Laboratory for
Nuclear Technologies
Applied to the Environment

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Centro Nazionale di Ricerca in HPC
Big Data and Quantum Computing

WP6
FLAGSHIP 2.6.3
AI algorithm for (satellite) imaging reconstruction

Detecting vineyard diseases using high-resolution images acquired by airborne platforms

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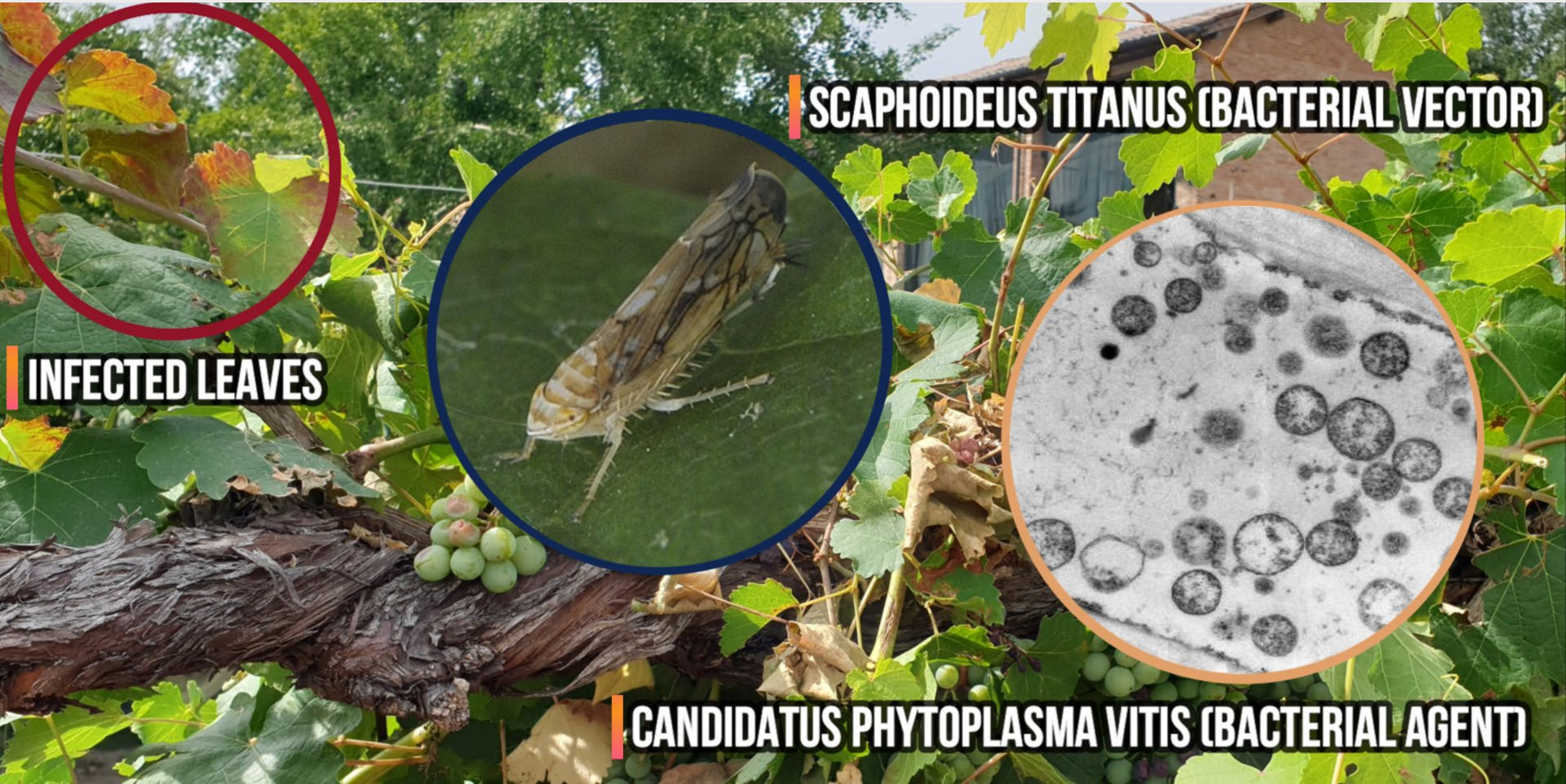
Flavescence Dorée is a devasting vine disease



The Radgyro: our aerial sentinel

- Engine: 1.2 liter turbo – 90 kW
- Payload: 150 kg
- Fuel tank: 90 liter
- Fuel: regular gasoline
- Space for take off: < 70 m
- Range of flight: < 3.5 hours
- Range of investigation: ~ 50 km^2 / h
- Easy to move without disassemble

Sensors in automatic and synchronized acquisition

- RGB phorogrammteric cameras
- Multispectral camera (infrared)
- Thermal camera
- Radioactivity detectors
- Radar altimeter
- GPS + electronics
- Remote control

Three simple ideas

- Agility
- Compactness
- Affordability

Flying on the target area

Flight height: 95 m

Area: 44 ha

Duration: 21’

Storage: 160 GB

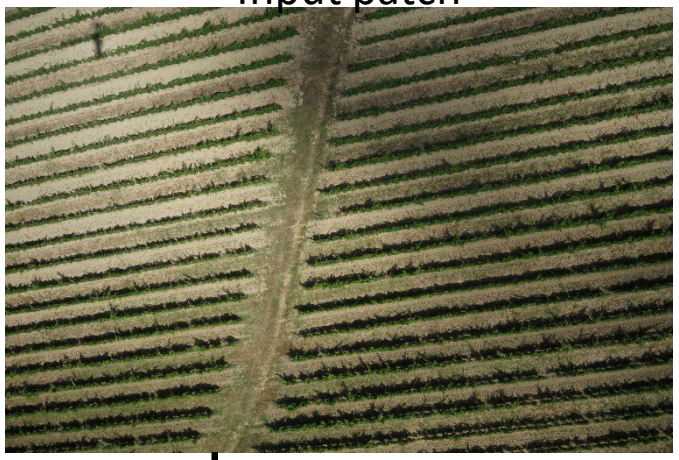
Resolution: 1 cm/pixel

Raw file: 60 MB/pic

N. pic/ha: 28

Pipeline software analysis

Input patch



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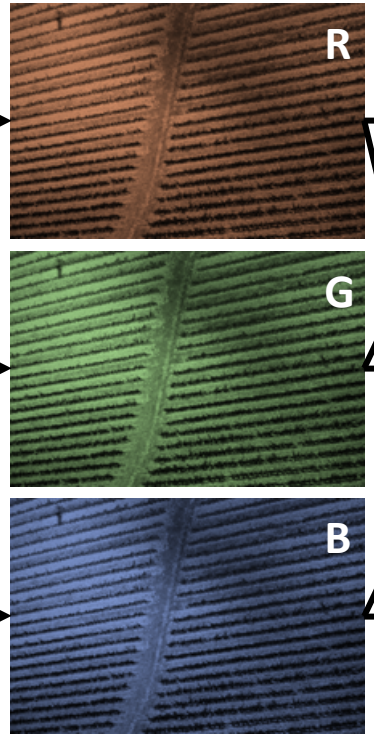
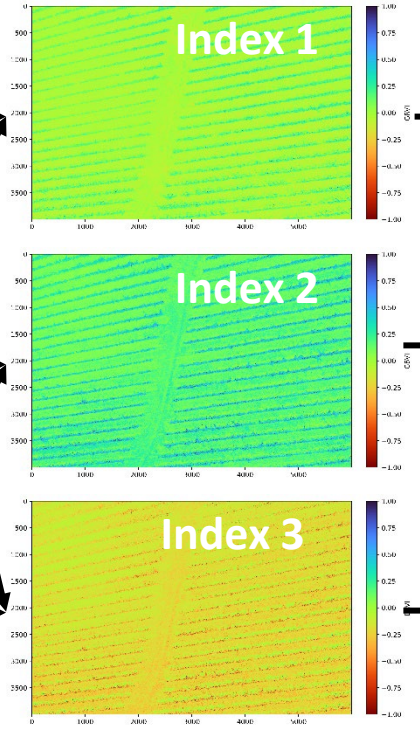
- **Optimization** of the algorithms to use in **computer clustering**
- Reduction of **processing time** for the 2024 season crop

RGB band extraction

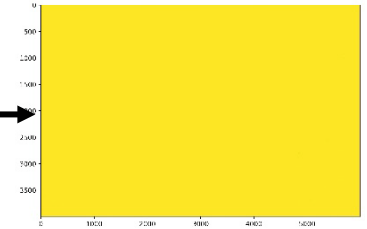


Index extraction



If Ind1 < o > value 1
& if Ind2 < o > value 2
& if Ind3 < o > value 3

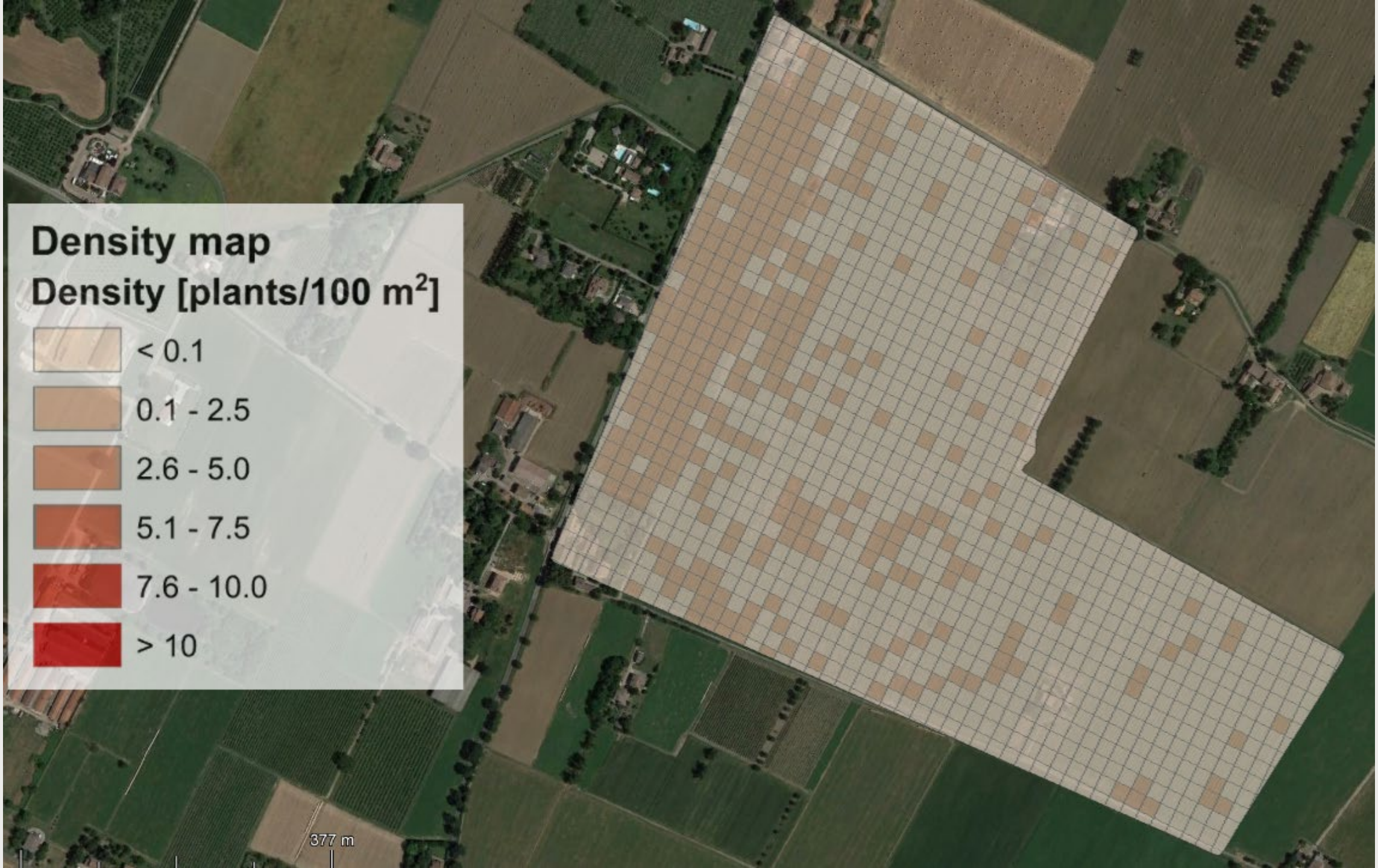
Surviving pixel map



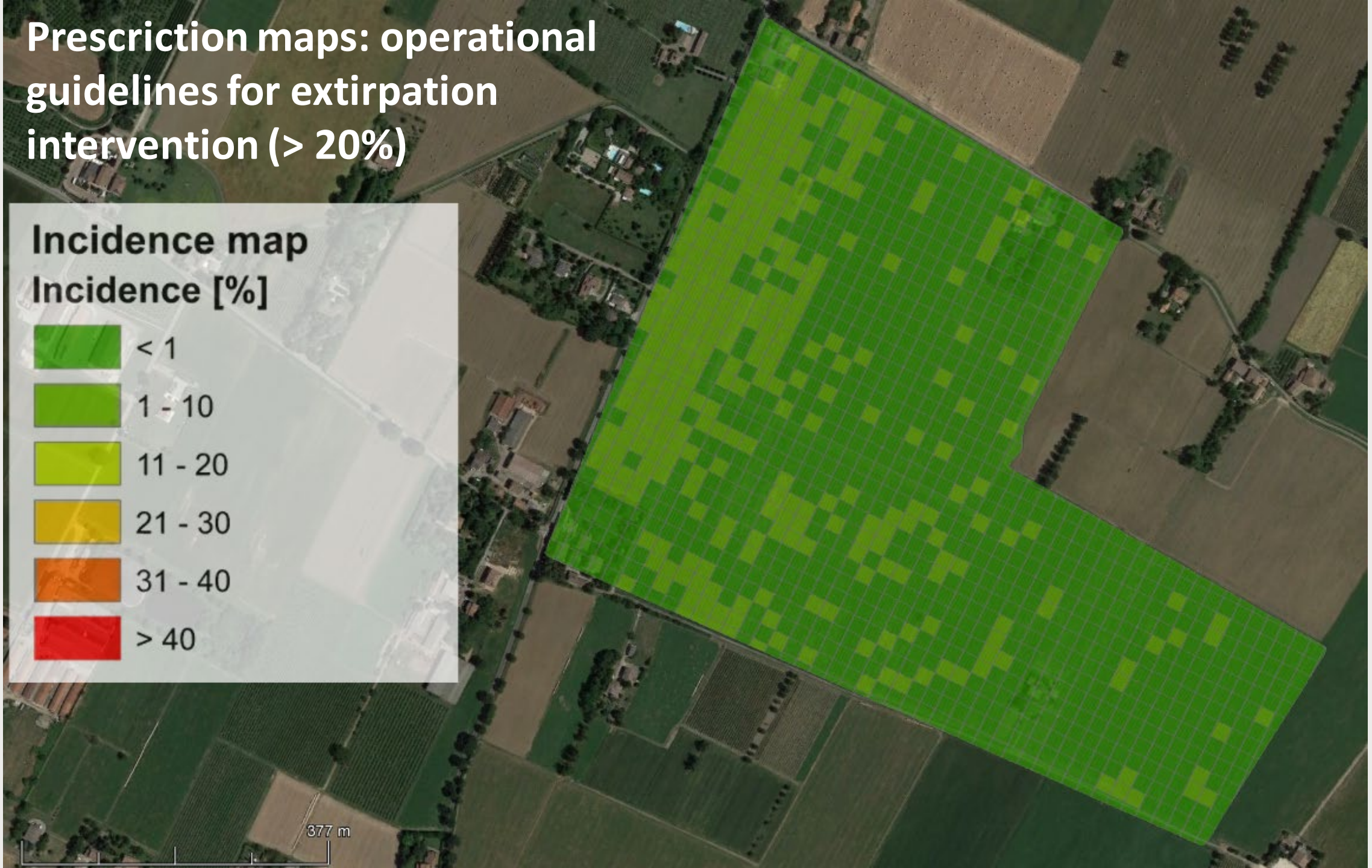
Georeferencing

DBSCAN

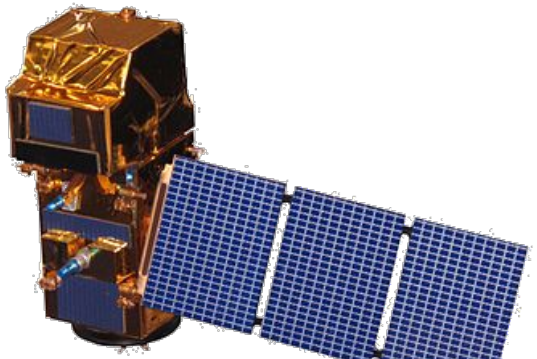
Processing time: 5.6 min/ha


Density map
Density [plants/100 m²]
< 0.1
0.1 - 2.5
2.6 - 5.0
5.1 - 7.5
7.6 - 10.0
> 10
377 m

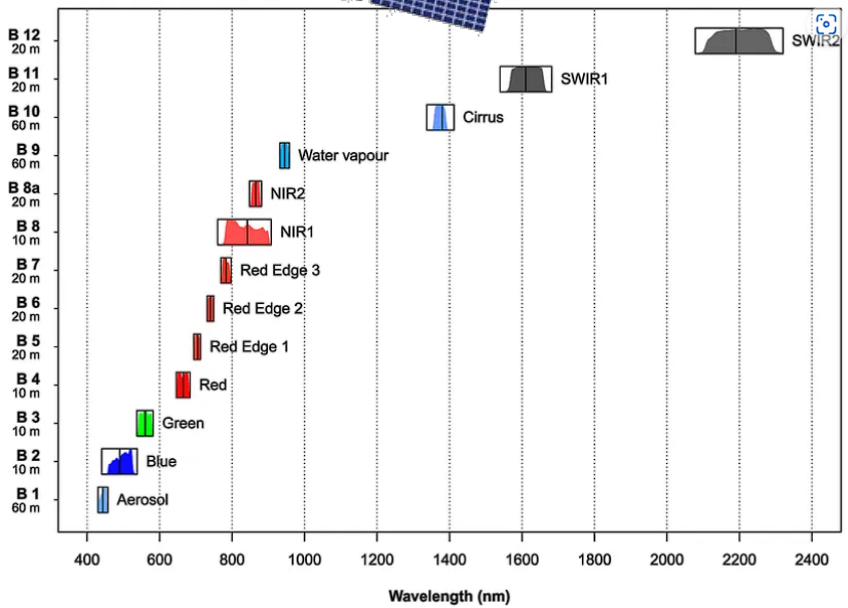
Prescriction maps: operational guidelines for extirpation intervention (> 20%)



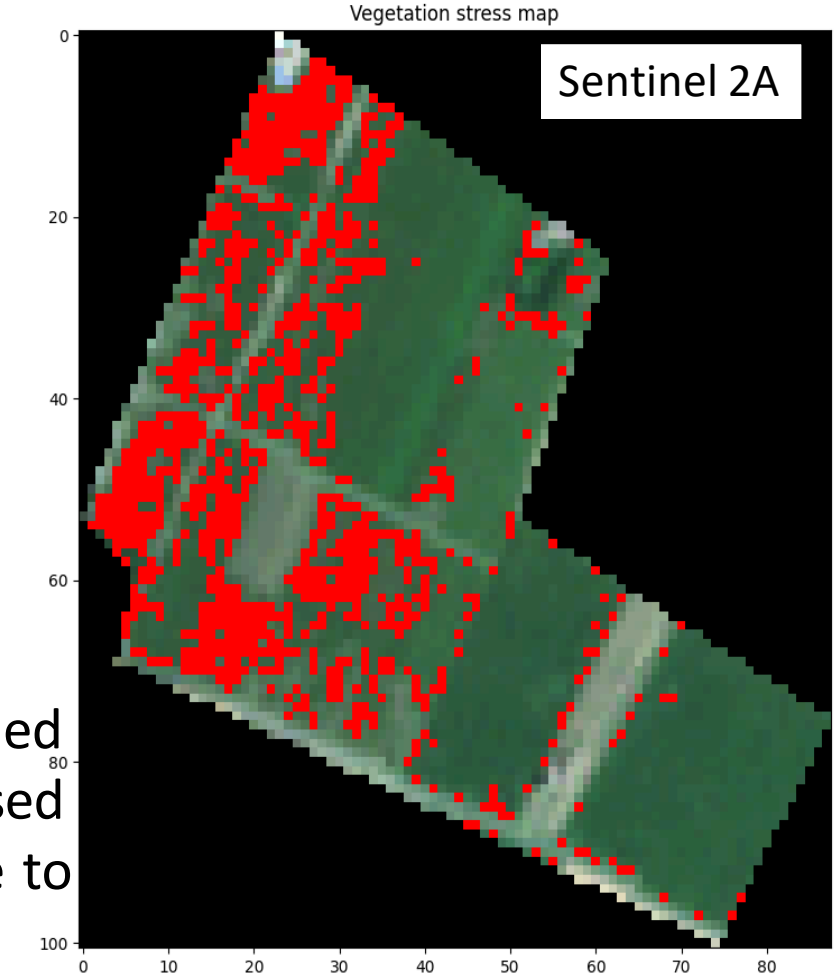
What next: use of satellite imagery

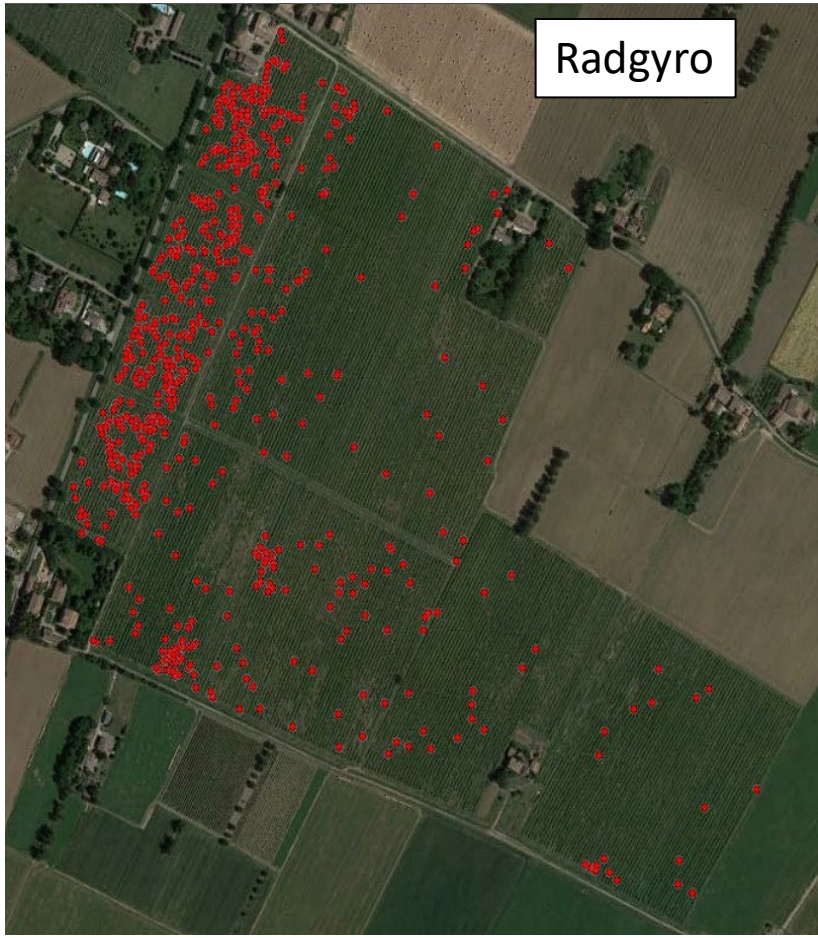


- **Sentinel-2A** is a satellite of the Copernicus constellation specifically designed for **vegetation monitoring** and **natural disaster management.**
- It acquires images in various spectral bands (spatial resolution: 10 m), allowing the calculation of many **vegetation indices.**



- First reproducibility tests were carried out using **clustering techniques** based on indices of vegetation susceptible to **flavescence dorée symptoms**.





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Thank you for the attention

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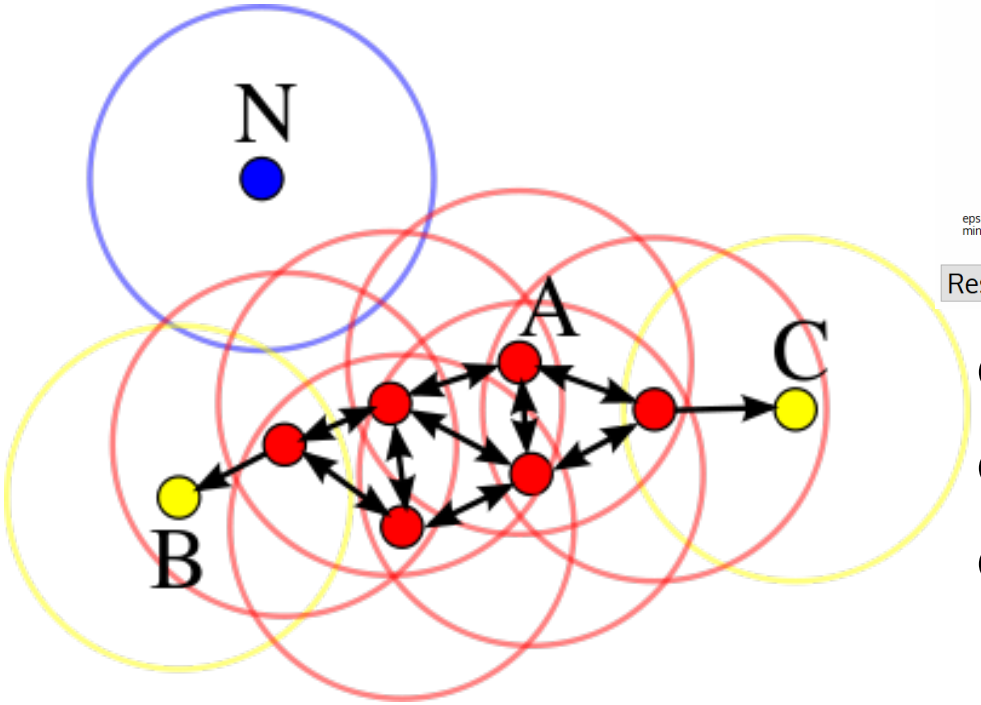
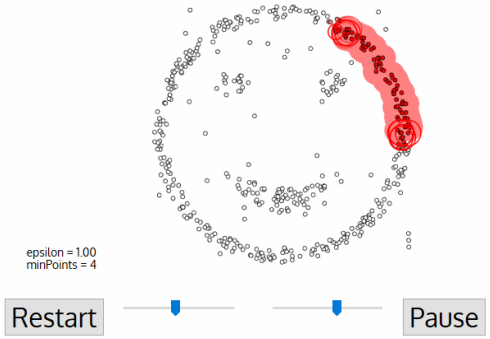
BACK UP

DBSCAN: density-based spatial clustering of applications with noise

Unsupervised learning method: it identifies distinct groups/cluster, on the basis that a cluster in the space is a region neighboring with high density points, separated from other clusters with regions with low density points..

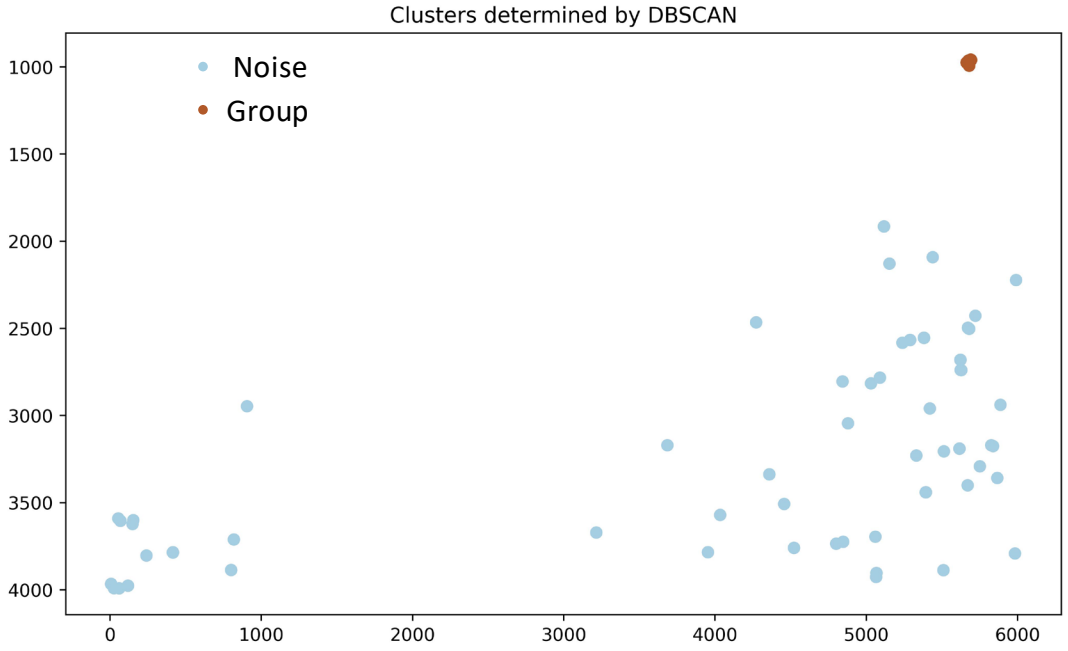




Core point

Border point

Noise point



2 parameters:

eps: radius defining the neighborhood of each point

min_samples: minimum number of points inside the neighborhood in order to the investigated point is considered as Core point

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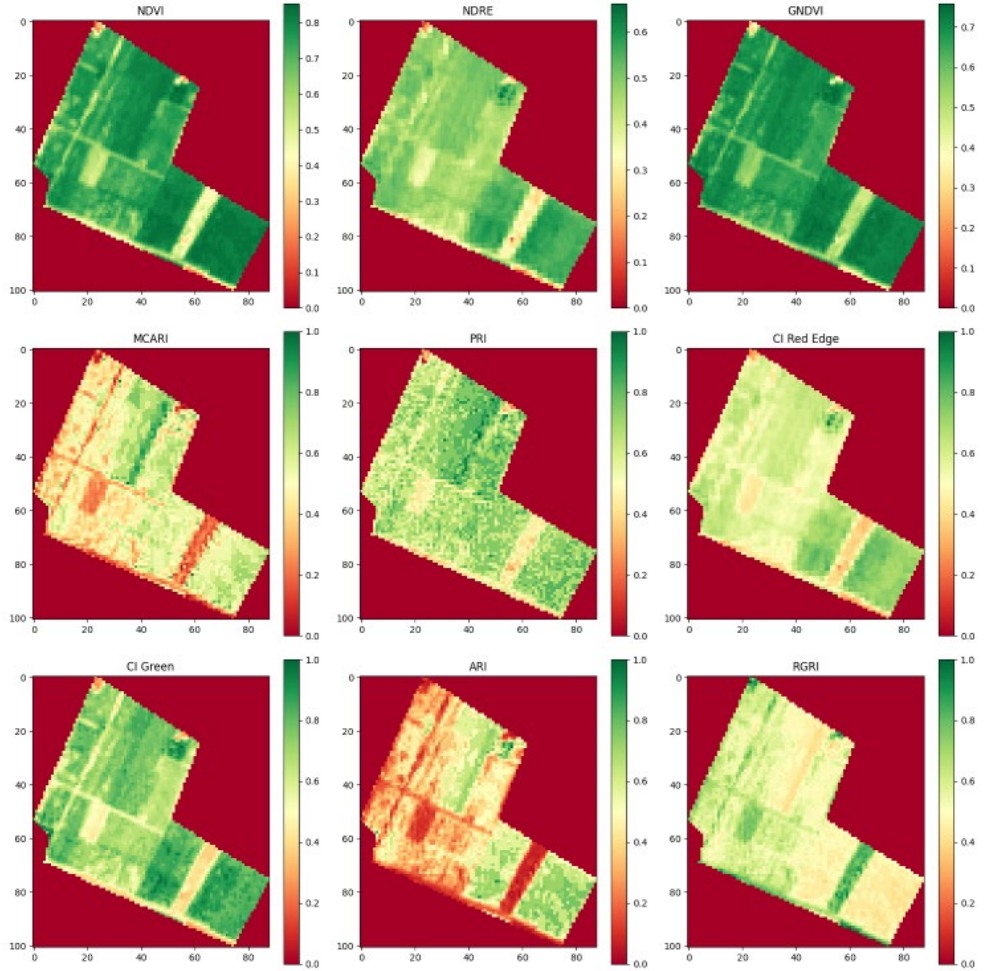
VEGETATION INDICES MAPPING

Full Name and Abbreviation	Calculation Formula	Description
Normalized Difference Vegetation Index (NDVI)	$\frac{NIR - Red}{NIR + Red}$	Measures vegetation density and health by reflecting how plants absorb and reflect sunlight.
Normalized Difference Red Edge Index (NDRE)	$\frac{NIR - RedEdge}{NIR + RedEdge}$	Similar to NDVI but uses the Red Edge band, useful for assessing chlorophyll and plant health.
Green Normalized Difference Vegetation Index (GNDVI)	$\frac{NIR - Green}{NIR + Green}$	Utilizes the green band for better assessment of vegetation health and chlorophyll.
Modified Chlorophyll Absorption in Reflectance Index (MCARI)	$((RedEdge - Red) - 0.2 \times (RedEdge - Green)) \times \frac{RedEdge}{Red}$	Designed to highlight the concentration of chlorophyll in leaves and reduce the impact of the soil.
Photochemical Reflectance Index (PRI)	$\frac{Green - Blue}{Green + Blue}$	Indicates the photochemical efficiency of photosynthesis in plants.
Red Edge Chlorophyll Index (CI Red Edge)	$\frac{NIR}{RedEdge} - 1$	Indicates plant health and chlorophyll concentration using the Red Edge band.
Green Chlorophyll Index (CI Green)	$\frac{NIR}{RedEdge} - 1$	Similar to CI Red Edge but utilizes the green band.
Anthocyanin Reflectance Index (ARI)	$\frac{1}{Red} - \frac{1}{Green}$	Used to estimate the anthocyanin content in vegetation, particularly in leaves. Anthocyanins are pigments responsible for red, purple, and blue colours.
Red Green Ratio Index (RGRI)	$\frac{Red}{Green}$	Indicates plant health through the ratio between red and green bands.



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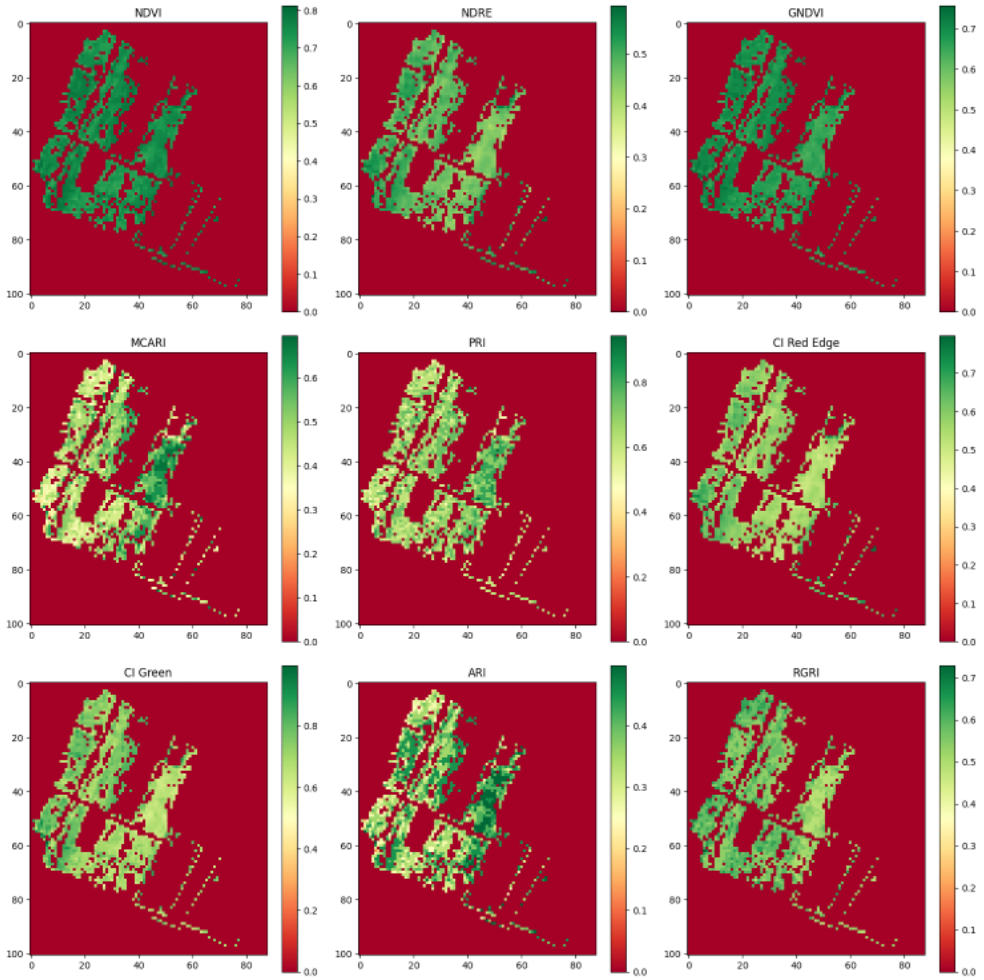
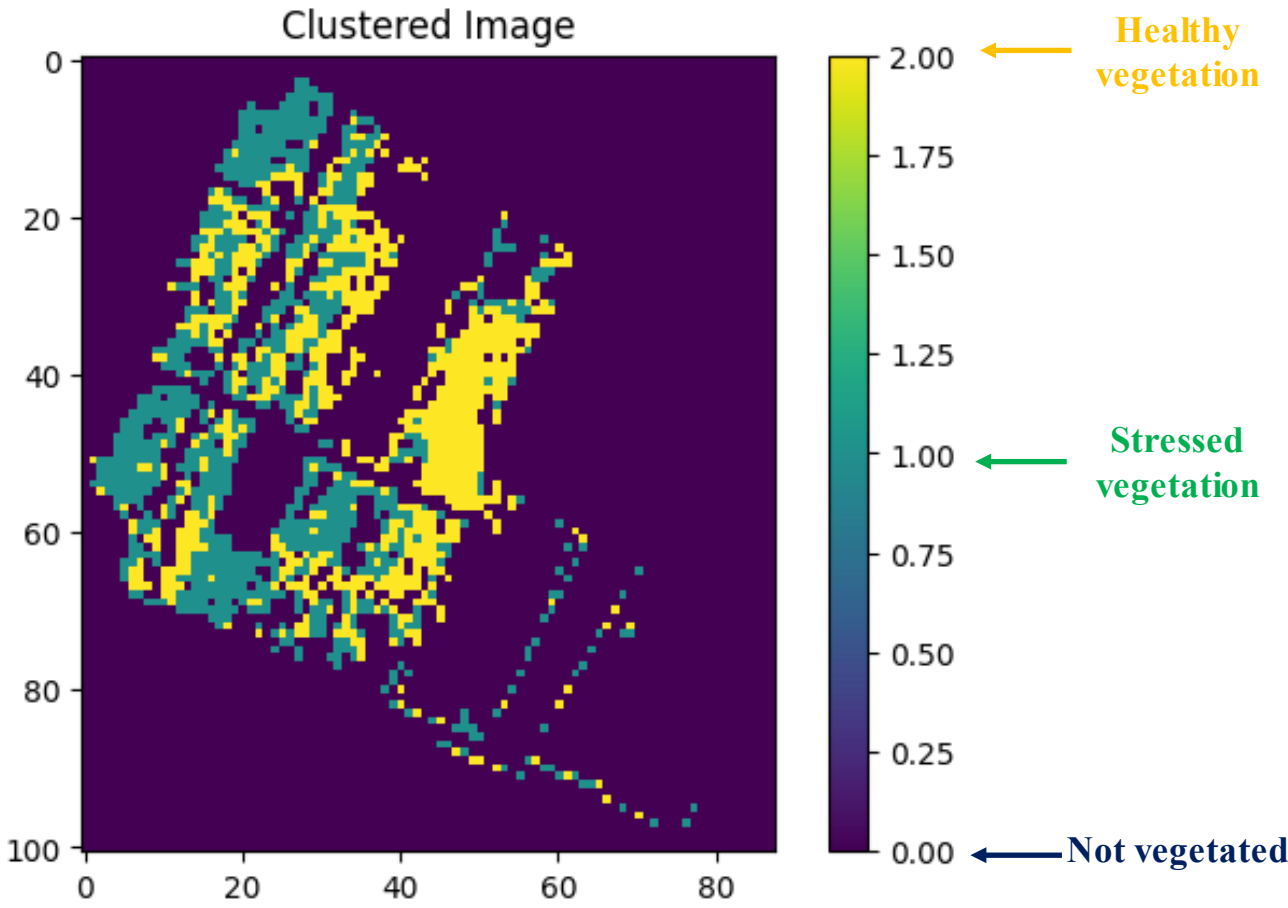
CLUSTERING WITH K-MEANS

N=3

APPLIED CUTS

1. NDVI > 0.7
2. MCARI < 0.7
3. ARI < 0.5