. Select the index and declare directory path to save output
3. Compute index

NBR Results

Vegetation absence -0,6 0,8 Vegetation presence



September 2020



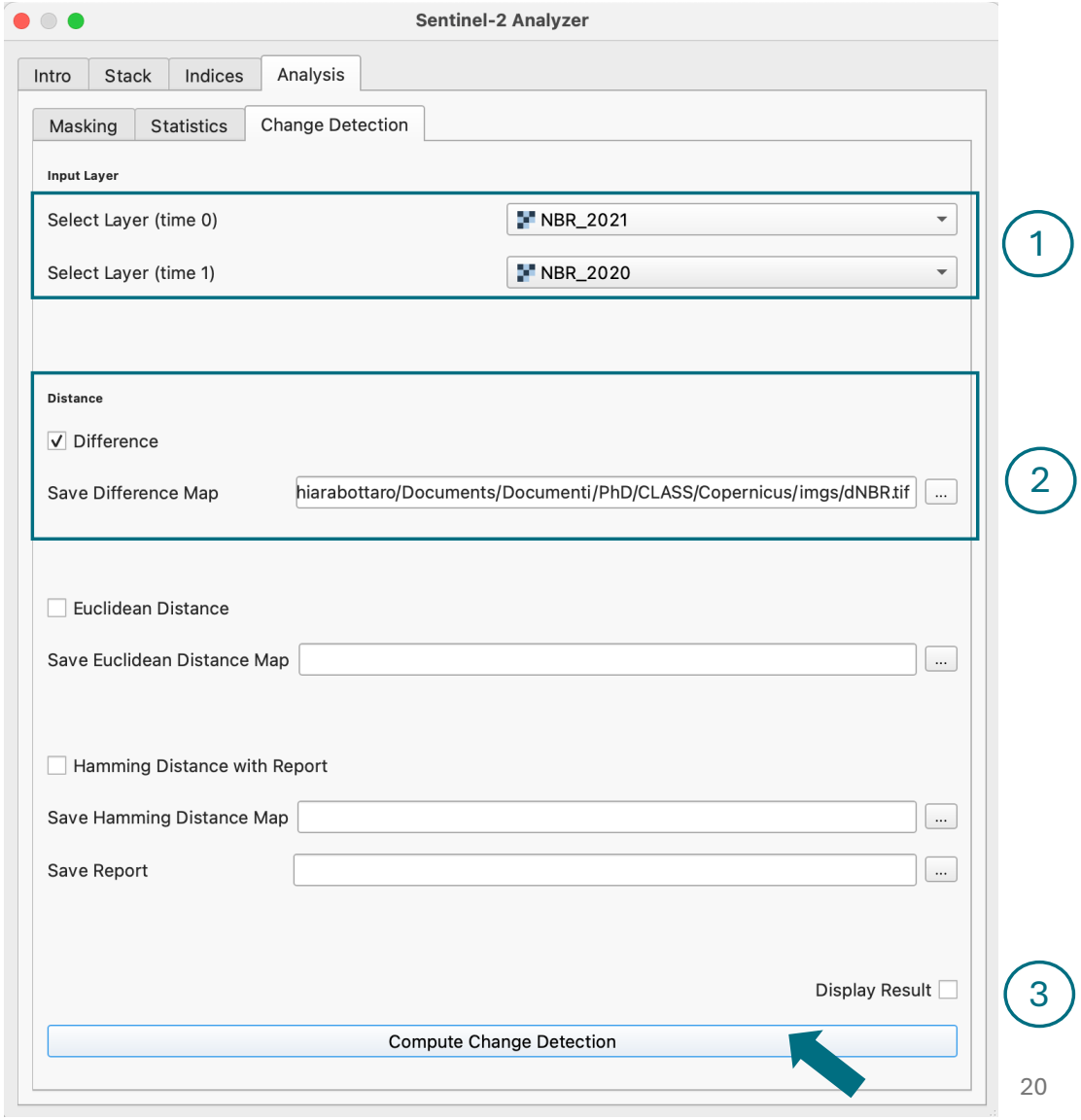
September 2021

Step 3 – Fire Severity dNBR

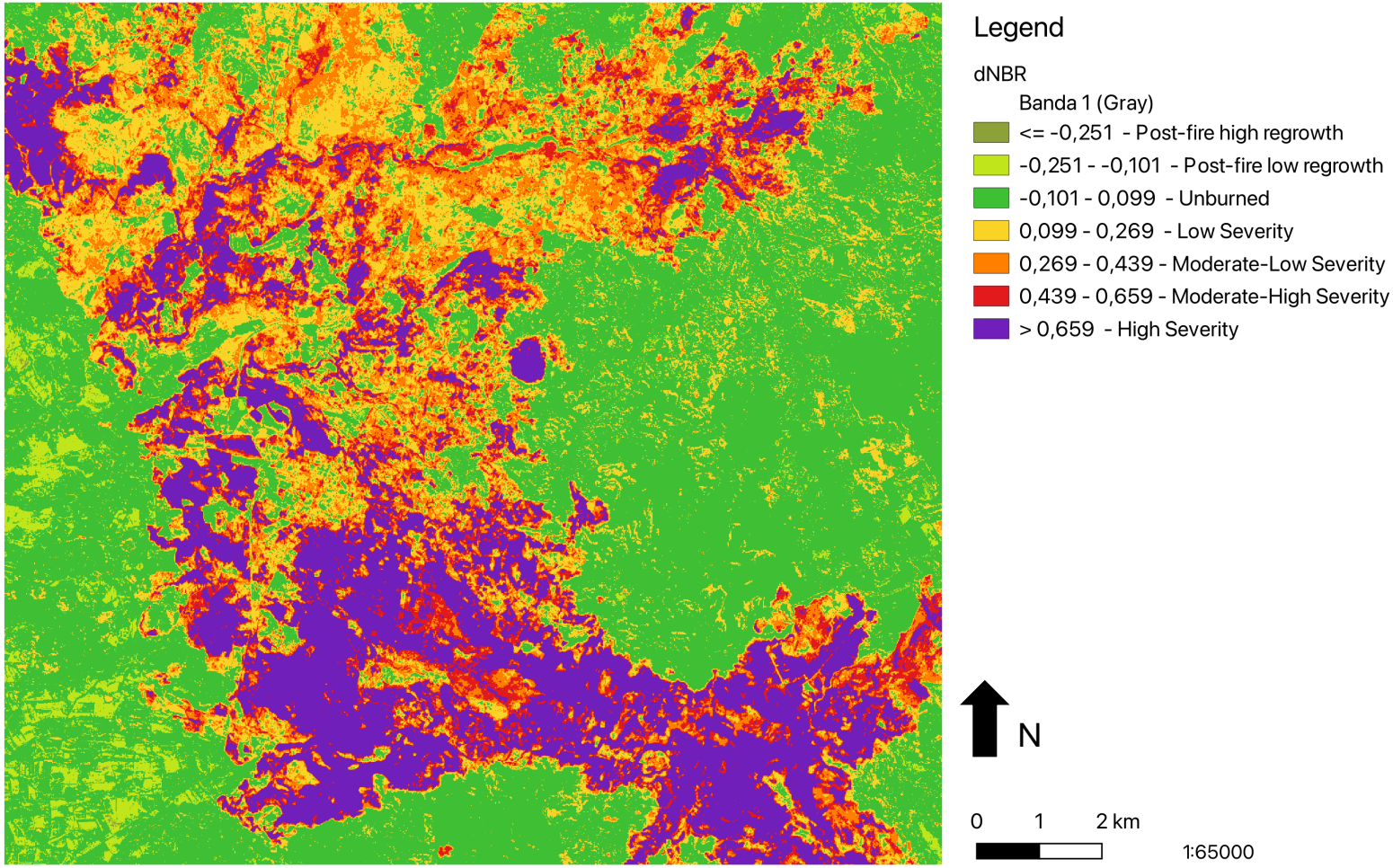
The difference between the pre-fire and post-fire NBR can be used to estimate the burn severity

dNBR = NBR 2020 – NBR 2021

A higher value of dNBR indicates more severe damage, while areas with negative dNBR values may indicate regrowth following a fire (USGS).

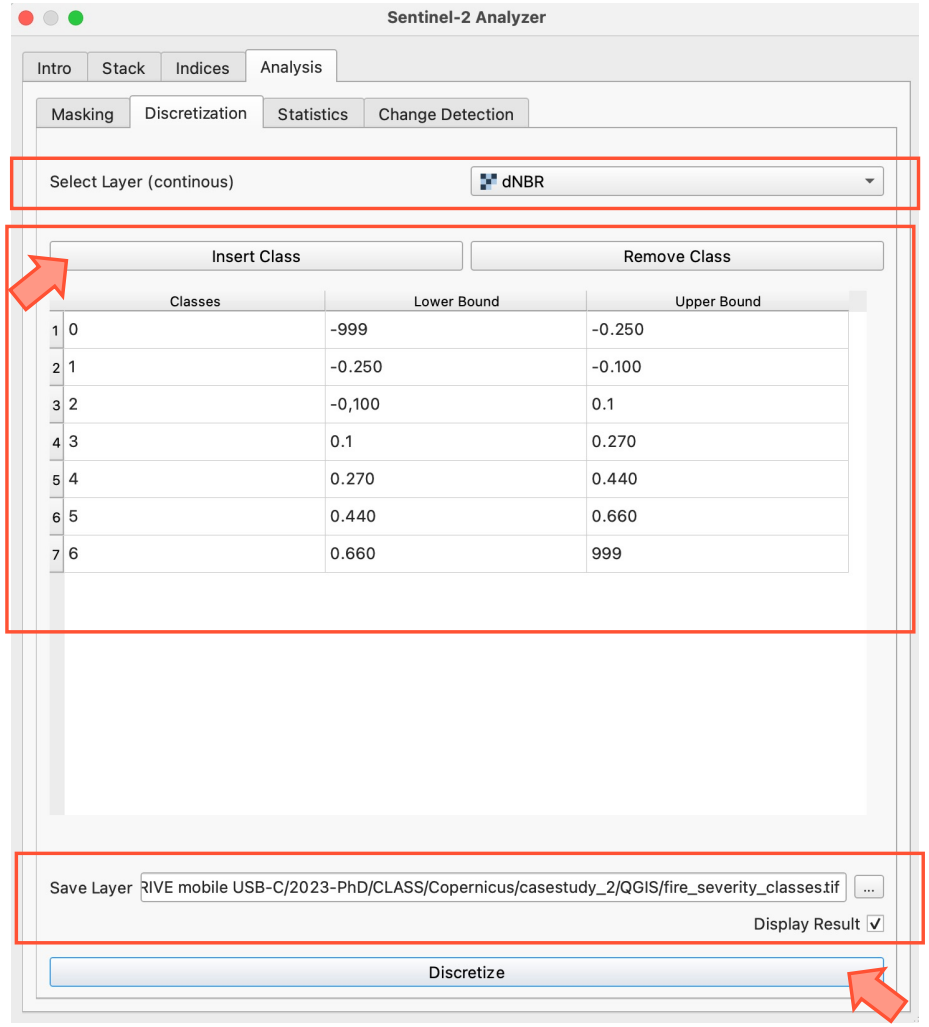


Fire Severity Results



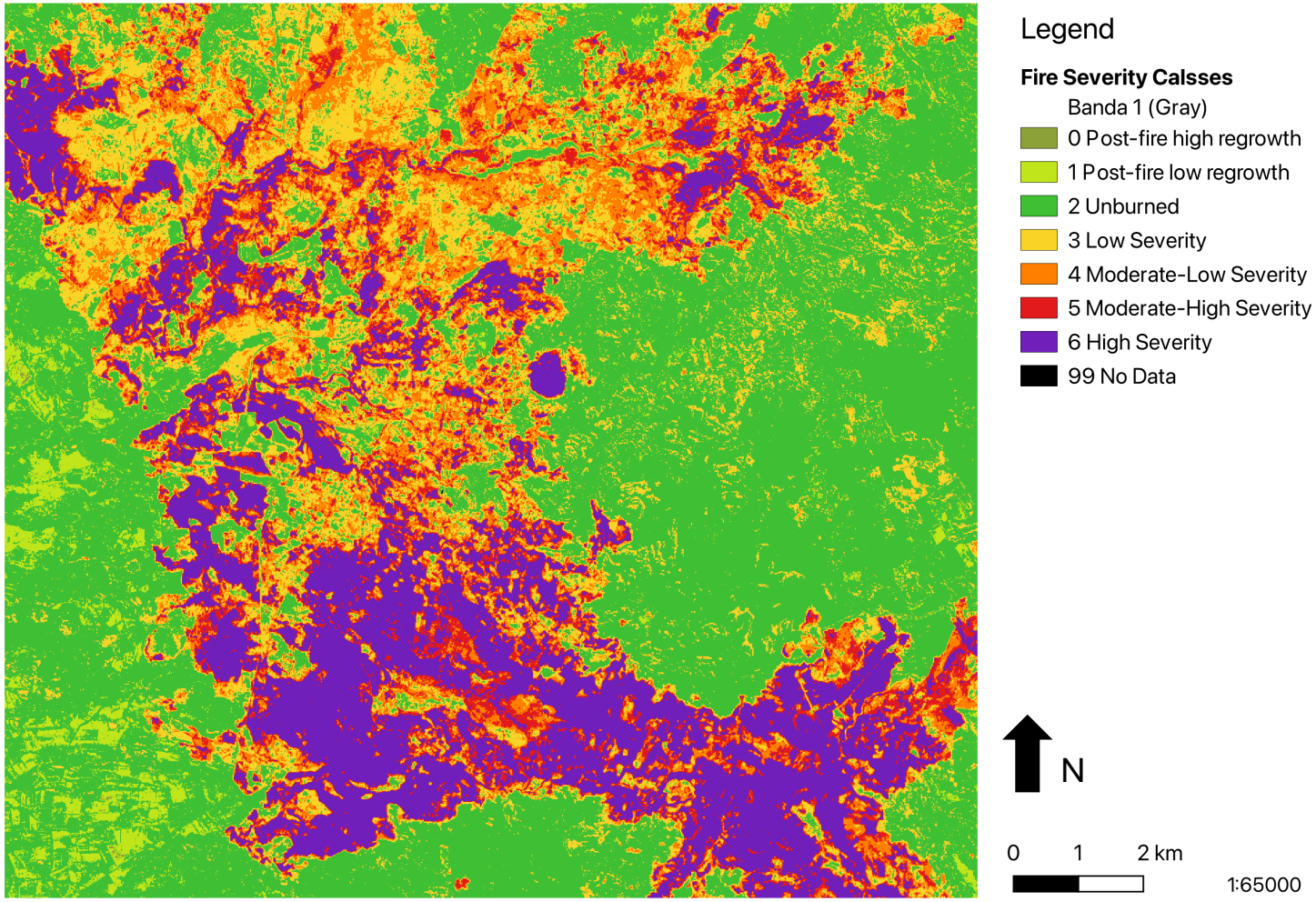
Fire Severity levels reference values proposed by USGS

Step 4 – Discretization into classes

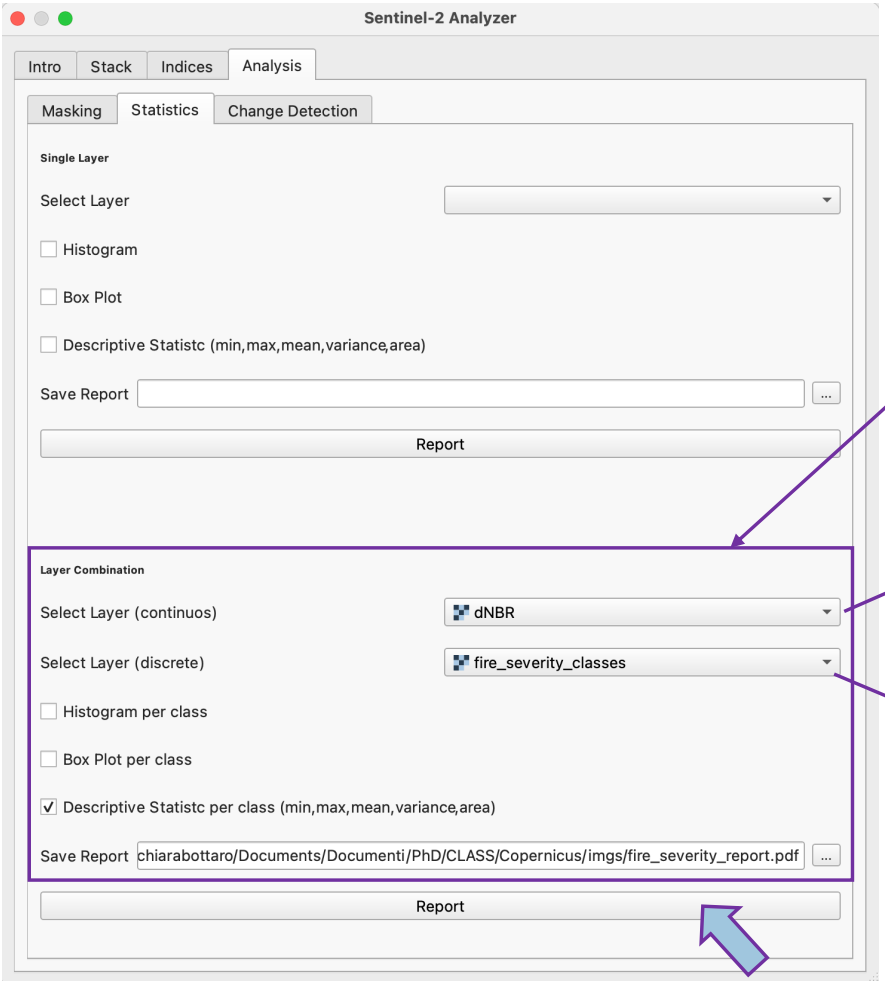


1. Select the continuous-value raster to discretize
2. Insert classes and define lower bound and upper bound range values
3. Declare directory path to save out
4. Discretize

Discretization results



Step 5 – Statistics of Fire Severity



The Statistics box allows to obtain histograms and boxplot to visualize data and to retrieve some descriptive metrics.

Compute the area extent of each fire severity class

Continuous Layer

Discrete Layer

Statistics Results – Area of Fire Severity Classes

Computation issued in the report → Area of Fire Severity Classes

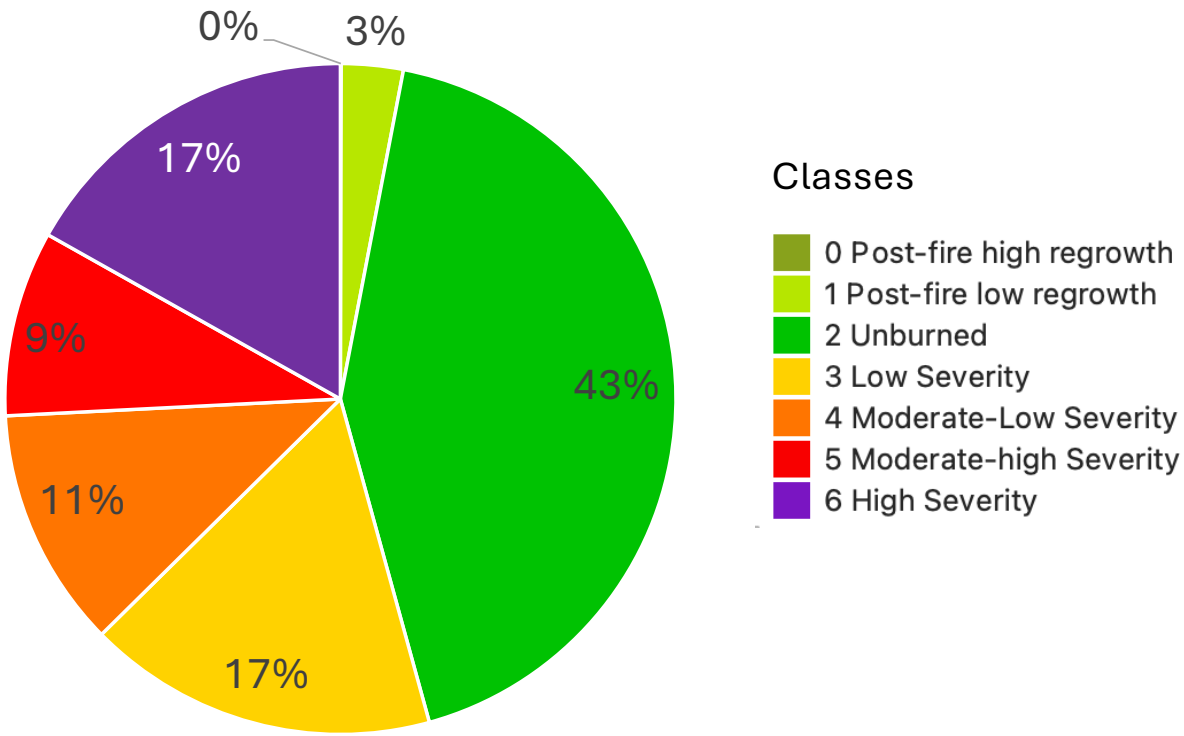
```
Geographic Information:

CRS: EPSG 32632

Resolution: 10.0 m

Statistical Information:

Class 0.0: Mean: -0.28, Variance: 0.00, Median: -0.27
         Min: -0.65, Max: -0.25
         Count: 848, Area: 84800.00 m²
Class 1.0: Mean: -0.14, Variance: 0.00, Median: -0.13
         Min: -0.25, Max: -0.10
         Count: 61383, Area: 6138300.00 m²
Class 2.0: Mean: 0.01, Variance: 0.00, Median: 0.01
         Min: -0.10, Max: 0.10
         Count: 880986, Area: 88098600.00 m²
Class 3.0: Mean: 0.18, Variance: 0.00, Median: 0.17
         Min: 0.10, Max: 0.27
         Count: 348339, Area: 34833900.00 m²
Class 4.0: Mean: 0.35, Variance: 0.00, Median: 0.34
         Min: 0.27, Max: 0.44
         Count: 238976, Area: 23897600.00 m²
Class 5.0: Mean: 0.54, Variance: 0.00, Median: 0.54
         Min: 0.44, Max: 0.66
         Count: 184562, Area: 18456200.00 m²
Class 6.0: Mean: 0.92, Variance: 0.03, Median: 0.91
         Min: 0.66, Max: 1.41
         Count: 347640, Area: 34764000.00 m²
```



Images attribution

- Venice (2019) t0 - Copernicus Sentinel data 2019, retrieved from Copernicus Browser in April 2025 at https://browser.dataspace.copernicus.eu
- Venice (2019) t1 - Copernicus Sentinel data 2019, retrieved from Copernicus Browser in April 2025 at https://browser.dataspace.copernicus.eu
- Sardinia (2020) t0 - Copernicus Sentinel data 2020, retrieved and pre-processed in Google Earth Engine https://earthengine.google.com/
- Sardinia (2021) t1 - Copernicus Sentinel data 2020, retrieved and pre-processed in Google Earth Engine https://earthengine.google.com/