

FLAGSHIP 2.6.3: AI ALGORITHM FOR (SATELLITE) IMAGING RECONSTRUCTION

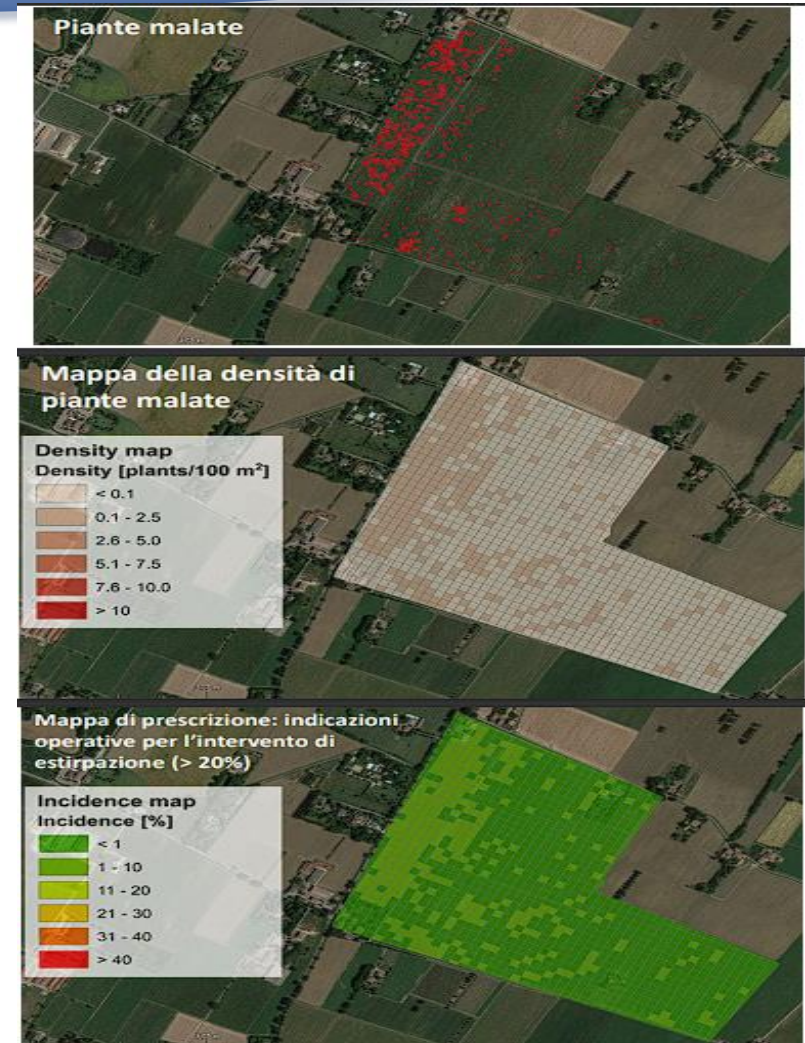
REPORT FOR

WP6 MEETING, 07/12/2023

A. Tricomi^{1,2,3}, G. Piparo¹, G. A. Anastasi²,
E. Tramontana², V. Strati⁴

1. INFN Sezione di Catania
2. Università degli studi di Catania
3. Centro Siciliano di Fisica Nucleare e Struttura della Materia (CSFNSM)
4. Università degli studi di Ferrara

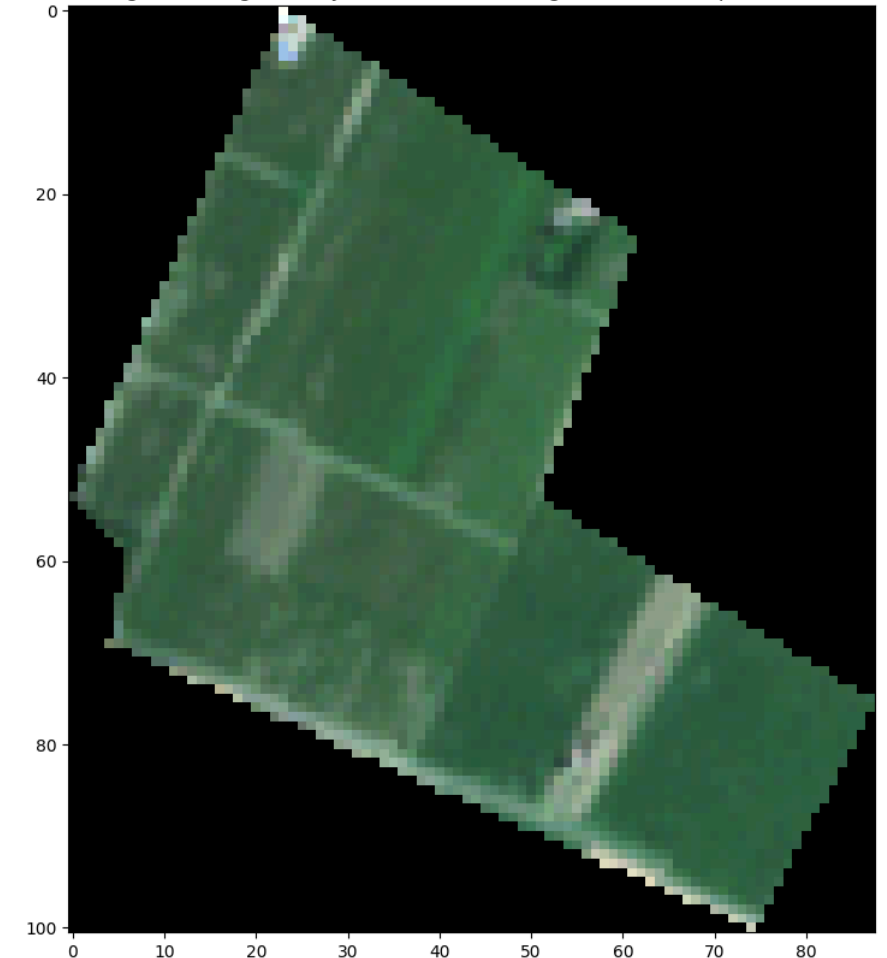
- Virginia presented two meetings ago the results of her group about the **identification of flavescence dorée disease** in an Emilia-Romagna vineyard (near Formigine).
- Using an RGB-based index filtering and a clustering technique based on DBSCAN they were able to identify the diseased plants and to calculate density and incidence maps.
- **The study of satellite images of this area could be an interesting starting point for our research, allowing us to simultaneously explore the potential of the two types of images (satellite and drone/aircraft).**



SENTINEL-2A TEST

- Thanks to their **free availability and ease of obtaining**, **Sentinel-2A** images are ideal for initial testing.
- Of course, the **low resolution** of the images (10 m) makes it **almost impossible** to obtain the same results as those obtained using aircraft images (res. of 1 cm in the case of Ferrara study).
- In any case, taking advantage of the **greater availability of spectral bands**, one can try to obtain an 'indicative' result, such as highlighting **regions where the vineyard shows greater stress** and roughly comparing them with the results of aircraft imagery.

RGB image of Formigine vineyard (Lat. 44.58°, Long. 10.88°) in the period 5-11/08/2023

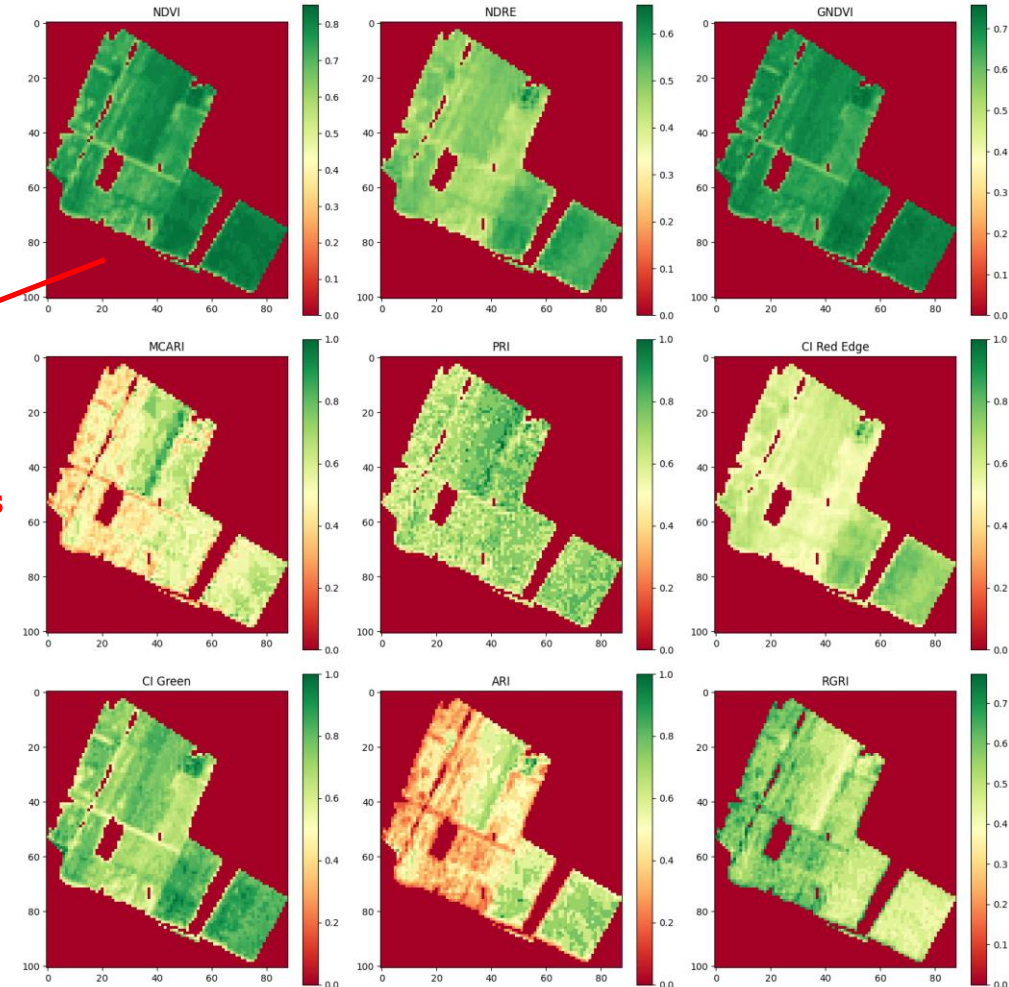


VEGETATION INDICES

IDB - Show Indices for selected Sensor (indexdatabase.de)

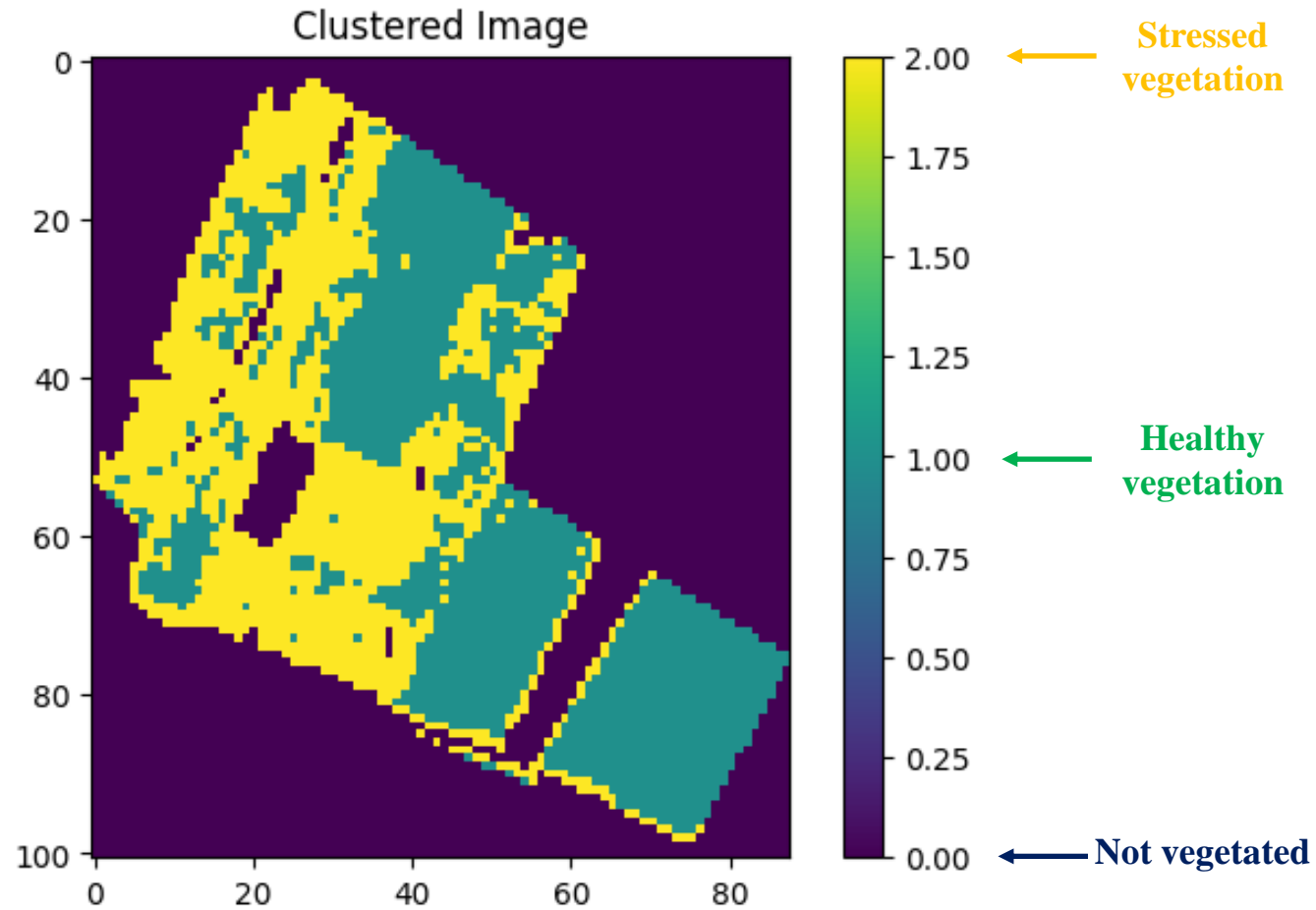
Full Name and Abbreviation	Calculation Formula	Description
Normalized Difference Vegetation Index (NDVI)	$\frac{NIR - Red}{NIR + Red}$	Measures vegetation density and health by reflecting how plants absorb and reflect sunlight.
Normalized Difference Red Edge Index (NDRE)	$\frac{NIR - RedEdge}{NIR + RedEdge}$	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)	$\frac{(RedEdge - Red) - 0.2 \times (RedEdge - Green)}{Red}$	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.

We applied a cutoff at NDVI < 0.6 to select the regions of the image containing vegetation

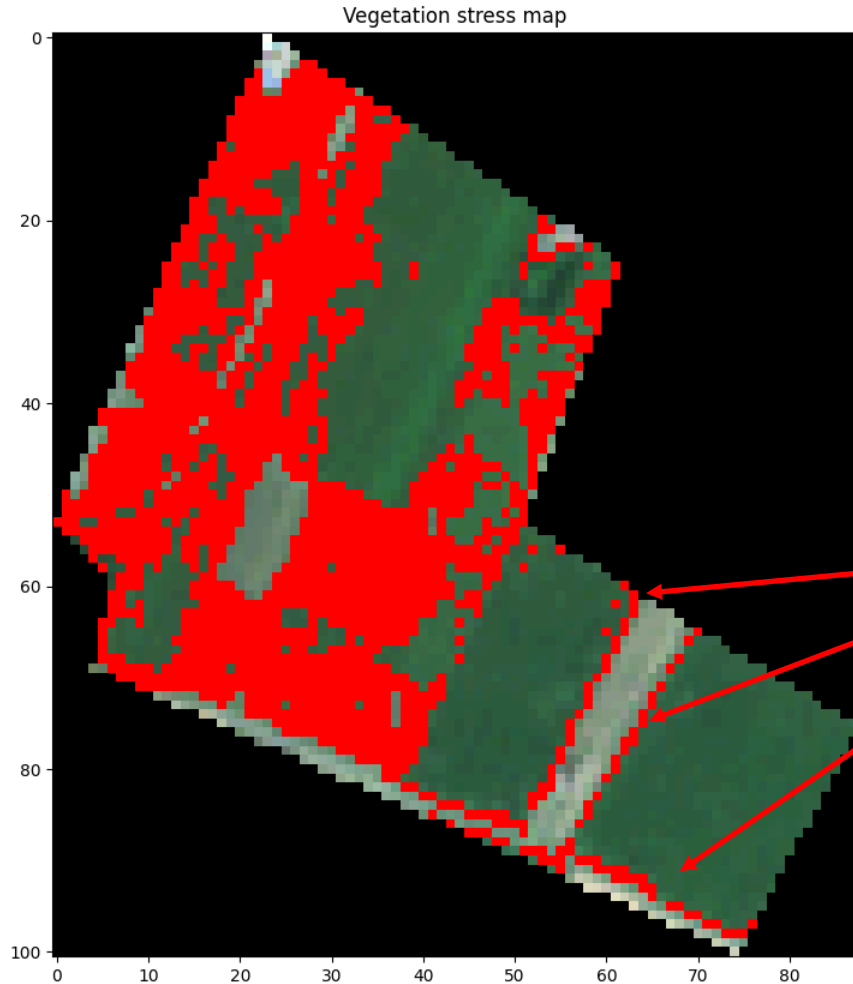


CLUSTERING WITH K-MEANS

N=3



MAP OF VEGETATION STRESS VS. MAP OF DISEASED PLANTS



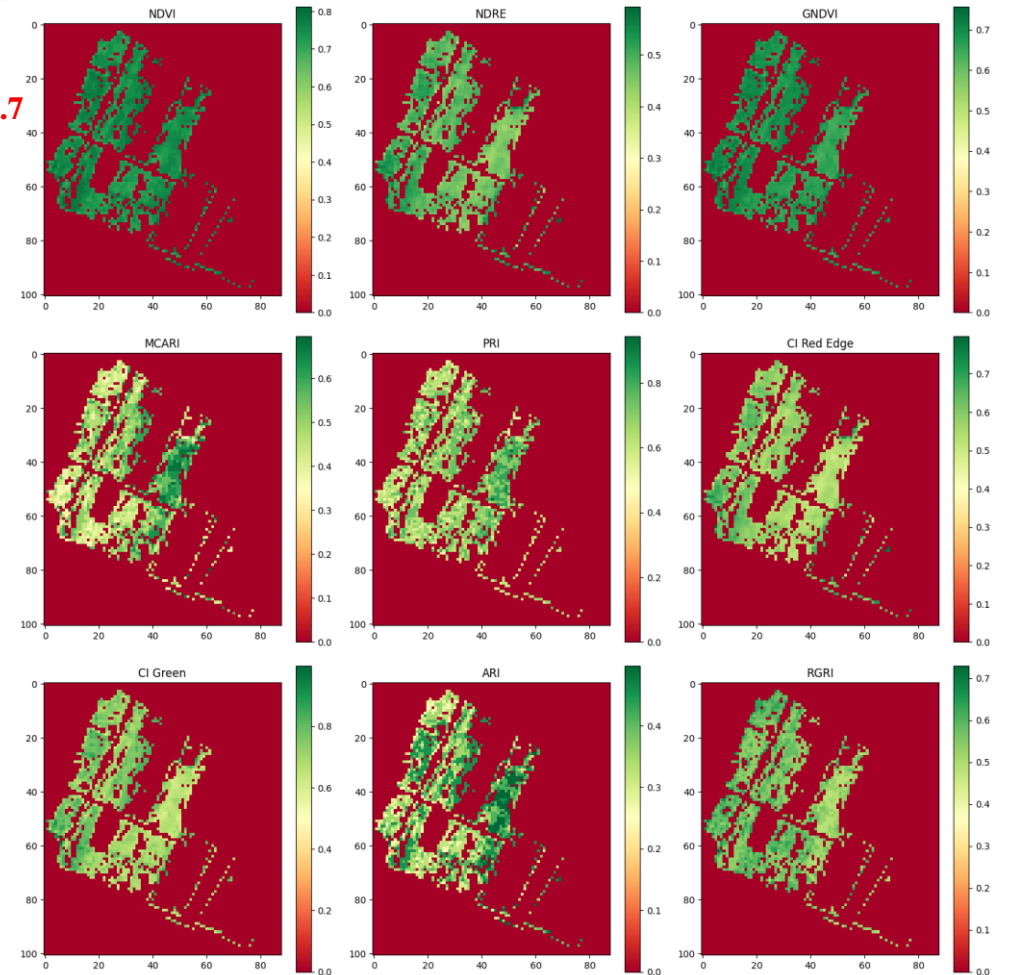
A bit of roadside
effect



INTRODUCING SOME MORE CUT

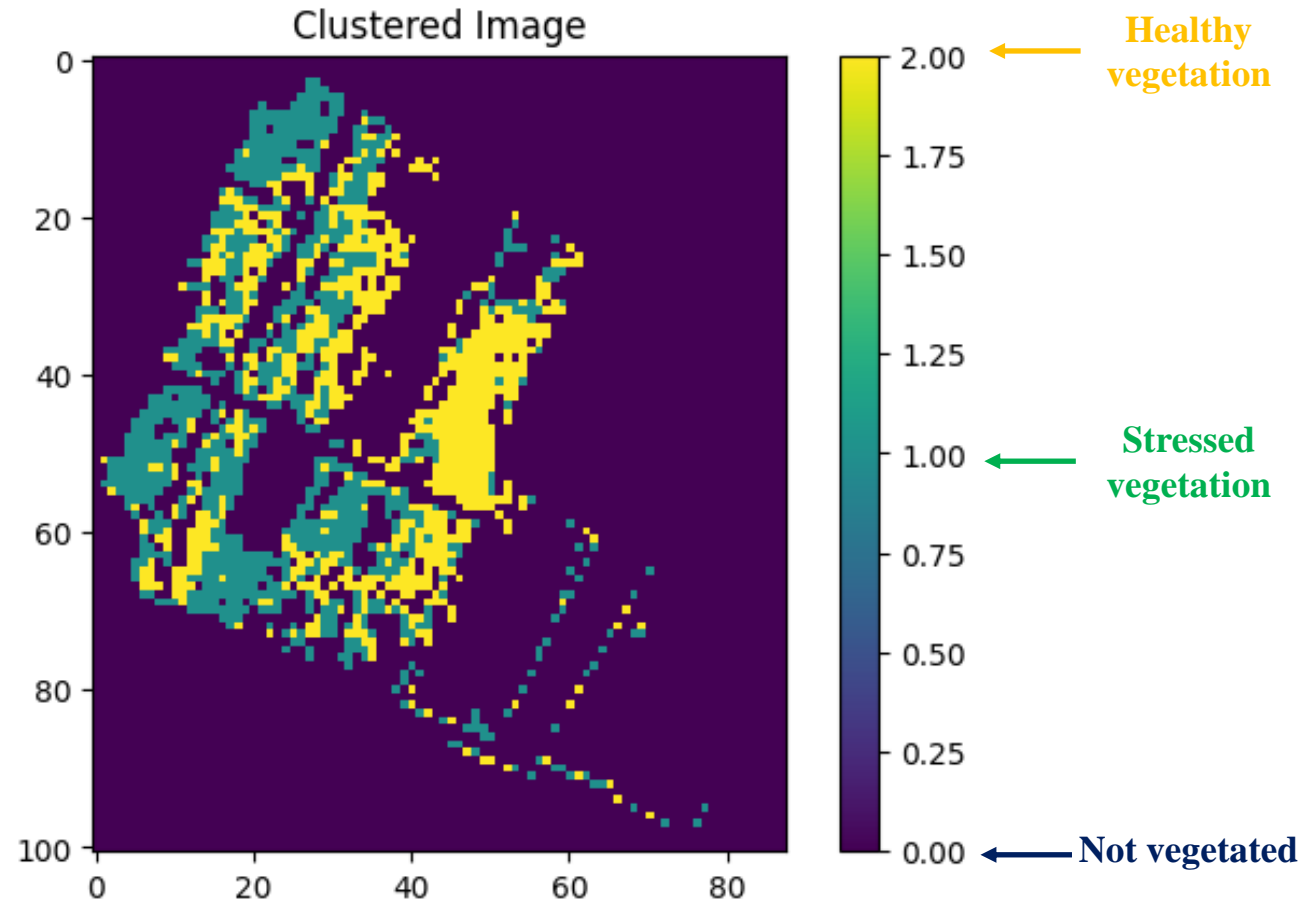
Full Name and Abbreviation	Calculation Formula	Description
Normalized Difference Vegetation Index (NDVI)	$\frac{NIR - Red}{NIR + Red}$	Measures vegetation density and health by reflecting how plants absorb and reflect sunlight.
Normalized Difference Red Edge Index (NDRE)	$\frac{NIR - RedEdge}{NIR + RedEdge}$	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)	$\frac{((RedEdge - Red) - 0.2 \times (RedEdge - Green)) \times \frac{RedEdge}{Red}}$	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.

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



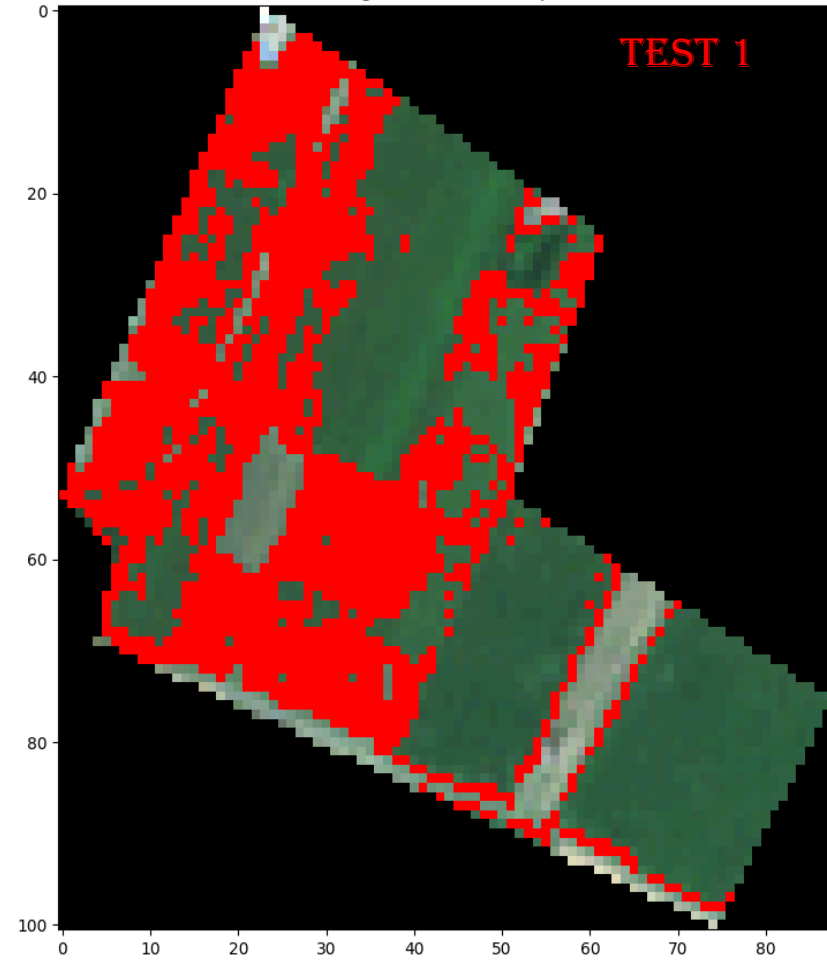
N=3

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



MAP OF VEGETATION STRESS VS. MAP OF DISEASED PLANTS II

Vegetation stress map



Vegetation stress map

