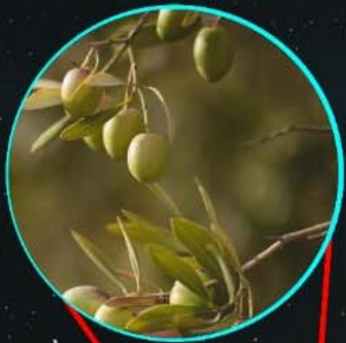
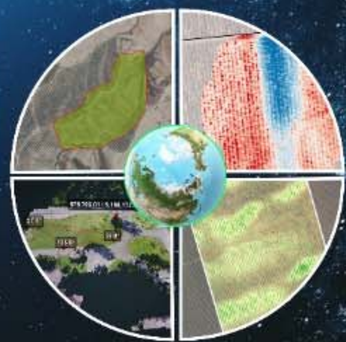


**SUSTAINABLE Project (Stop running, stop and start using our knowledge to be reachable):** Horizon 2020 program under the Marie Skłodowska-Curie RISE (Research and Innovation Staff Exchange) GA 101007702.

**From farm to fork: drones and satellites in the field and sensors in the lab.**

Vanessa M. Martos Núñez

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.



SustAInable

**SUSTAINABLE Project (Stop running, stop and start using our knowledge to be reachable)**

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

**SUSTAINABLE Project (Stop running, stop and start using our knowledge to be reachable)** is a European initiative funded by the Horizon 2020 program under the Marie Skłodowska-Curie RISE (Research and Innovation Staff Exchange) action, agreement number 101007702. (projectsustainable.eu)

## General Objective

- ✓ The main goal of SUSTAINABLE is to develop and validate next-generation Artificial Intelligence (AI)-based Decision Support Systems (DSS) for precision agriculture management.
- ✓ These systems are designed to adapt to specific climate, geographic, and environmental conditions, offering optimal solutions that consider limitations linked to the development levels of different areas, types of farmers, crops, and infrastructure.

| Work Package No | Work Package Title | Activity Type | Lead Ben | Start Month | End month |
|---|---|---|---|---|---|
| 1 | Project Management | Management | UGR | 1 | 48 |
| 2 | SUSTAINABLE PILOT1: Beer and wine from crops to table | Research & Training | DPH | 4 | 42 |
| 3 | SUSTAINABLE PILOT2:<br><br>Moringa and olive oil from crops to table | Research & Training | ISI | 4 | 42 |
| 4 | SUSTAINABLE PILOT3:<br><br>Aquaculture and crops irrigation | Research & Training | SAEIO Global | 4 | 42 |
| 5 | SUSTAINABLE PILOT4:<br><br>Fresh fruits and horticulture from crops to table | Research & Training | UNIPA | 4 | 42 |
| 6 | SUSTAINABLE DSS | Research & Training | TOELT | 25 | 45 |

UNIVERSIDAD DE GRANADA

# SUSTAINABLE Project (Stop running, stop and start using our knowledge to be reachable)

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

As part of the SUSTAINABLE project, the University of Granada (UGR) has focused its efforts on the strategic **"From Farm to Fork"** approach, aiming to optimize agricultural practices and product quality through the integration of advanced technologies throughout the entire agri-food value chain.

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This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

# SUSTAINABLE Project (Stop running, stop and start using our knowledge to be reachable)

UGR has achieved the following key milestones: WP2-WP3

1. **Remote sensing using drones and satellites**: We have successfully deployed aerial platforms to monitor the status of vineyards, olive groves, and other agricultural crops. These technologies enabled more efficient resource use and improved crop management through real-time data analysis and predictive modeling.

2. **Development and application of agri-food sensors in the laboratory**: Advanced sensors were designed and implemented to assess key chemical and physical parameters of agricultural products, particularly wine, extra virgin olive oil (EVOO), and other crops, contributing to quality assurance and traceability.

3. **Installation of field sensors for disease prediction**: A network of low-cost, portable field sensors was used to monitor environmental and crop health indicators. These systems allowed for the early detection of disease risks, enabling timely and precise interventions.

4. **Sensory analysis in laboratory settings**: Structured sensory assessments were conducted to evaluate the final quality of wine, EVOO, and other agri-food products. Laboratory results were correlated with sensory attributes to validate the impact of technological interventions along the production chain.

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# SUSTAINABLE Project (Stop running, stop and start using our knowledge to be reachable)

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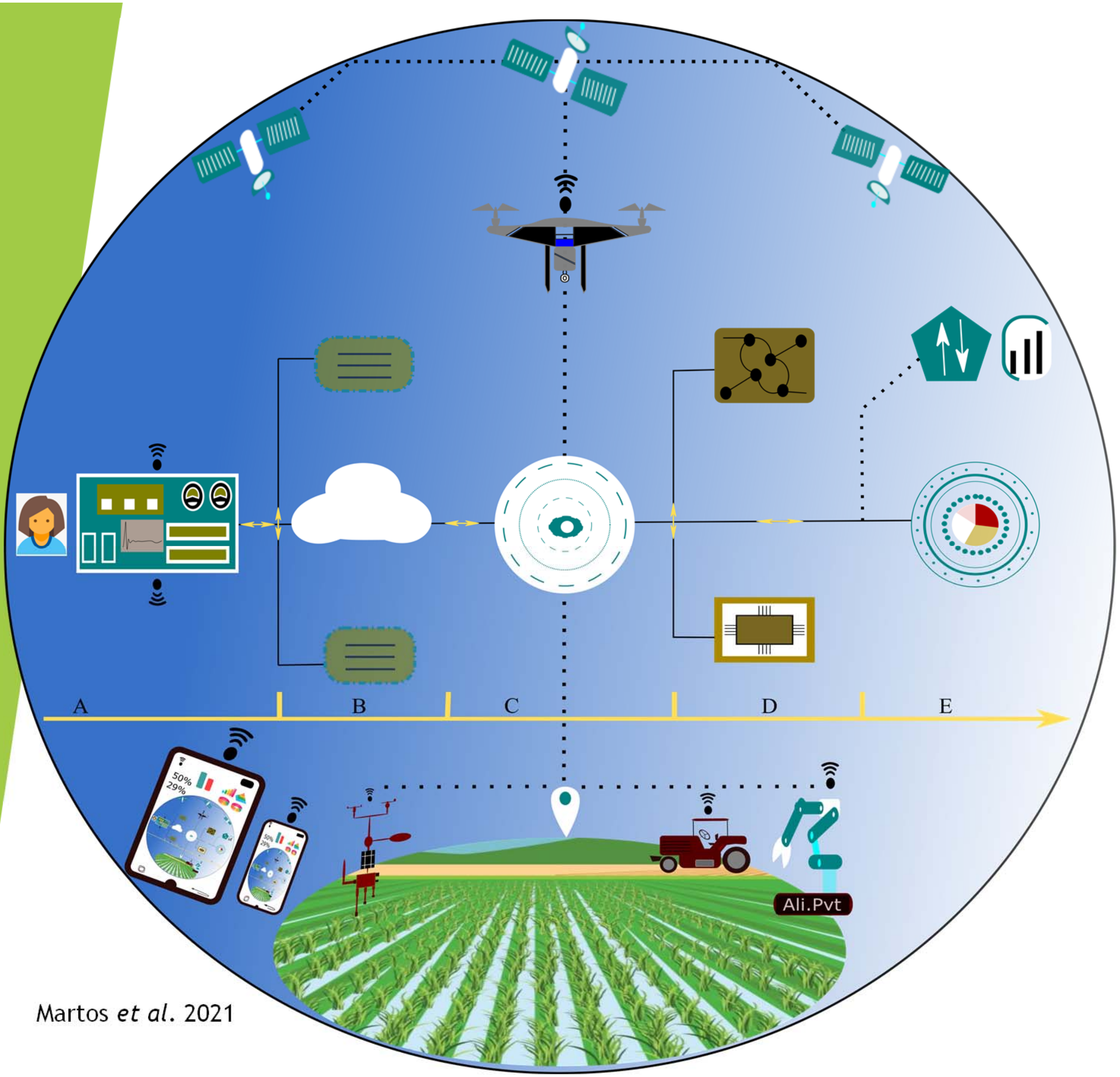
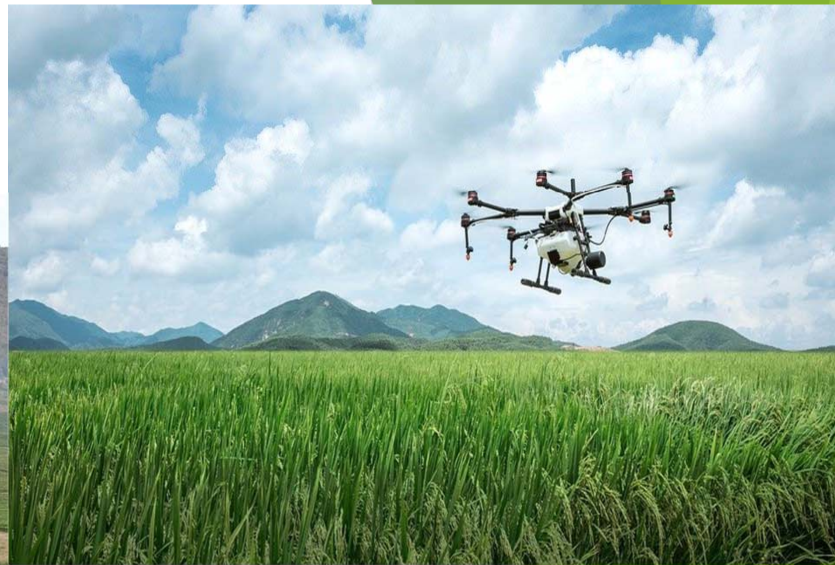
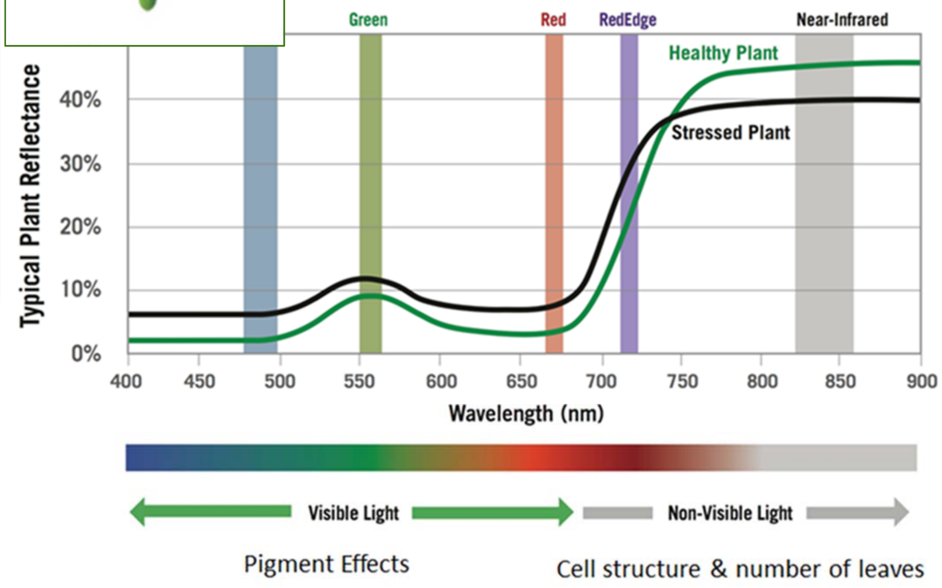



- The application of remote sensing in agriculture is essential to achieve highly productive and sustainable farming.
- There is growing concern about improving crops.
- Constant industrial innovation: 2021 marked the beginning of the "Industry 5.0" era, according to the European Commission.
- The industrial world, including the agricultural sector, is beginning this year to move closer to more digitized and automated systems.

Teledetección: Plataformas






- Plants reflect light at predictable wavelengths within the full light spectrum, which are related to crop health.
- Multispectral remote sensing uses scientific sensors with narrow-band filters to capture the energy reflected by plants.

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

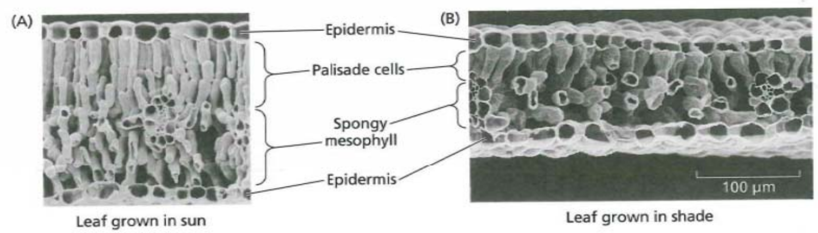
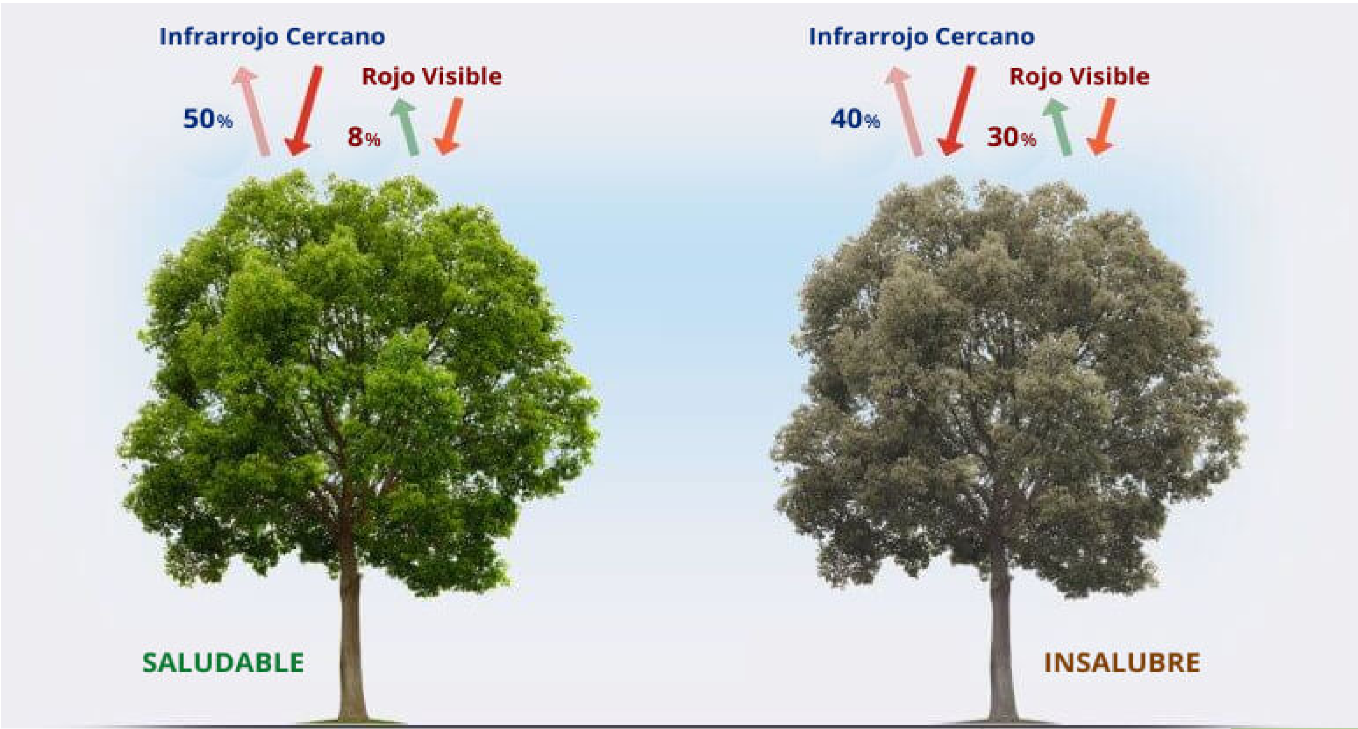



**Figure 9.1** Scanning electron micrographs of the leaf anatomy of a legume (*Thermopsis montana*) grown in different light environments. Note that the sun leaf (A) is much thicker than the shade leaf (B) and that the palisade (columnlike) cells are much longer in the leaves grown ir sunlight. Layers of spongy mesophyll cells can be seen below the palisade cells. (Courtesy of T. Vogelmann.)

- Chlorophyll (an indicator of plant health) absorbs a large amount of visible light, while the cellular structure of leaves strongly reflects near-infrared (NIR) light.
- When a plant becomes dehydrated, diseased, etc., the spongy mesophyll deteriorates, and the plant absorbs more NIR light instead of reflecting it.
- Therefore, observing changes in NIR compared to red light provides an accurate indication of chlorophyll presence, which is linked to plant health.

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

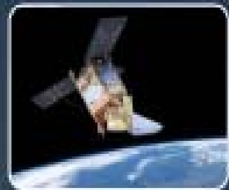


# SATELLITES


Families of satellites dedicated to Copernicus *"The Sentinels"*

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

# Sentinel Launch Overview

| S-1 | S-2 | S-3 | S-4 | S-5P | S-5 | S-6 |
|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |
| Radar | High Resolution Optical | Medium Resolution Optical & Altimetry | Atmospheric Chemistry (GEO) | Atmospheric Chemistry (LEO) | Atmospheric Chemistry (LEO) | Altimetry |
| A 3 Apr. 2014 | A 23 Jun. 2015 | A 16 Feb. 2016 | A 2021 | A 13 Oct. 2017 | A 2021 | A 2020 |
| B 25 Apr. 2016 | B 6 Mar. 2017 | B 2018 | B 2027 | | B 2027 | B 2025 |

## COPERNICUS SERVICES

- Atmosphere
- Marine
- Land
- Climate Change
- Security
- Emergency

## COPERNICUS THEMATIC HUBS

**HEALTH HUB**

The Copernicus Health Hub brings together all the Copernicus environmental data and products pertinent to Health, including that related to physical health, mental health and well-being.

**COASTAL HUB**

The Copernicus Coastal Hub provides open and free access to a selection of coastal Earth observation data from the Copernicus Sentinel satellites and all Copernicus Services.

**ENERGY HUB**

Copernicus Energy Hub: Connecting environmental data and Earth Observations to the green energy transition.

**ARCTIC HUB**

The Copernicus Arctic Hub provides access to data and information in the Arctic. Explore interactive maps and thematic use cases and empower decision-making and sustainable practices.

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

Satélites

SustAInable

**Sentinel-2: 13 spectral bands covering wavelengths from the visible to the shortwave infrared.**

- **Vegetation indices:Chlorophyll content in the leaf areaWater contentMonitor plant growth.**
- **Maps changes in the Earth's surfaceObserve forests.**
- **Alerts for pollution in lakes and coastal waters, floods, volcanic eruptions, and landslides**

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

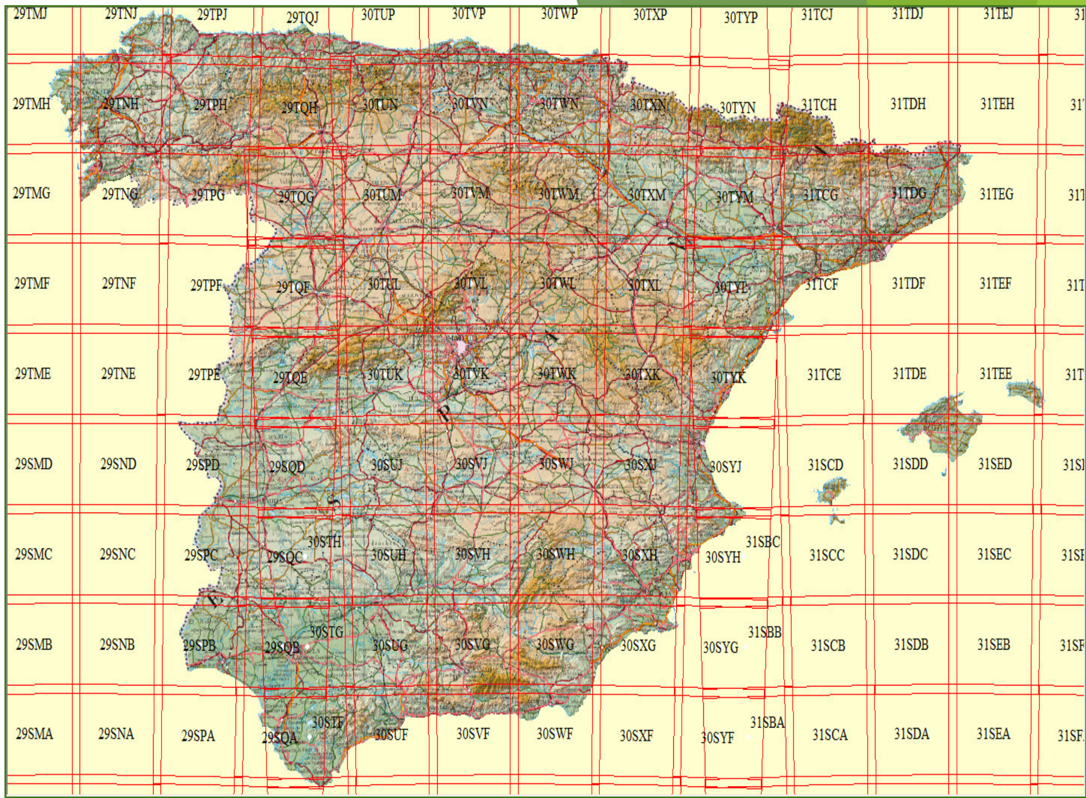
Copernicus
Europe's eyes on Earth


SustAInable

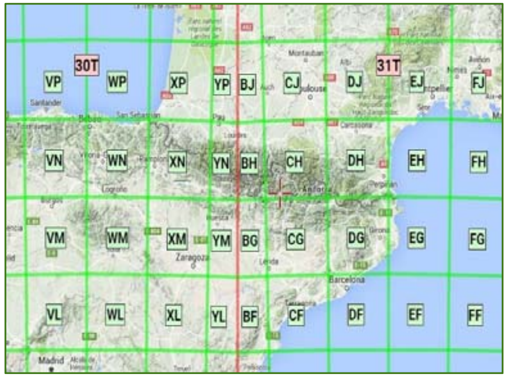
This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

system:time_start: 1620472249530






MGRS Tile




- Military Grid Reference System

30S VG

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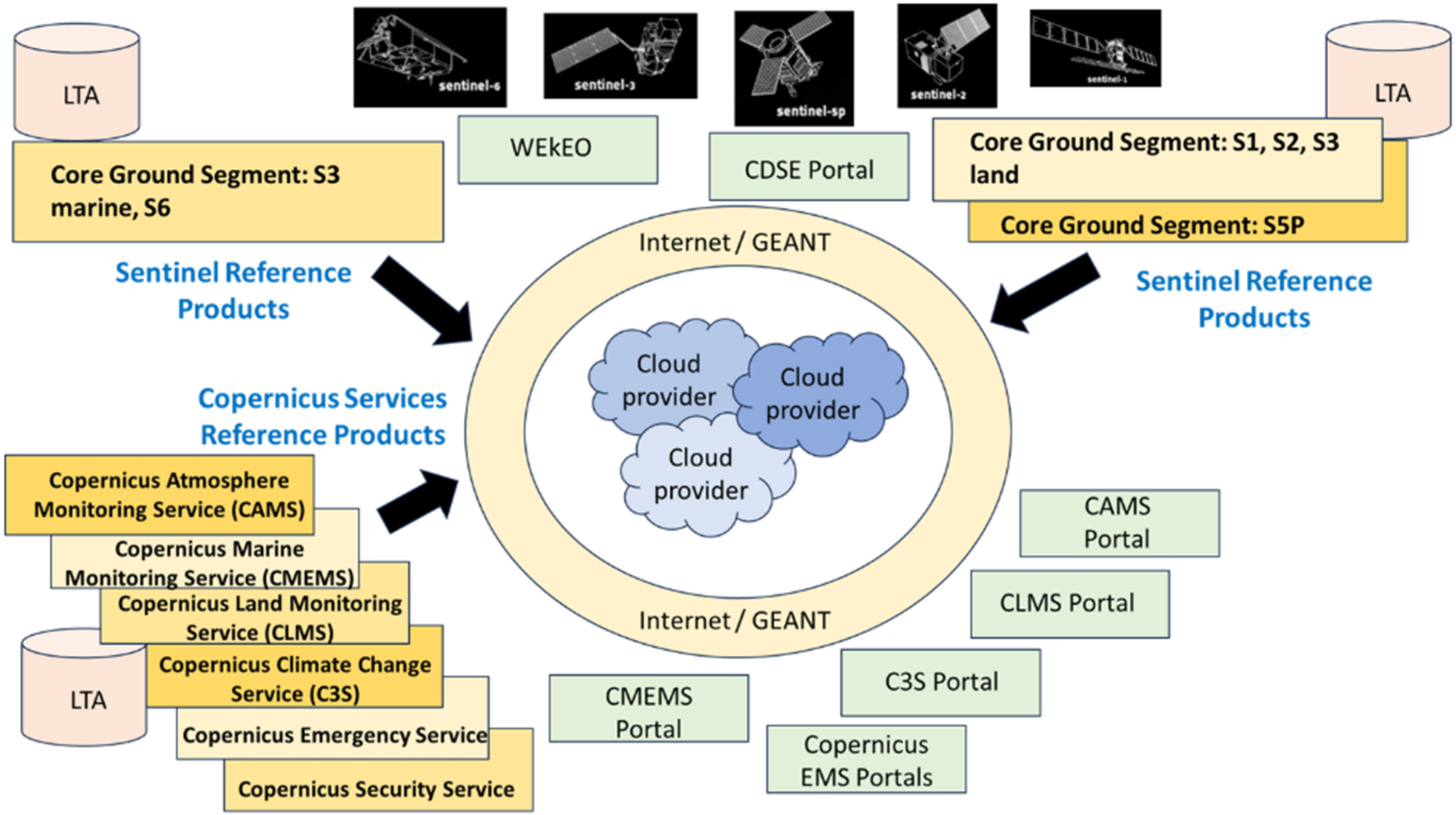
sensor Sentinel-2 MSI

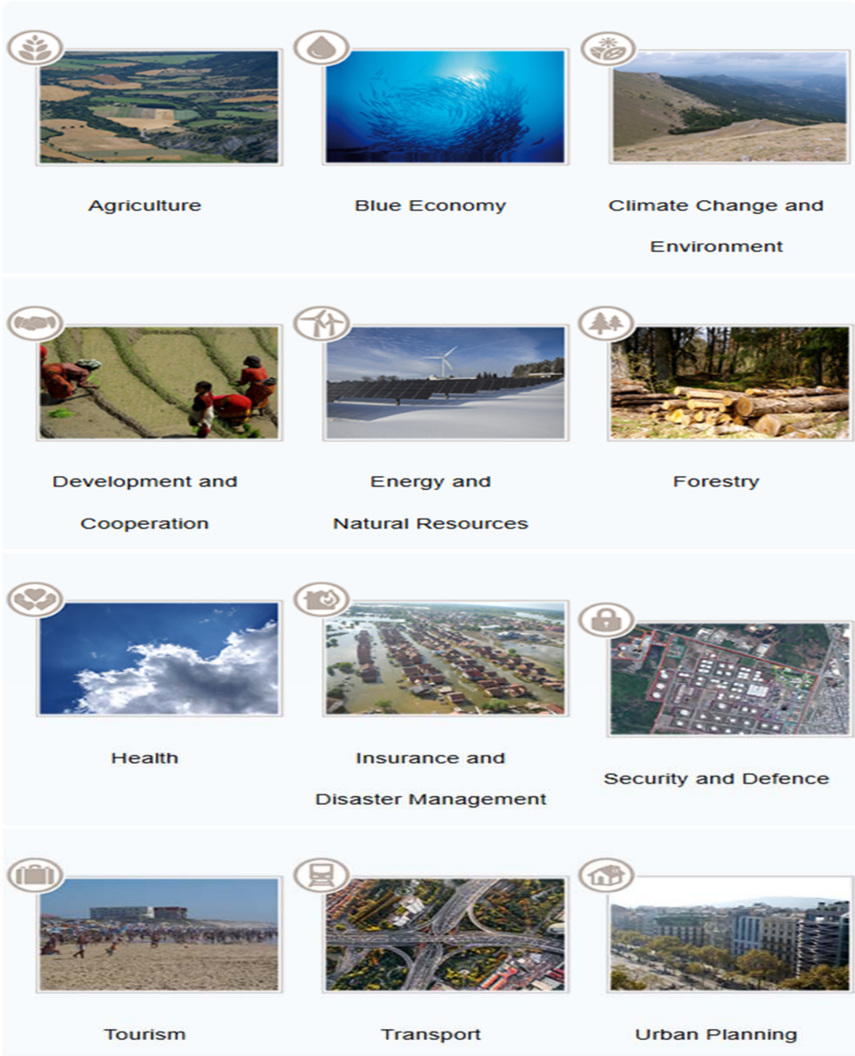



This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

# Impact of Copernicus

European citizens, ranging from policy makers, researchers, commercial to private users, as well as the g community can benefit in many ways from the data and information provided by Copernicus.

Indeed, Copernicus supports a variety of applications in several non-space domains, which potentially im organisations in day-to-day activities and operations.

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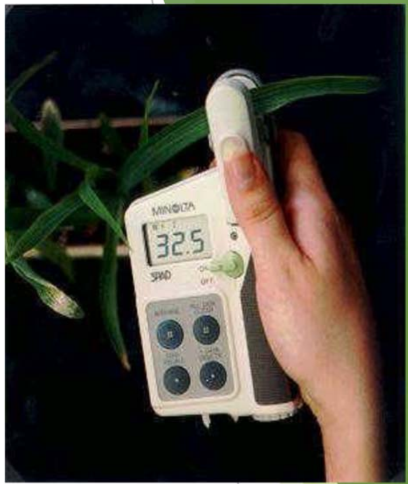


we have to cross-check the remotely sensed data with portable field equipment.

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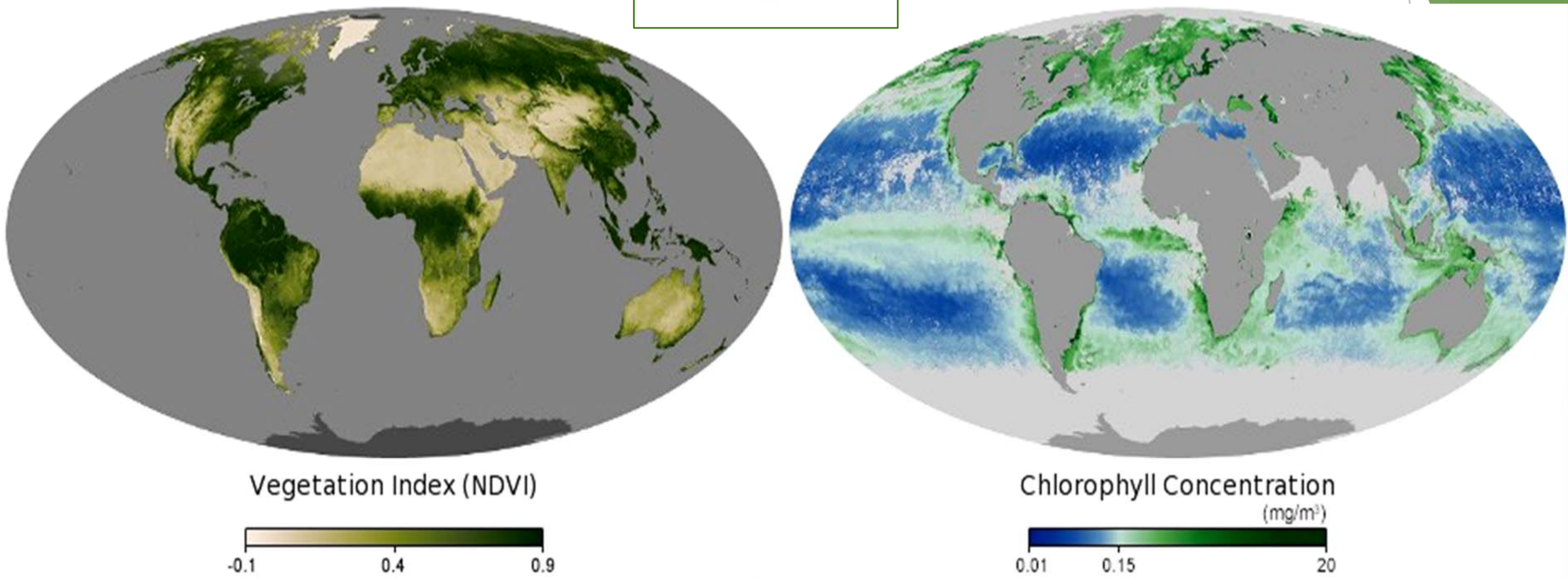
# Satélites: Lansat




July 2002


Satellite maps of vegetation show the density of plant growth over the entire globe. The most common measurement is called the Normalized Difference Vegetation Index (NDVI). Very low values of NDVI (0.1 and below) correspond to barren areas of rock, sand, or snow. Moderate values represent shrub and grassland (0.2 to 0.3), while high values indicate temperate and tropical rainforests (0.6 to 0.8).

Los zigzags anuales en la Curva de Keeling se deben a variaciones estacionales.

Los niveles de $CO_2$ bajan durante la primavera y el verano del hemisferio norte, cuando las plantas absorben más $CO_2$ de la atmósfera para crecer.


This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

Satélites

**Specific Applications in Agriculture:**

- Detection of plant water status
- Detection of nutritional stress in crops
- Crop monitoring
- Indices related to crop quality
- Real-time agrometeorological information
- Early identification of plant diseases

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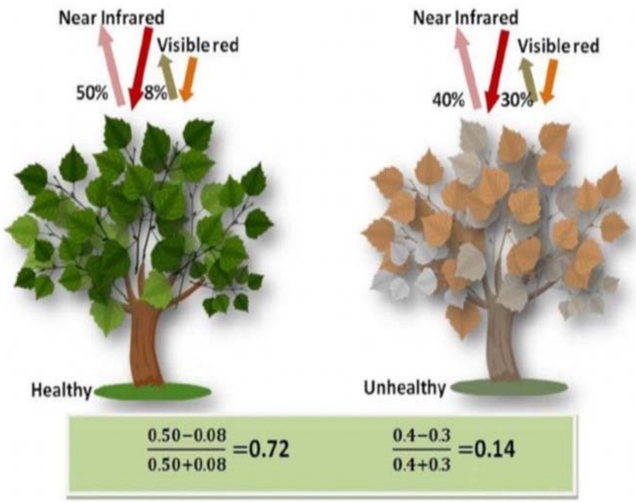
# Vegetation Index NDVI

## Indices de vegetación

* Indices de Vegetación: NDVI

**NDVI:** Normalized Difference Vegetation Index, mide la vigorosidad de la planta

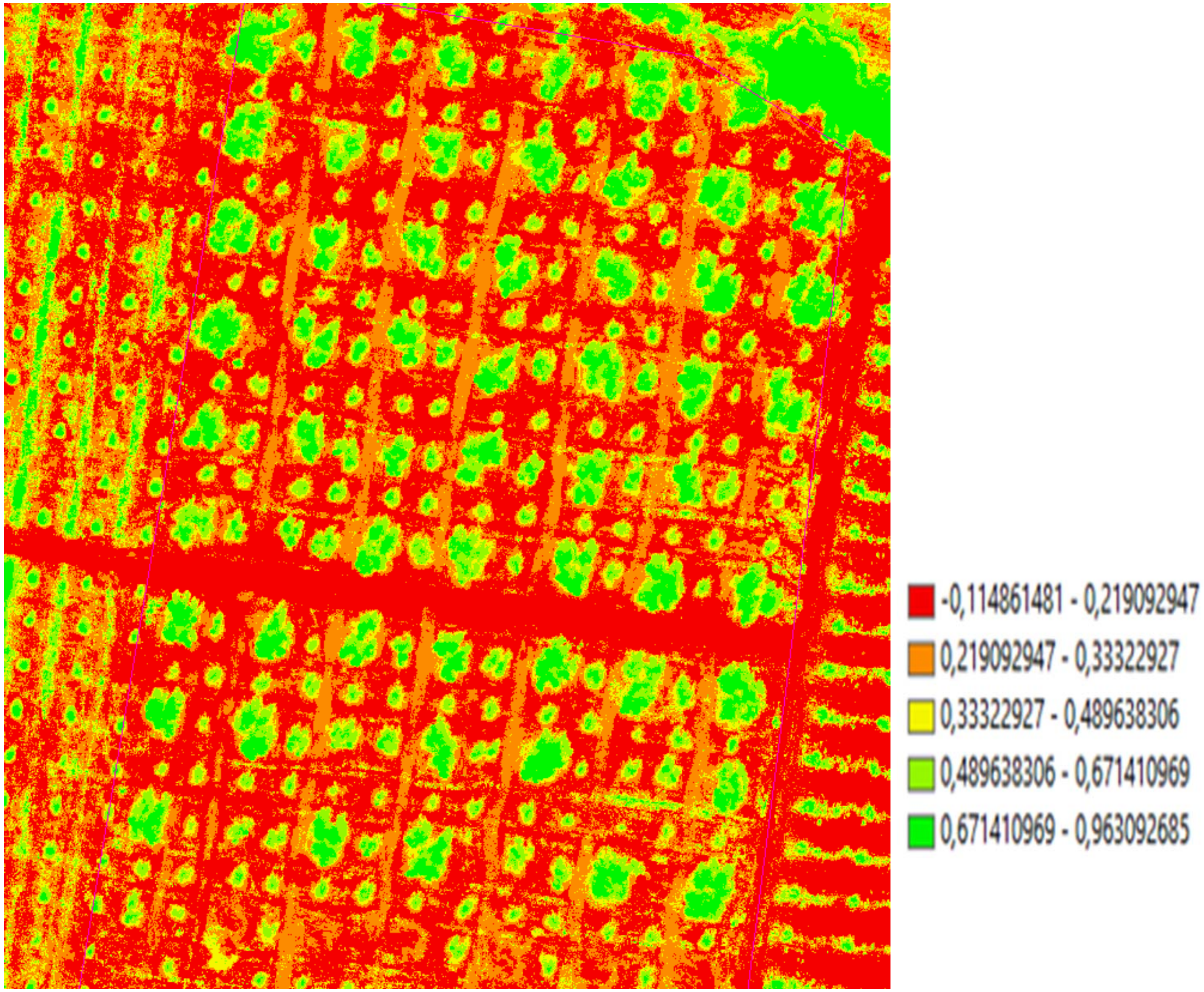
$$NDVI = \frac{Nir - Red}{Nir + Red}$$



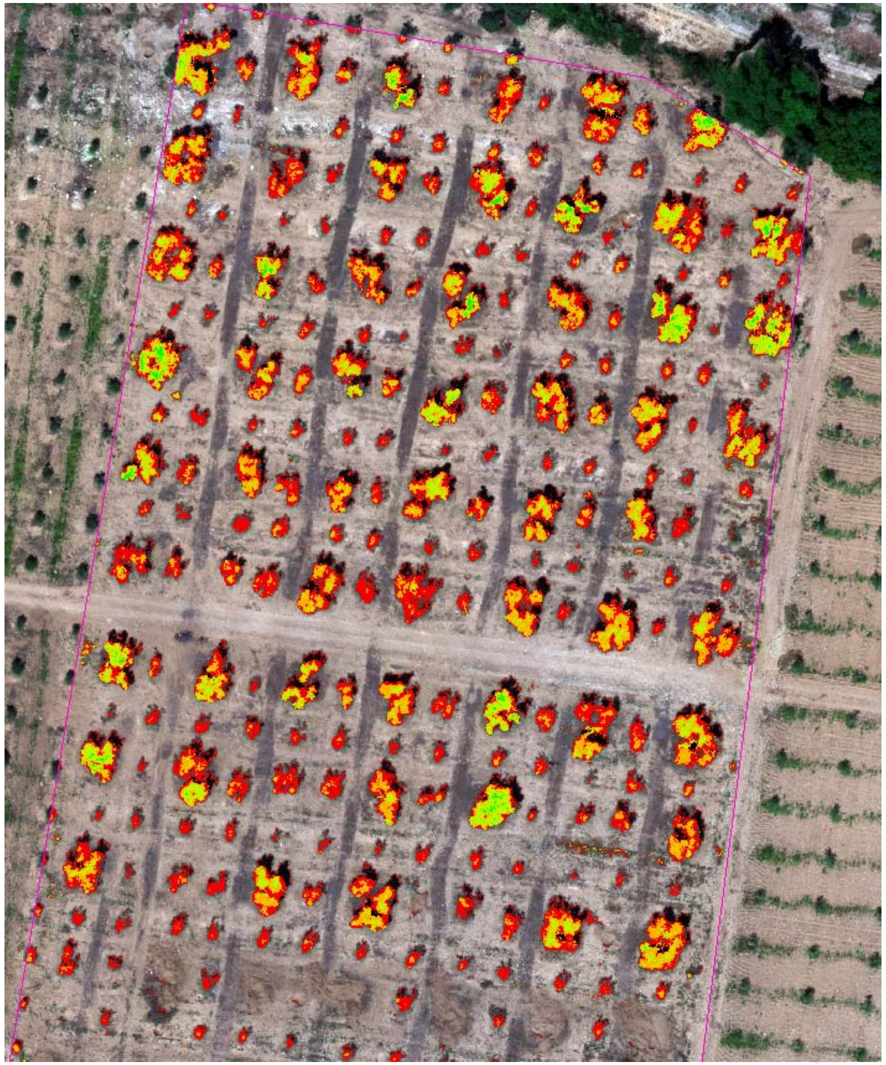

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

**Resultados** Vuelos sobre parcela de Olivos

NDVI en bruto




NDVI exclusivo Olivos



# SAVI Index

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

## Indices de vegetación

- **Solución: SAVI,** Soil-Adjusted Vegetation Index

$$SAVI = \frac{(\mathrm{NIR}-\mathrm{Red})}{(\mathrm{NIR}+\mathrm{Red}+\mathrm{L})} * (1+\mathrm{L})$$

*L* es un factor de ajuste del suelo con valores entre 0 y 1

Cuando la cobertura vegetal es 100%, *L* = 0

Cuando la cobertura vegetal es 0%, *L* = 1

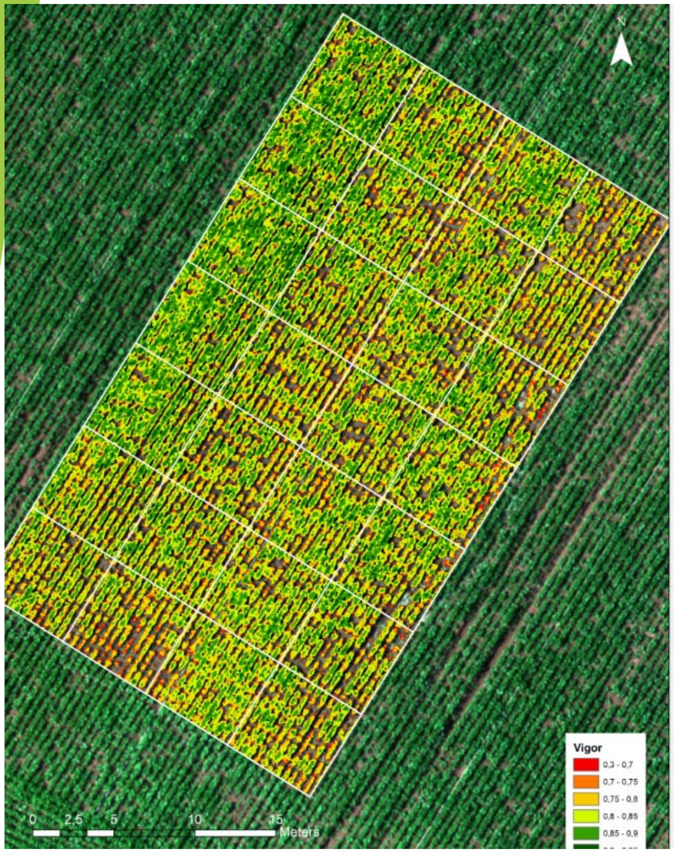
Es habitual emplear *L* = 0,5

SAVI

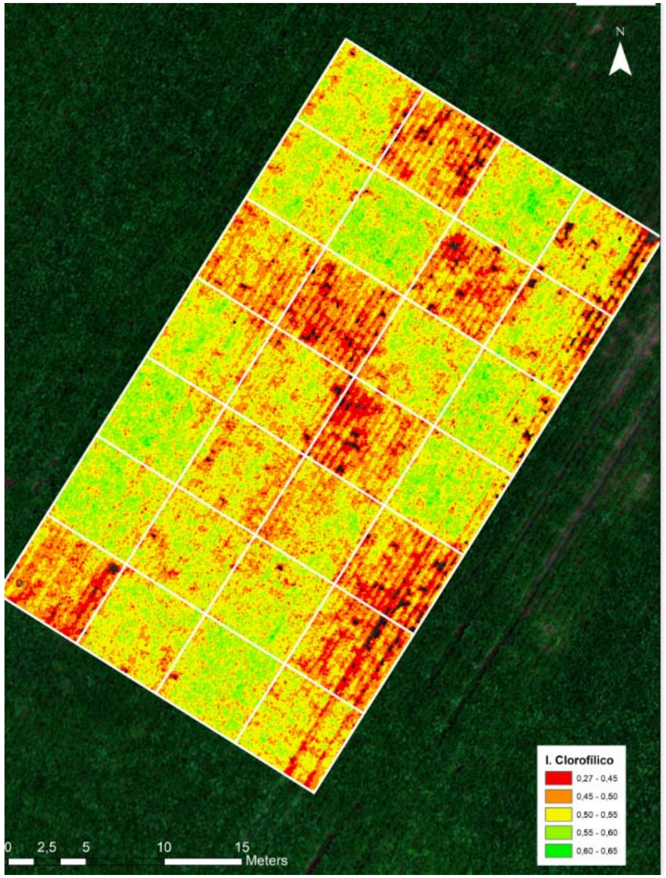
NDVI

Copyright: Contains modified Copernicus data/ESA

NDVI




Clorof. Index




Color RGB

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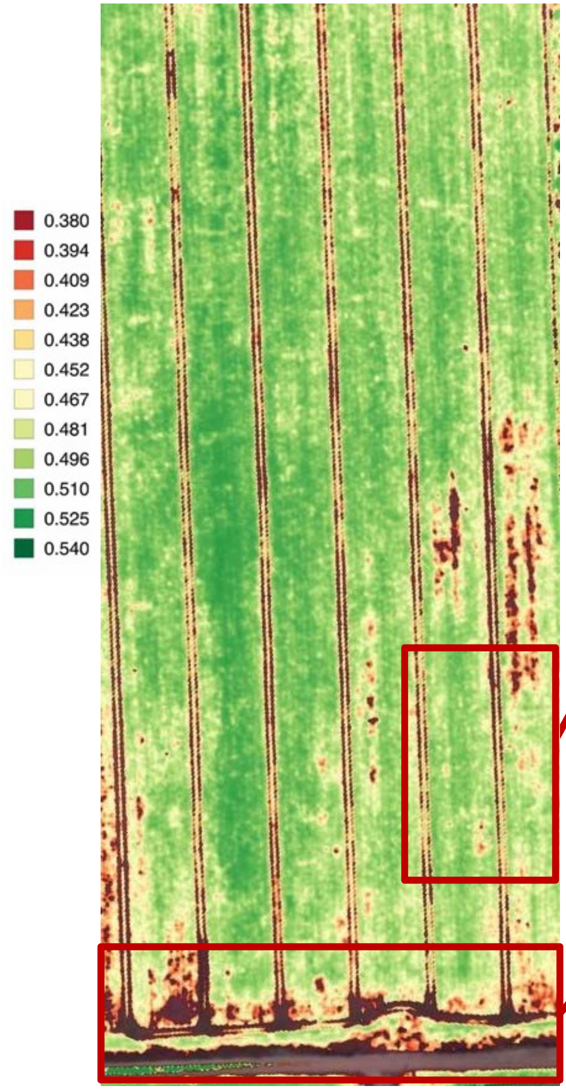
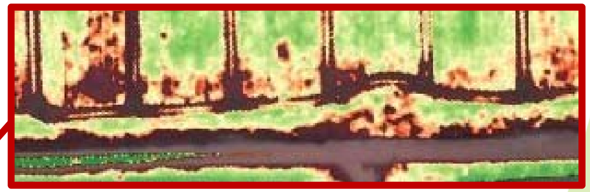
Spectralgeo




Tomate-Grecia

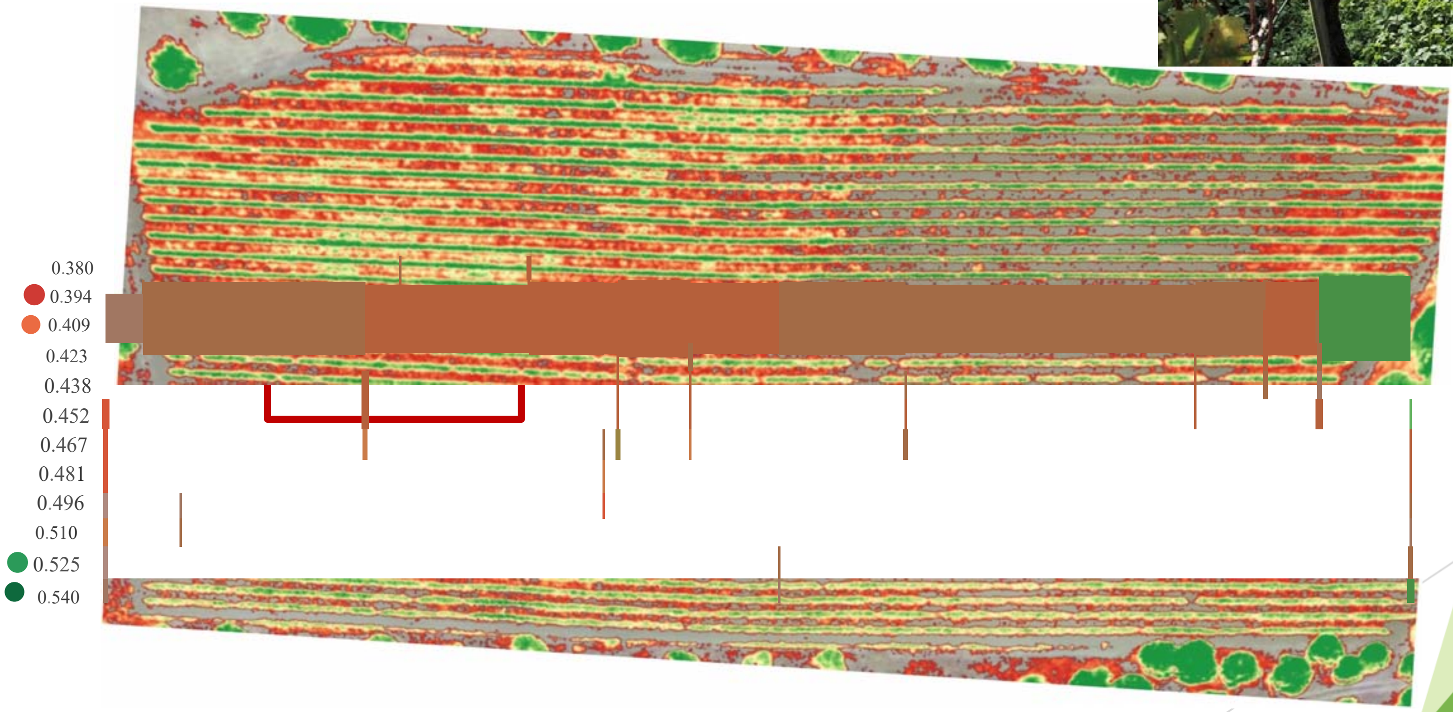
Development of a disease that would have been discovered much later by conventional means.



Subtle fluctuations in crop health, plants that have more dust on their leaves due to their proximity to the dirt road.

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

32 ha of vineyards: green zones: detection of weeds and diseased plants



# DRON

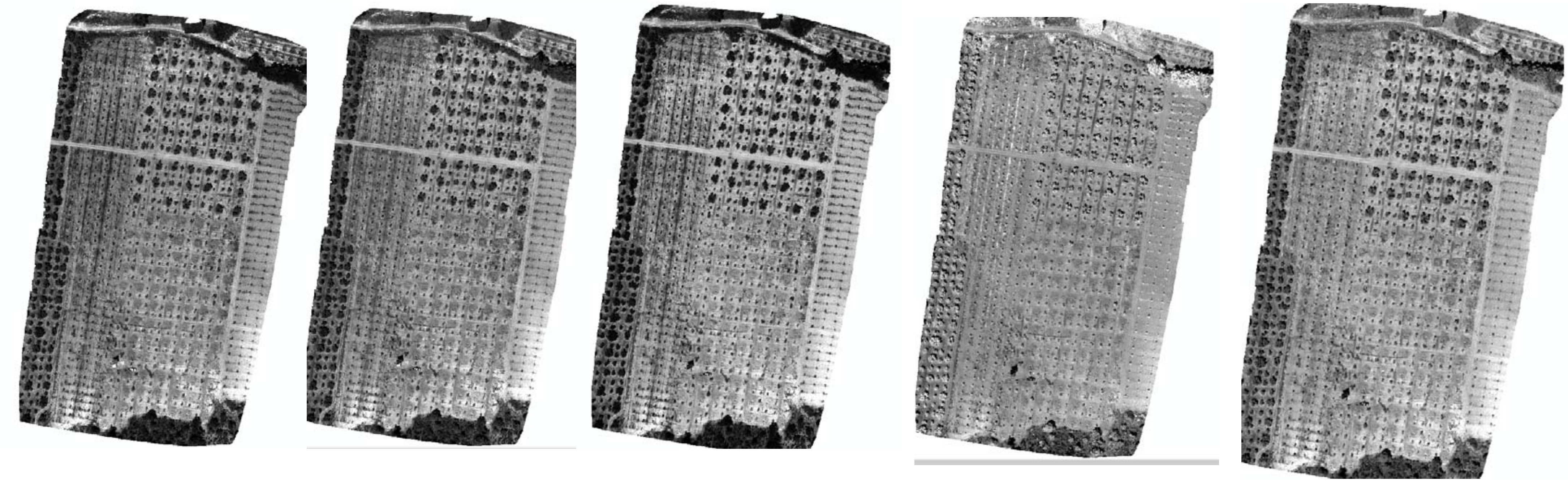
This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

# Results Flights over Olivos plot

## Reflectance maps

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

Blue Green Red NIR



## Results Flights over Olivos plot

**Reflectance maps**

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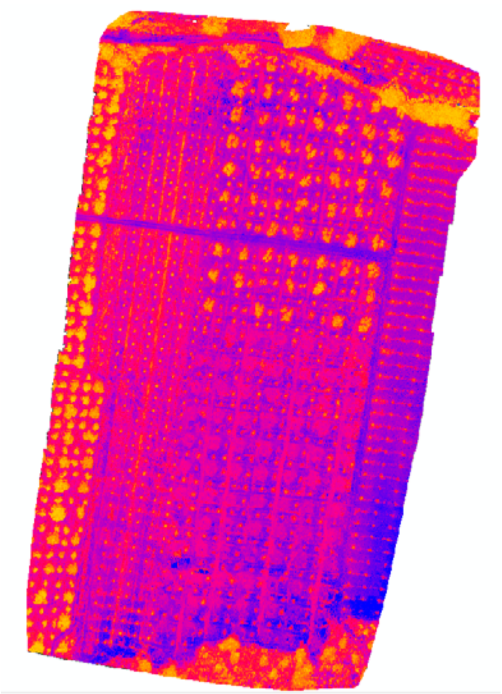
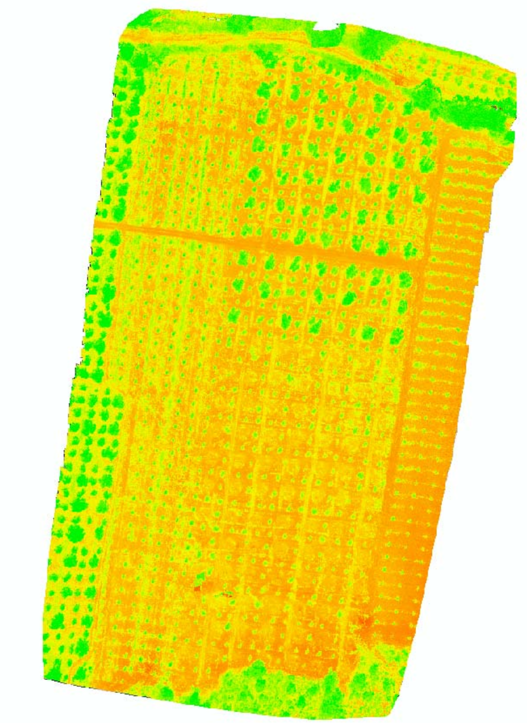
### NDWI



High : 0,115871

Low : -0,943801

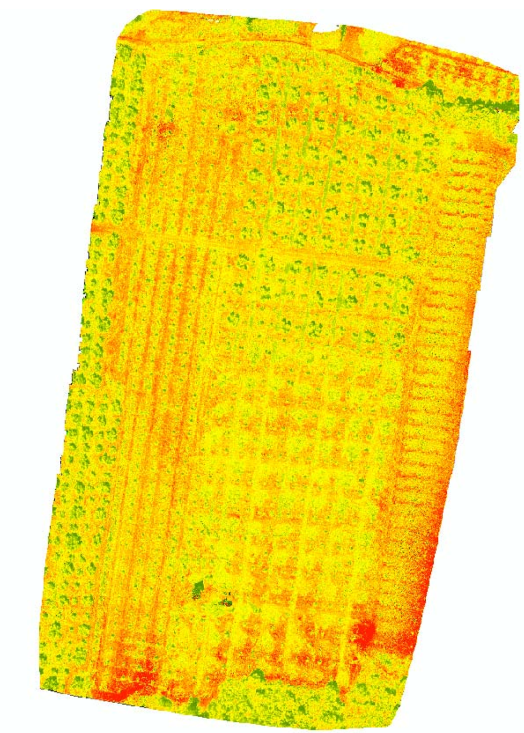
### NDRE



High : 0,914536

Low : -0,455112

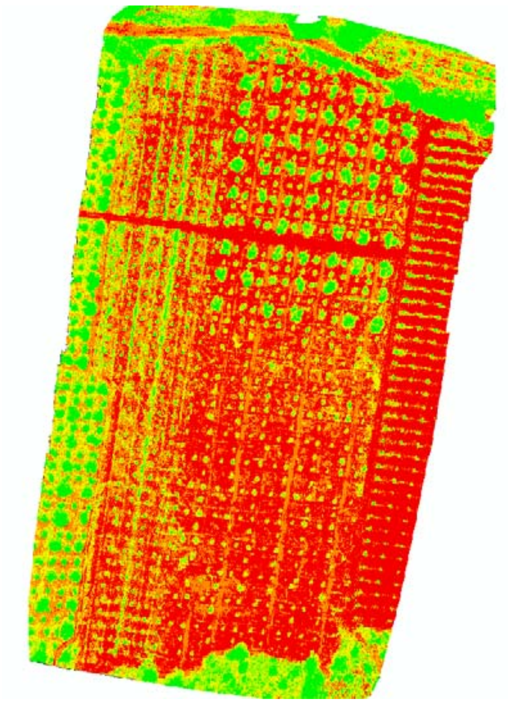
### TCARI/OSAVI



High : 44,3713

Low : -16,1554

### NDVI



-0,114861481 - 0,219092947
0,219092947 - 0,33322927
0,33322927 - 0,489638306
0,489638306 - 0,671410969
0,671410969 - 0,963092685

SPECTRALGEO

## Results Flights over Olivos plot

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

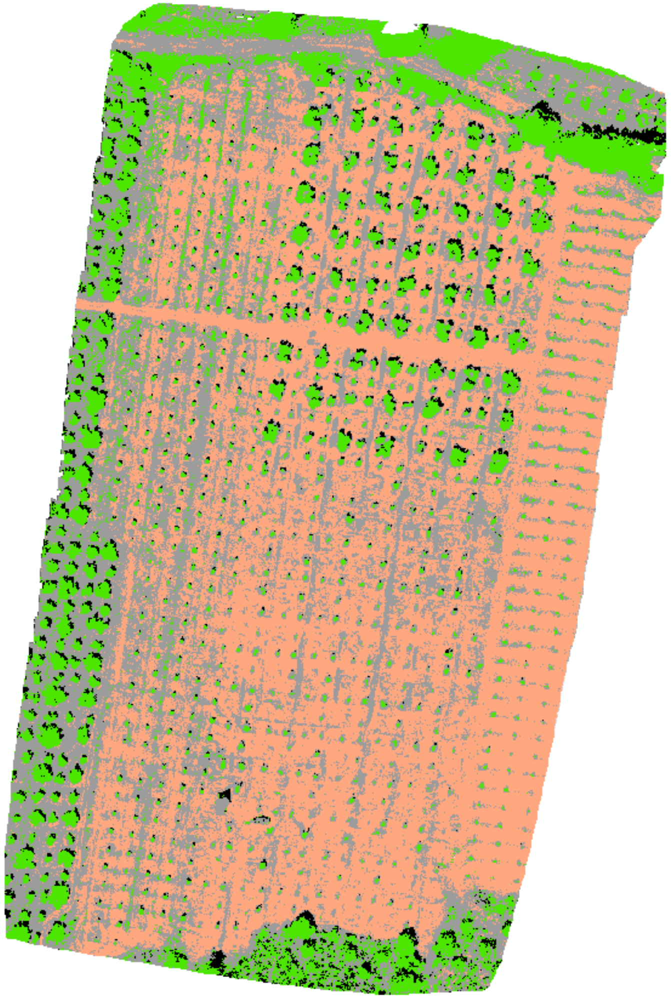
**Composición** RE-NIR-R

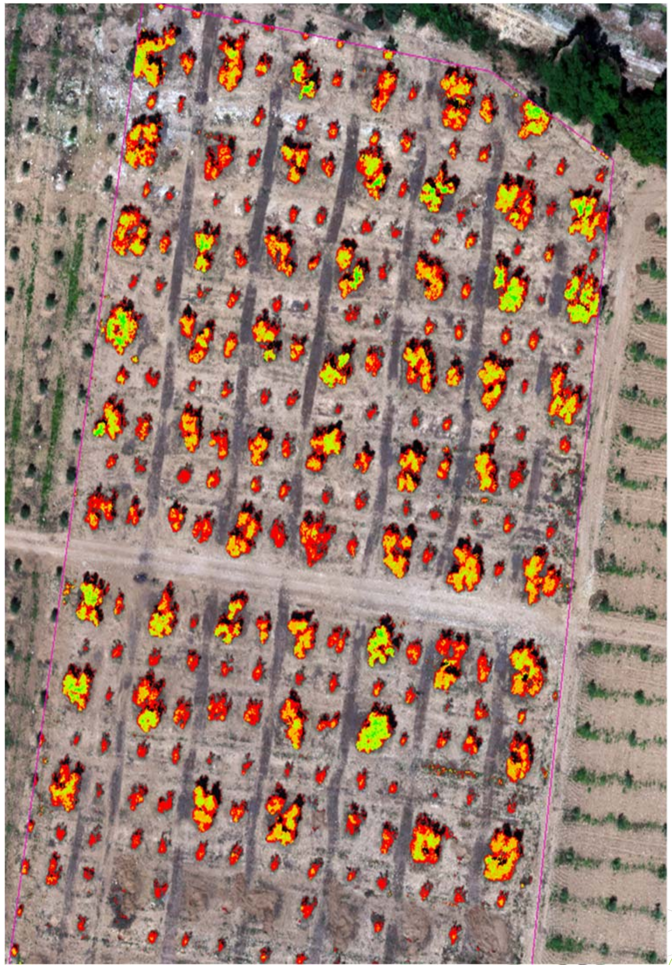
**Composición** R-G-B

**Sentinel-2**

SustAInable

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

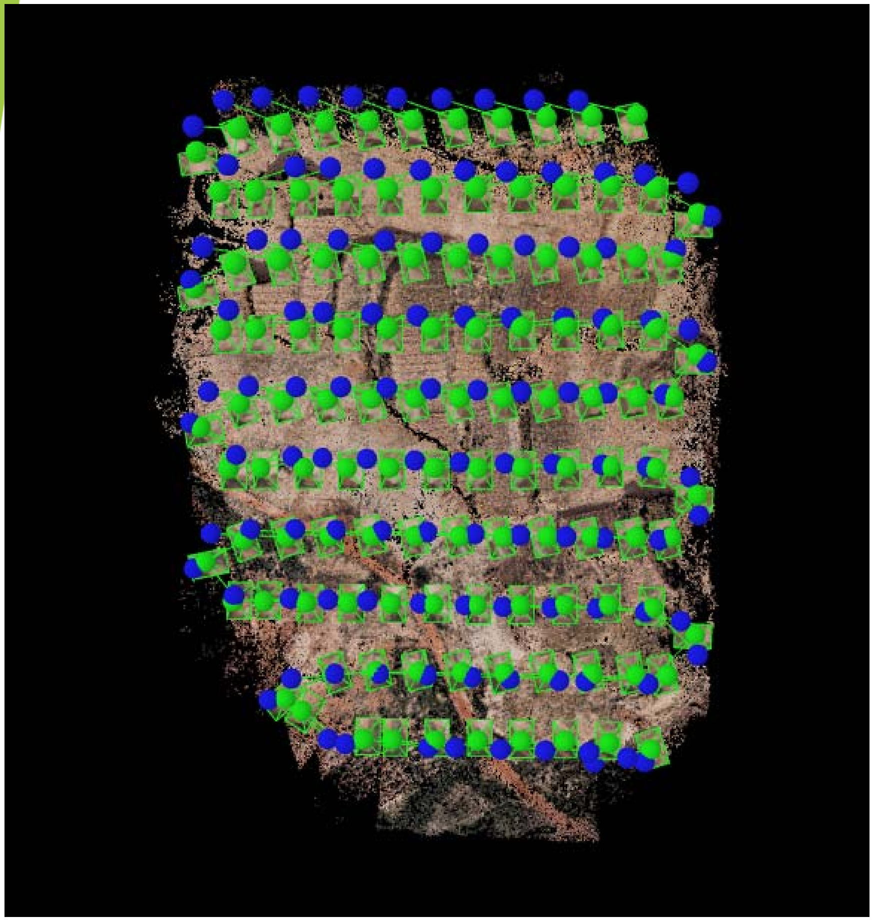


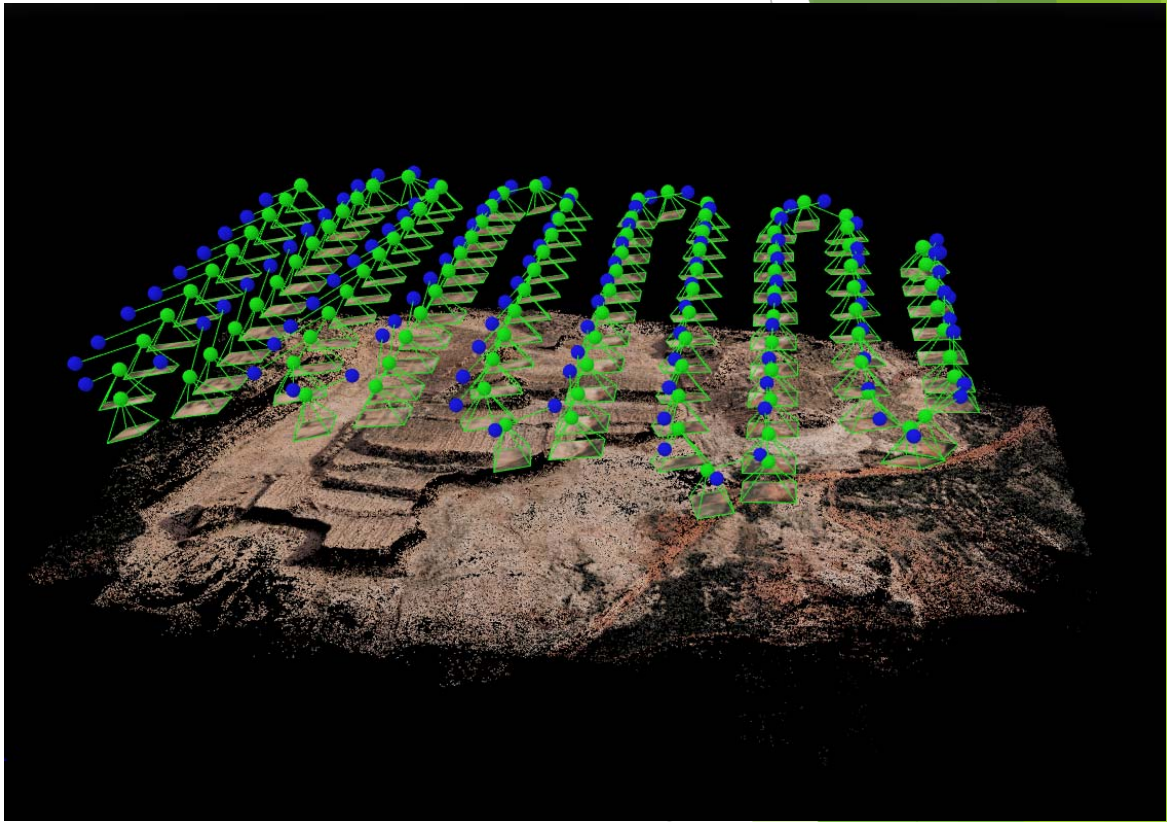


SPECTRALGEO

Procesamiento en Pix4D

Paso 1 – Resultado del Proceso inicial





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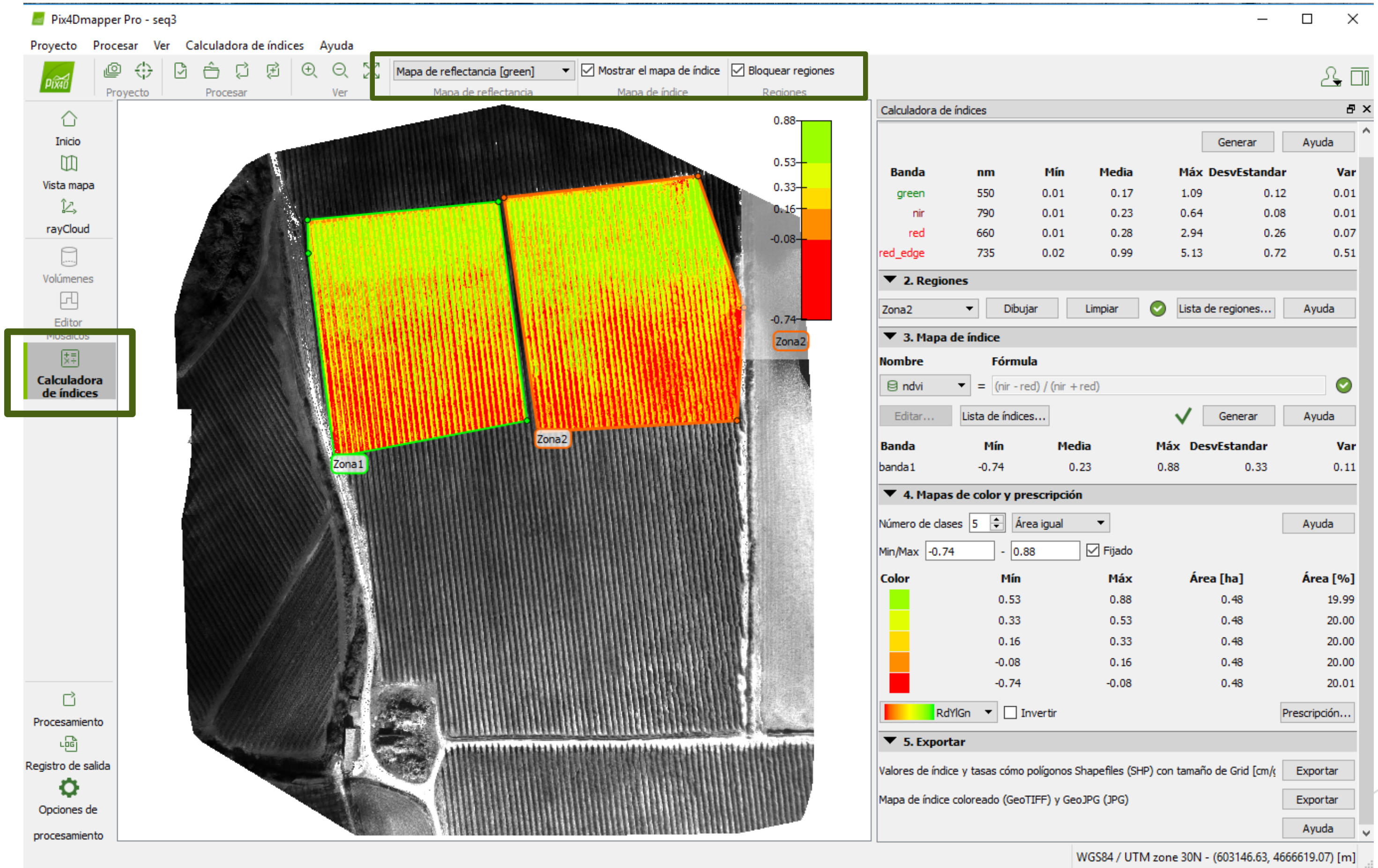
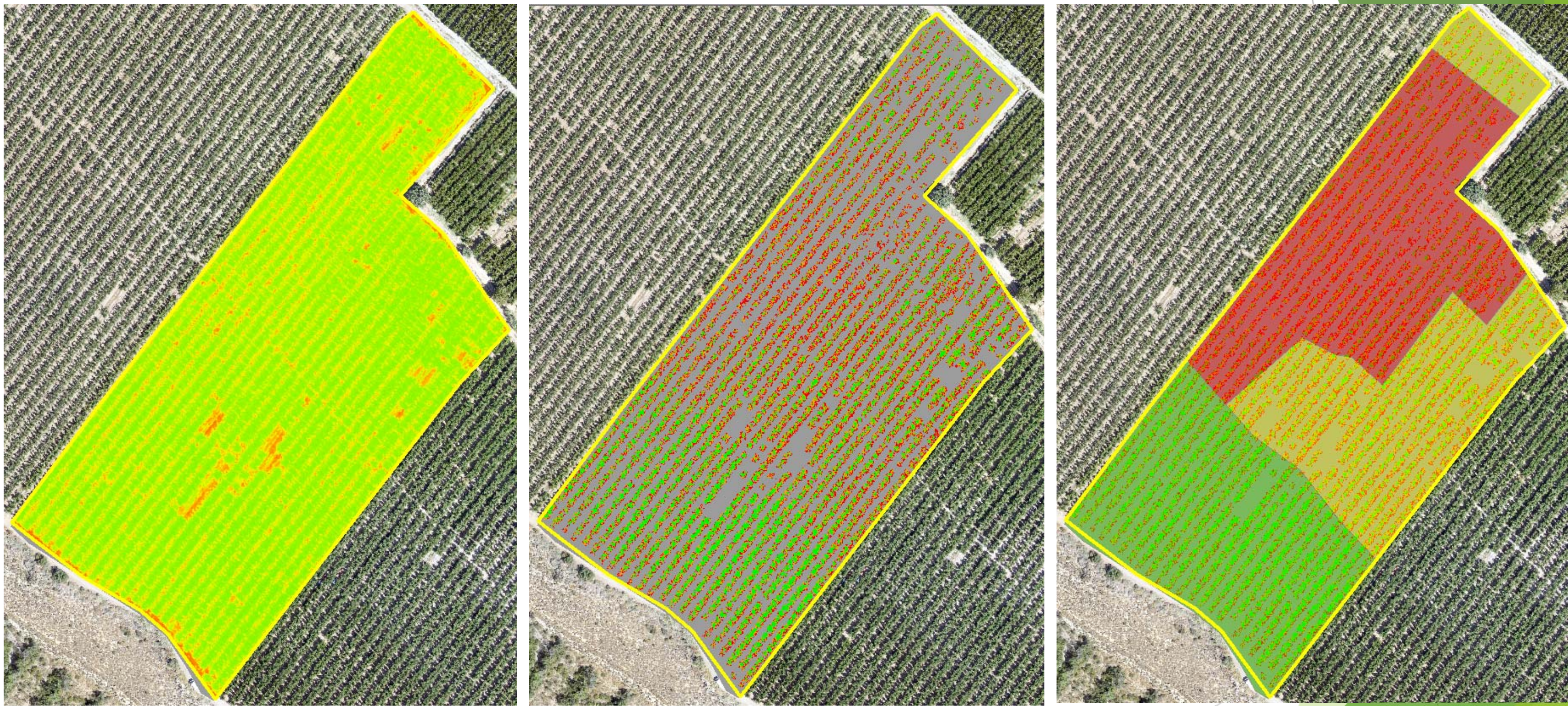
spectralgeo




This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

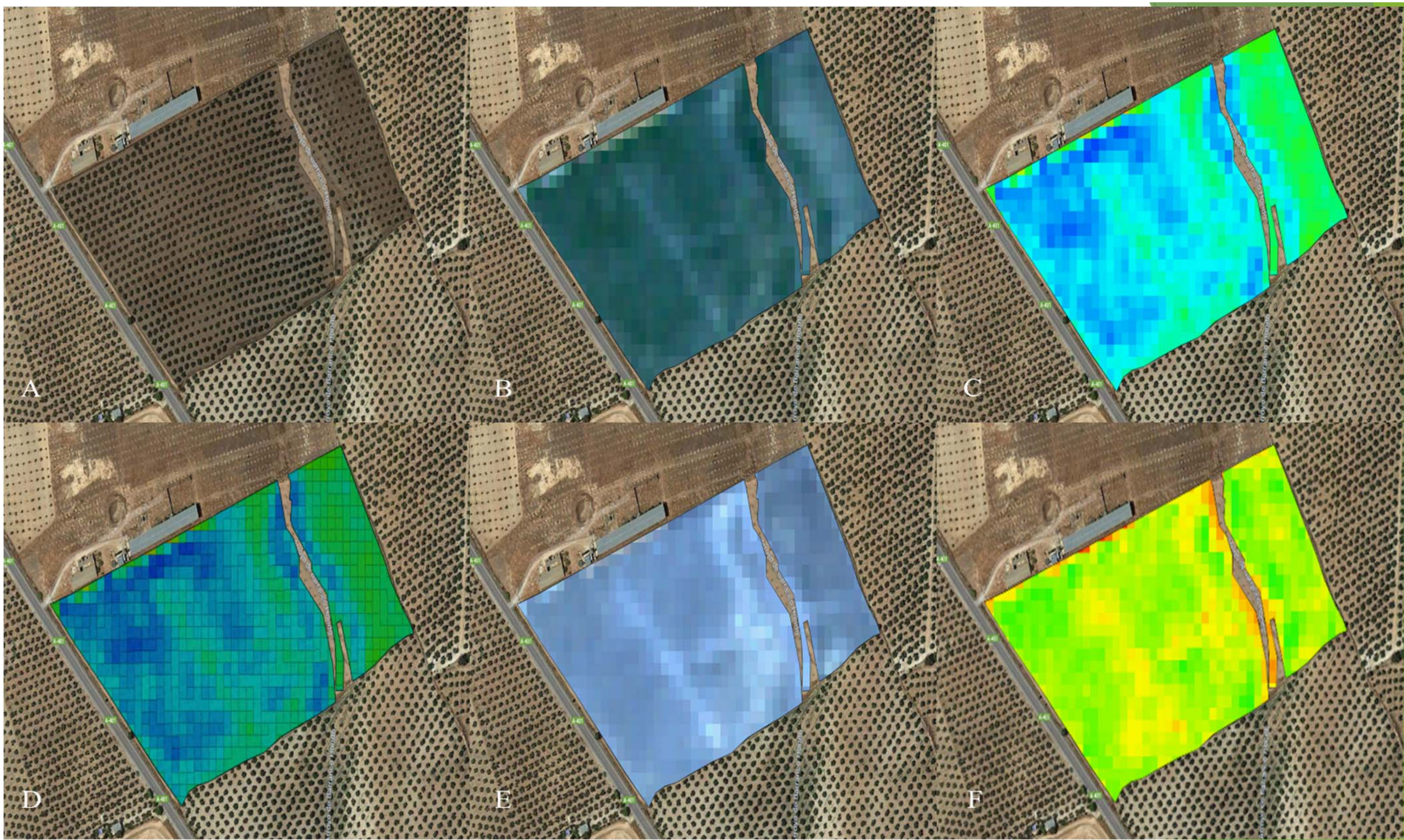
## Geographic Information System SIG

Visualisation, consultation, analysis, processing and cartographic output of the images obtained.



Generation of crop vegetative state maps.

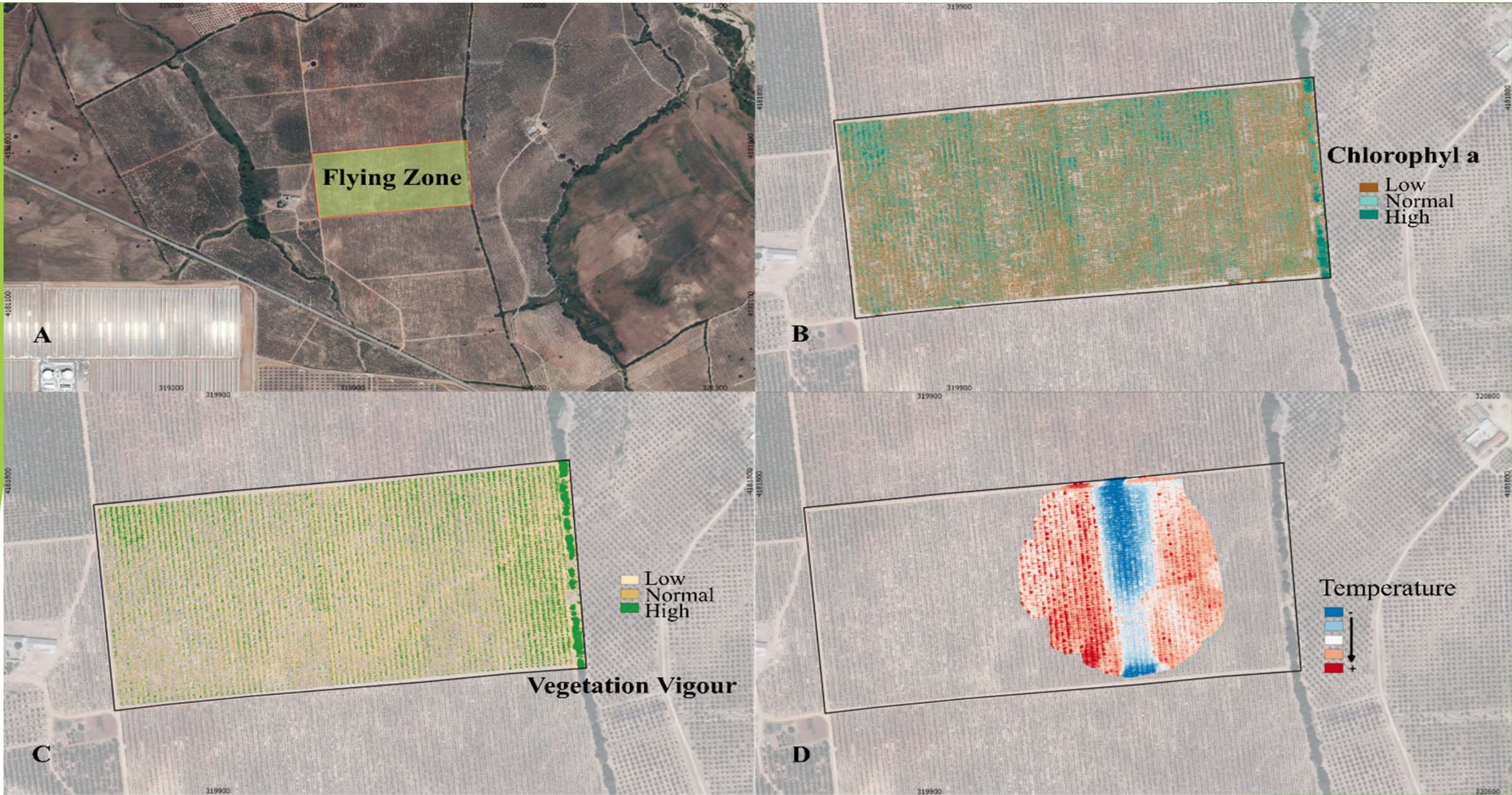
spectralgeo




Sentinel 2-Google Earth Engine (GEE)

A: Area de interes , B: RGB field , C: NDVI Raster Tile, D: NDVI Vector Tile, E: RGB , F: NDVI Raster Tile. Imagenes A, B, C y D del 02.02.2021, imagenes E y F cedidas el17.07.2020. (Images facilitadas por Graniot).

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.



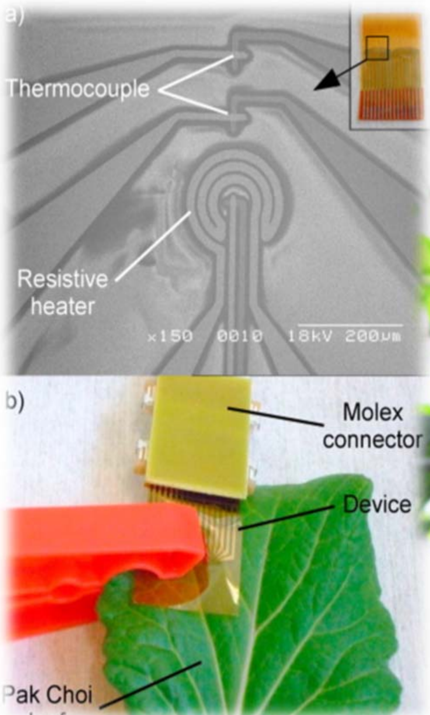

Indices de Vegetal ion (VIs) (A) Área de estudio. (B) Mapa de contenido Clorofila-NDRE. (C) Mapa NDVI. (D) mapa térmico. (Imagines facilitadas por MCBiodrone).

Dron

- Thickness probes

*Developed by Penn State University*

- Thermal sensors

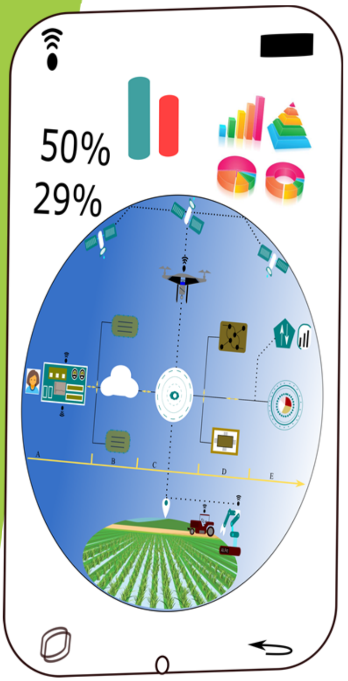



*Atherton et al., (2012)*

*Developed by Ghent University*

DSS o Decision Support System

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

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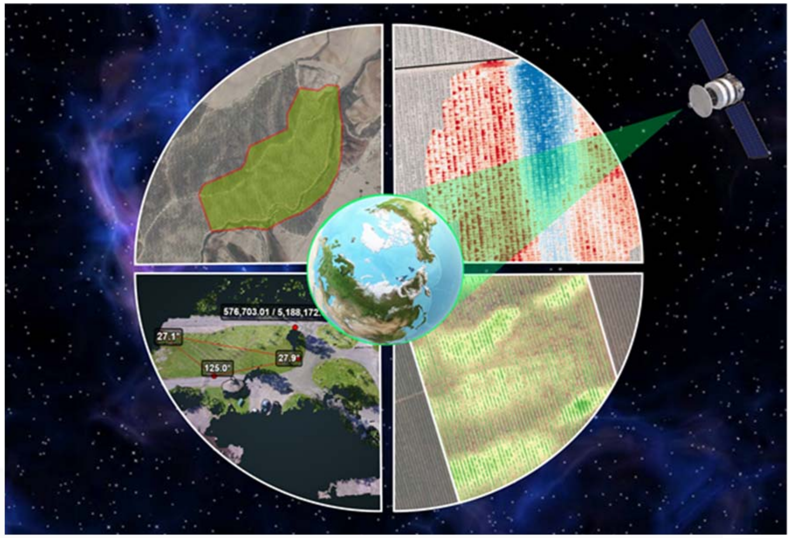
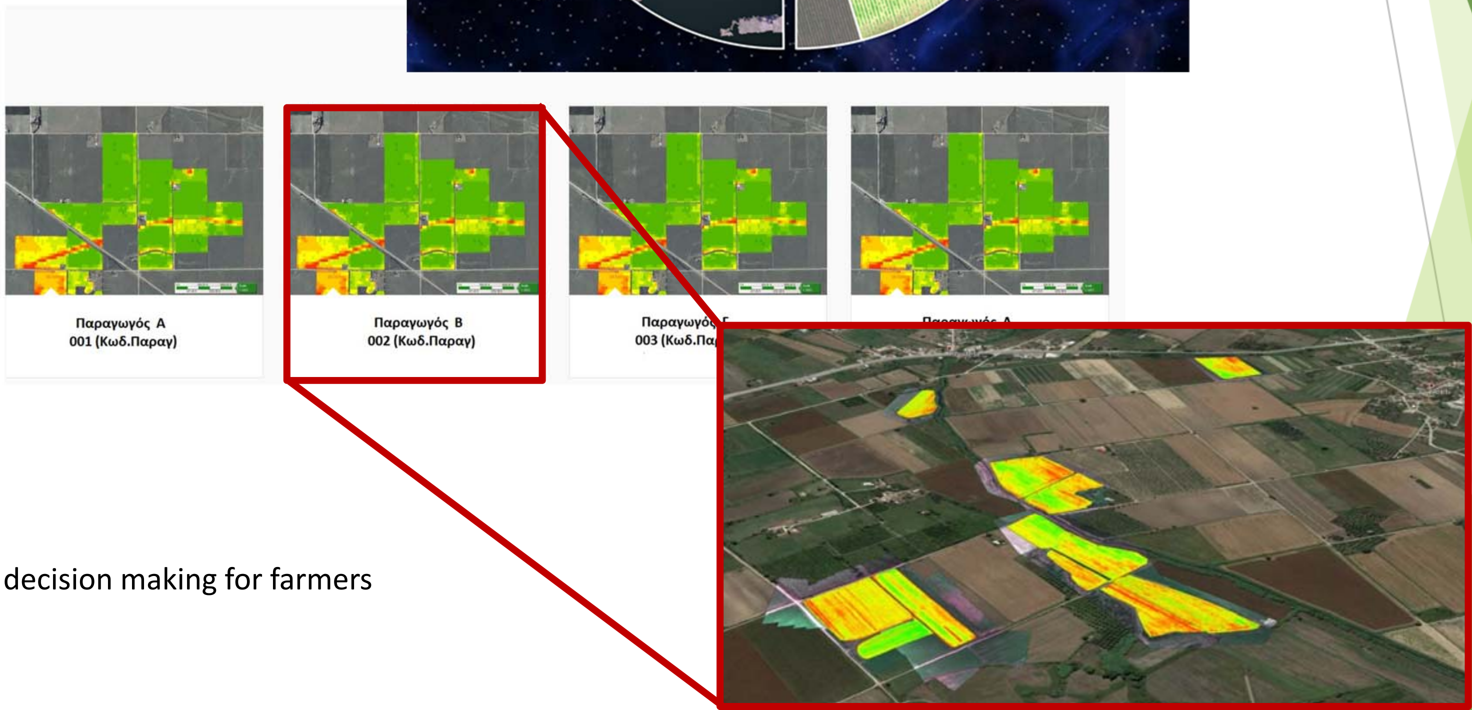
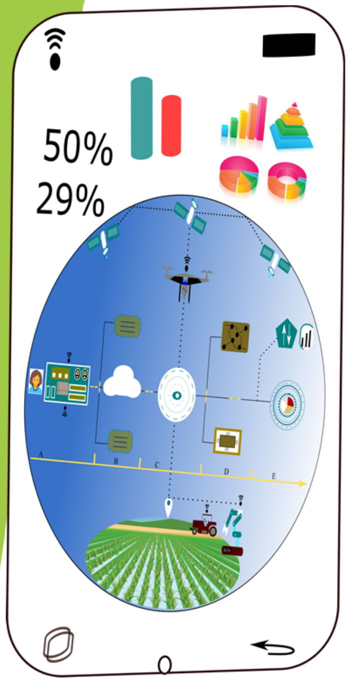





This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

Applications: Rapid decision making for farmers




**Applications: Rapid decision making for farmers:** (WP3 O.3.2)

- ✓ Designed an integrated dashboard that allows **agronomists to combine multiple sources of information**, such as satellite images, field sensor data, and weather forecasts.

- ✓ The fusion of these diverse data sources is valuable as it provides a comprehensive and **holistic view of the situation**, enabling more accurate analysis and informed decision-making.

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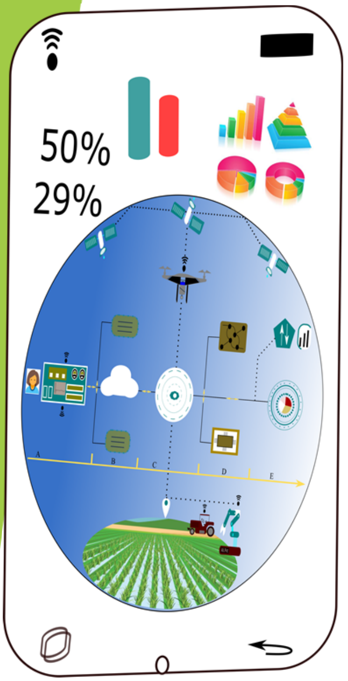
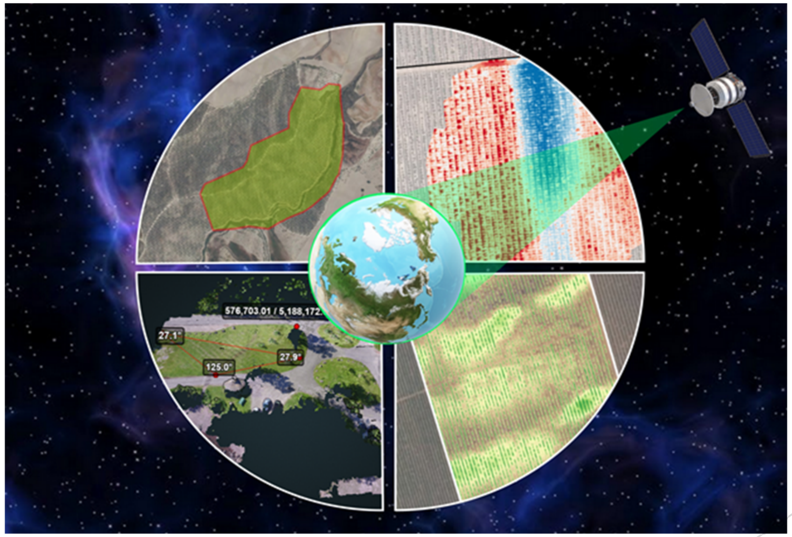



**Applications: Rapid decision making for farmers:** (WP3 O.3.2)

Additionally, we **gather information on fungal infections** to gain deeper insights, identify patterns, and respond proactively to potential issues, ultimately enhancing the efficiency and effectiveness of operations within the Olive oil spanish cooperative. To facilitate the incorporation of these manually obtained images and custom data.

We developed a Telegram bot that is both user-friendly and ready to use, effectively bridging the technological gap between data scientists and agronomists.



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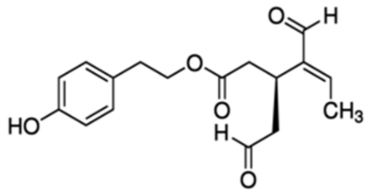
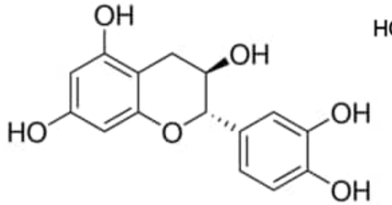
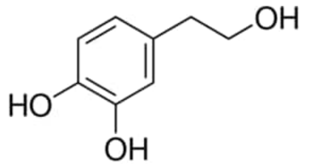
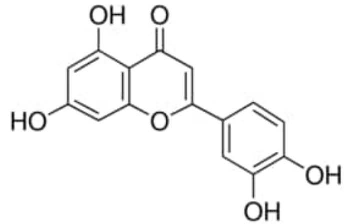
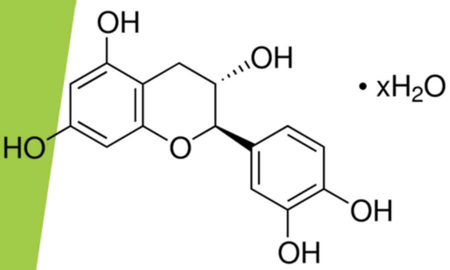
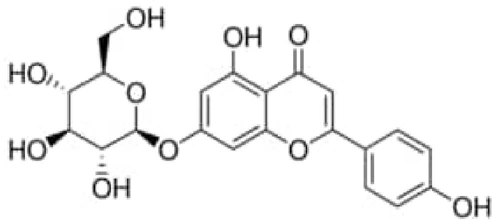
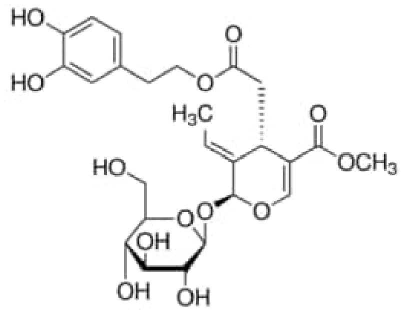
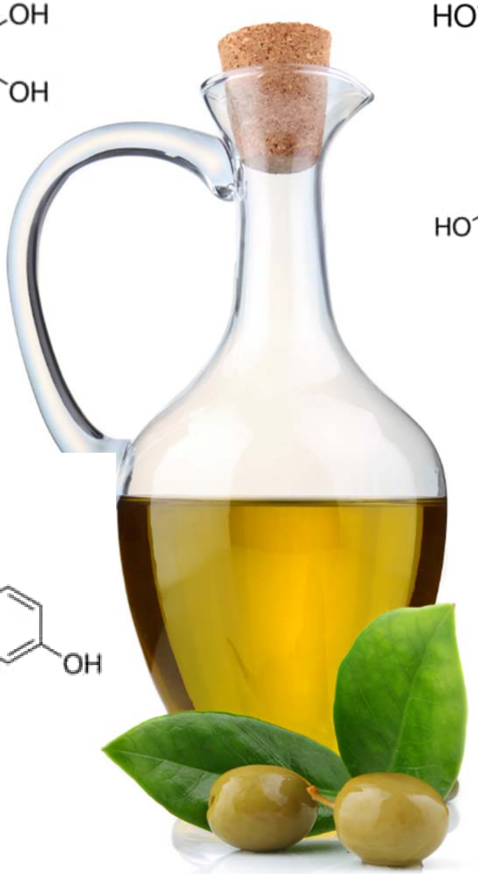
# OLIVE OIL CONTAINS HUNDREDS OF COMPOUNDS WITH ANTIOXIDANT ACTIVITY

Content of biophenols such as oleocanthal and oleocin, which are naturally present in the oil and are attributed with anti-inflammatory properties, so that their content gives extra value to extra virgin olive oil.

Currently, their determination involves tedious extraction processes before their determination by liquid chromatography, which involves a high expenditure of reagents and time.

We have developed a smart optical sensor that allows the determination of both biophenols in just 15 minutes using the development of a sensor in nanostructured paper.

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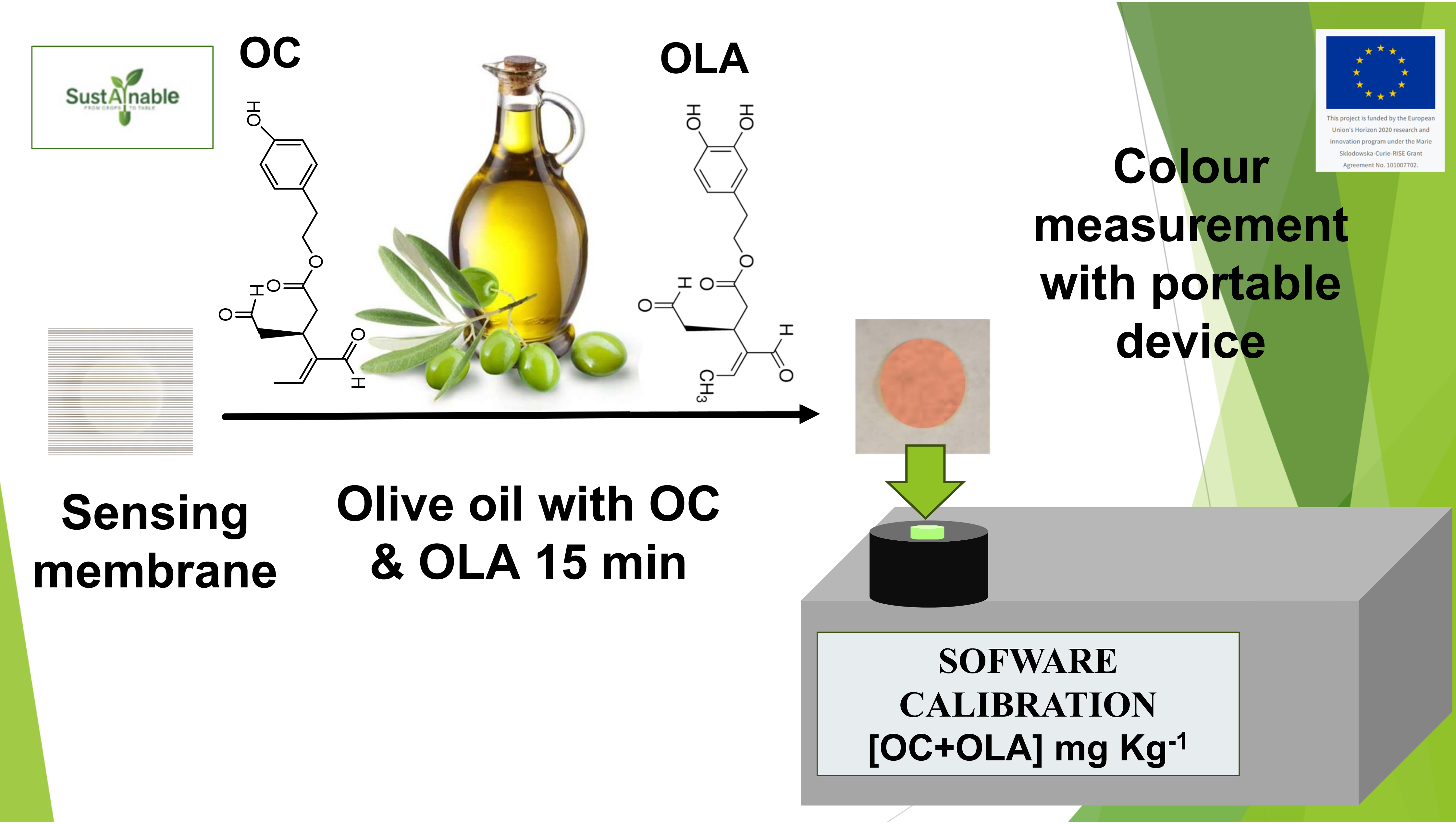
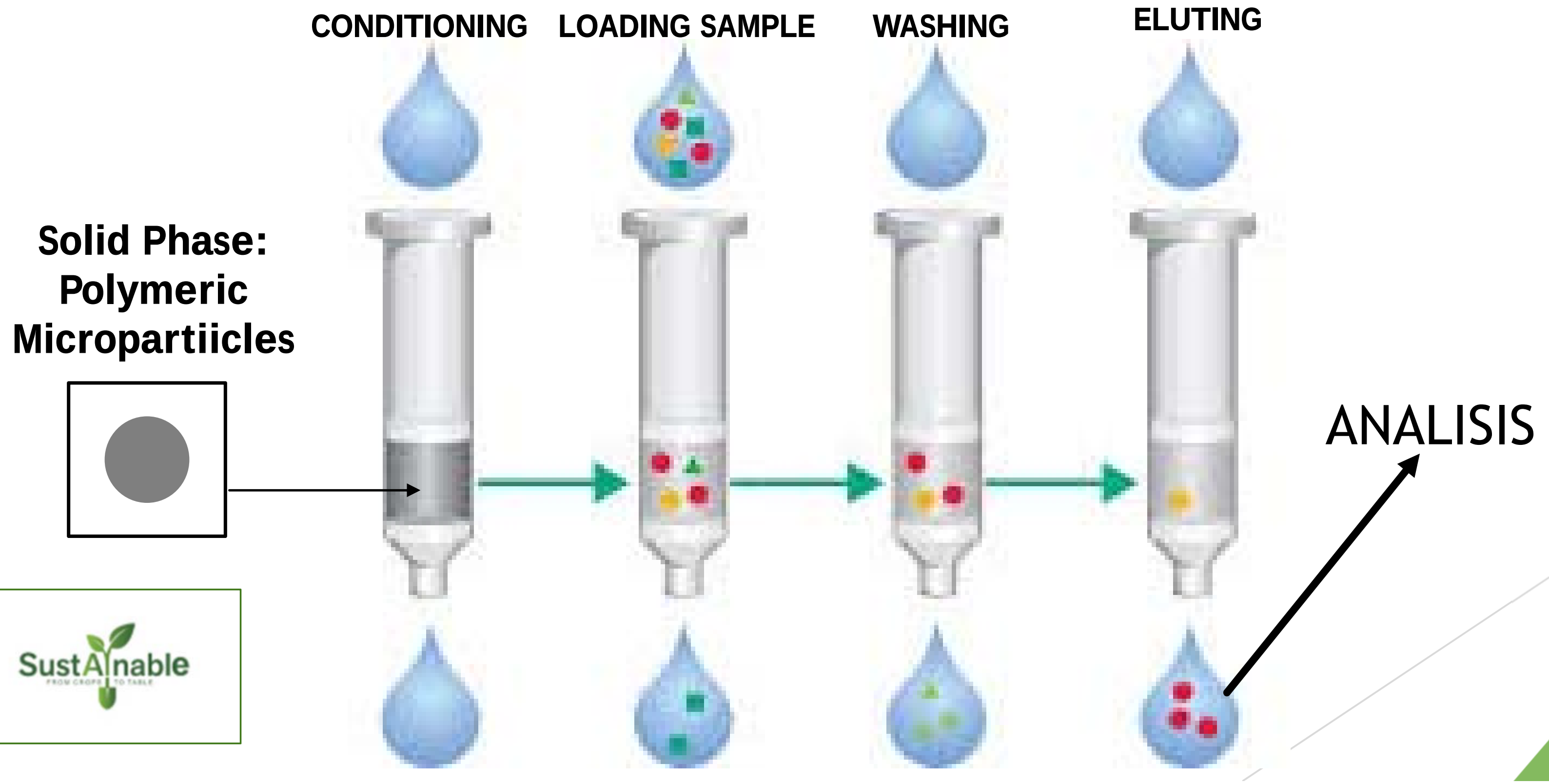

SustAInable
OC
OLA
This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.
Colour measurement with portable device
Sensing membrane
Olive oil with OC & OLA 15 min
SOFWARE CALIBRATION
[OC+OLA] mg Kg-1

**SOLID PHASE EXTRACTION (SPE) is a technique designed for rapid, selective sample preparation and purification prior to the chromatographic analysis** (e.g. HPLC, GC, TLC). In SPE, one or more analytes from a liquid sample are isolated by extracting, partitioning, and/or adsorbing onto a solid stationary phase.

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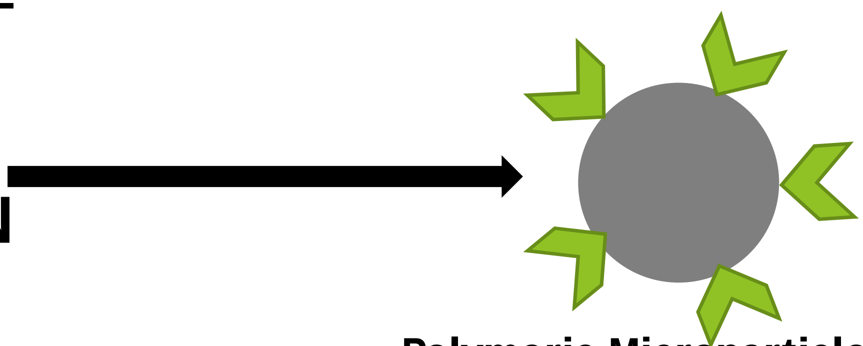
# OBJECTIVE: DESIGN AND SYNTHESYS OF MICROPARTICLES FOR THE SELECTIVE EXTRACTION AND PURIFICATION OF OLEOCANTHAL IN OLIVE OIL

This project is funded by the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie-RISE Grant Agreement No. 101007702.

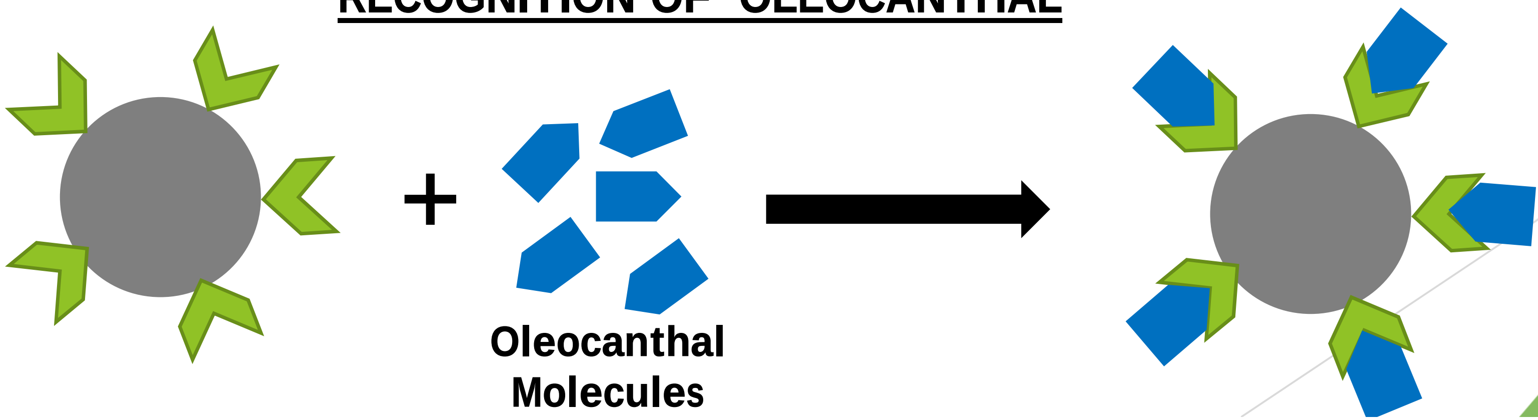
## 1) Synthesis of polymeric microparticles with specific receptors for oleocanthal:

**PRECIPITATION POLYMERIZATION**



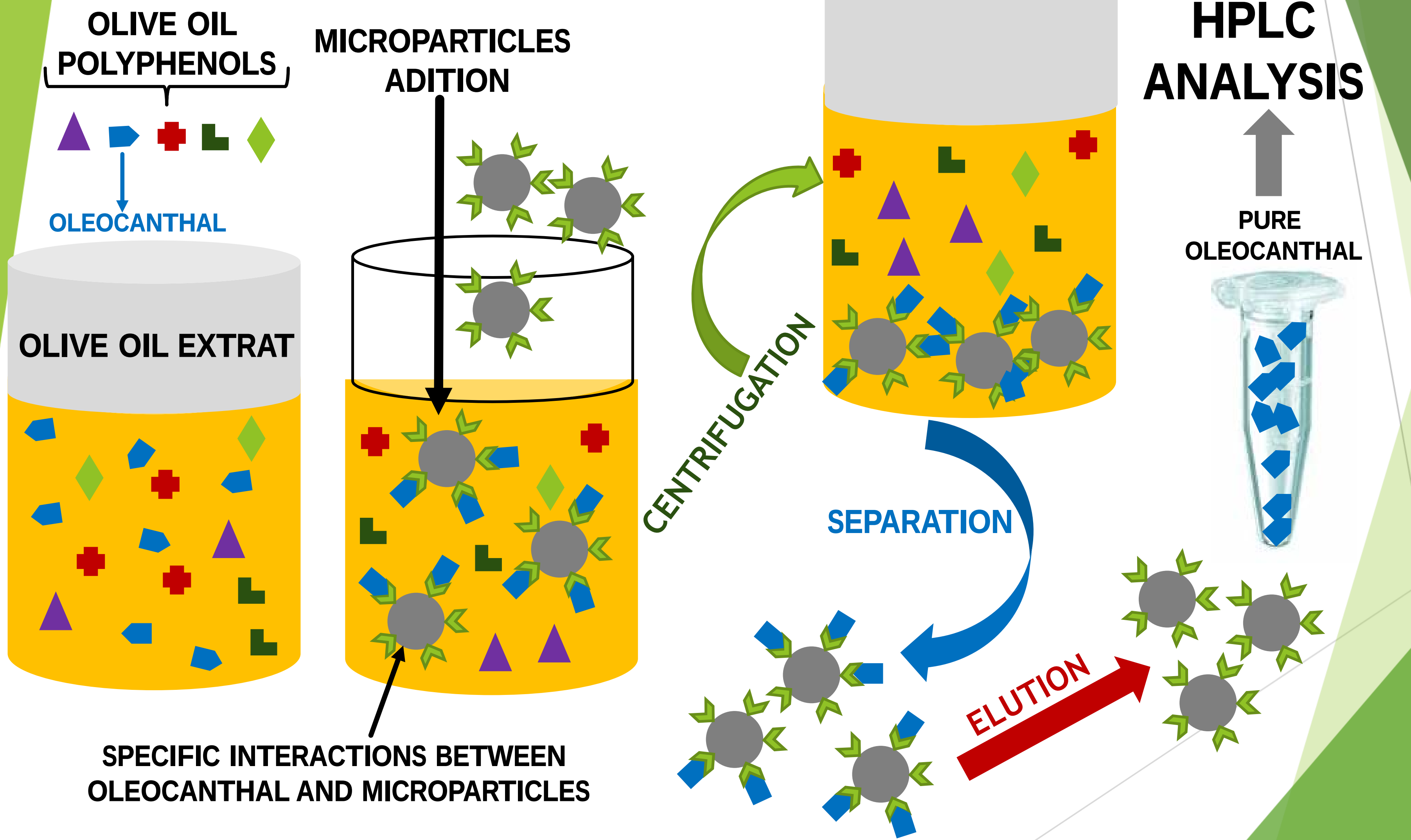
**Polymeric Microparticles with specific receptors for Oleocanthal**

### RECOGNITION OF OLEOCANTHAL



**Oleocanthal Molecules**

## 2) Application of the microparticles for Oleocanthal extraction and purification:

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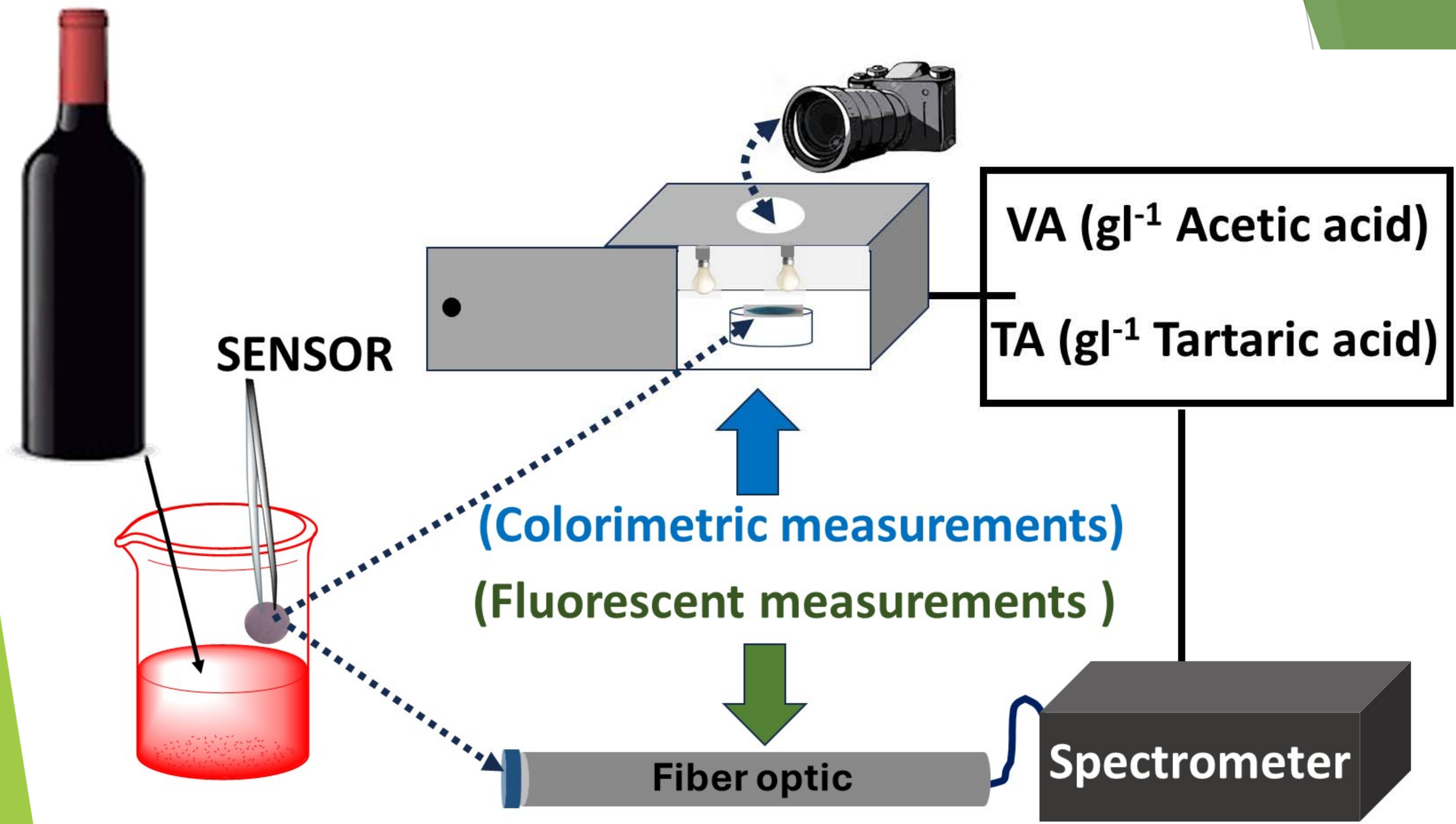
# OLIVE OIL CONTAINS HUNDREDS OF COMPOUNDS WITH ANTIOXIDANT ACTIVITY

The high consumption of expensive and polluting reagents and the use of tedious reactions with long analysis times are key problems in quantifying total (TA) in vinegar and wine and volatile acidity (VA) in wine by official methods (titration with sodium hydroxide and the enzymatic method).

We have exploited the advantages of othe optically responsive paper-membrane (Paper- FM) to perform the dual simultaneous determination of TA and VA in vinegar and wine.
This new method was applied to different and numerous samples of vinegar and wine from different sorts.

The results were successfully validated using official reference methods (titration with sodium hydroxide and enzymatic method) in an accredited laboratory, demonstrate that optical sensing technology enables direct, simple, reversible, reusable, fast, cost-effective, and environmentally friendly simultaneous dual quantification (fluorescent and colorimetric) of TA and VA in vinegar and wine samples without the use of additional reagents.

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9 FgTech srl IT
10 Universitas Muhammadiyah Pontianak ID
11 UNIVERSITA DEGLI STUDI DI PALERMO IT
12 Saeio Global ltd NG
13 Gaia Robotics Idiotiki Kefalaiouchiki Etaireia EL
14 Fisheries Department, Lagos State University, Lagos Nigeria NG
15 Association de Sauvegarde de Matmata TN

Validar sistemas de IA de última generación como sistema de apoyo a la toma de decisiones, sobre una base económica y técnica sólida, para procedimientos de gestión de la AP adecuados a las condiciones climáticas, geográficas y medioambientales específicas.


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MARIE CURIE ACTIONS

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3 Panel de Cata de la UGR
4 Tecnologías Avanzadas de Producción y Formulación de Biofertilizantes
5 **BIOTECNOLOGÍA Y ECOFISIOLOGÍA DE CULTIVOS Y PLANTAS DE INTERES ECOLÓGICO", integrado en el Instituto Andaluz de Biotecnología**
6 AgriDecision IT
7 Cuckoo Fruit Ba
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Vanessa M. Martos Núñez
Thank you very much for your attention
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