EUROGEO WORKSHOP 2023

Earth observation data for sustainable practices in viticulture

Federico Oldani
Tommaso Monopoli
Ernesto Bastidas
Rosa Araujo

FONDAZIONE links PASSION FOR INNOVATION

eleaf SPACE FOR GROWTH

eurecat

VITIGEOSS

BOLZANO 2-4 OCTOBER 2023

eurac research

Institute of Atmospheric Pollution Research
National Research Council of Italy

European Commission

Agenda

- Welcome
- Earth Observations for agriculture
- Introduction to VitiGEOSS project
- Earth Observations in VitiGEOSS
- Data in action
- Participatory activity & Discussion

VITIGEOSS

EUROGEO WORKSHOP 2023

Speakers

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AI Applied Researcher,
LINKS Foundation

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AI Applied Researcher,
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Project and Business Manager, **eLEAF**

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Eurecat

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Science Communicator,
Barcelona Supercomputing Center *(online moderation)*

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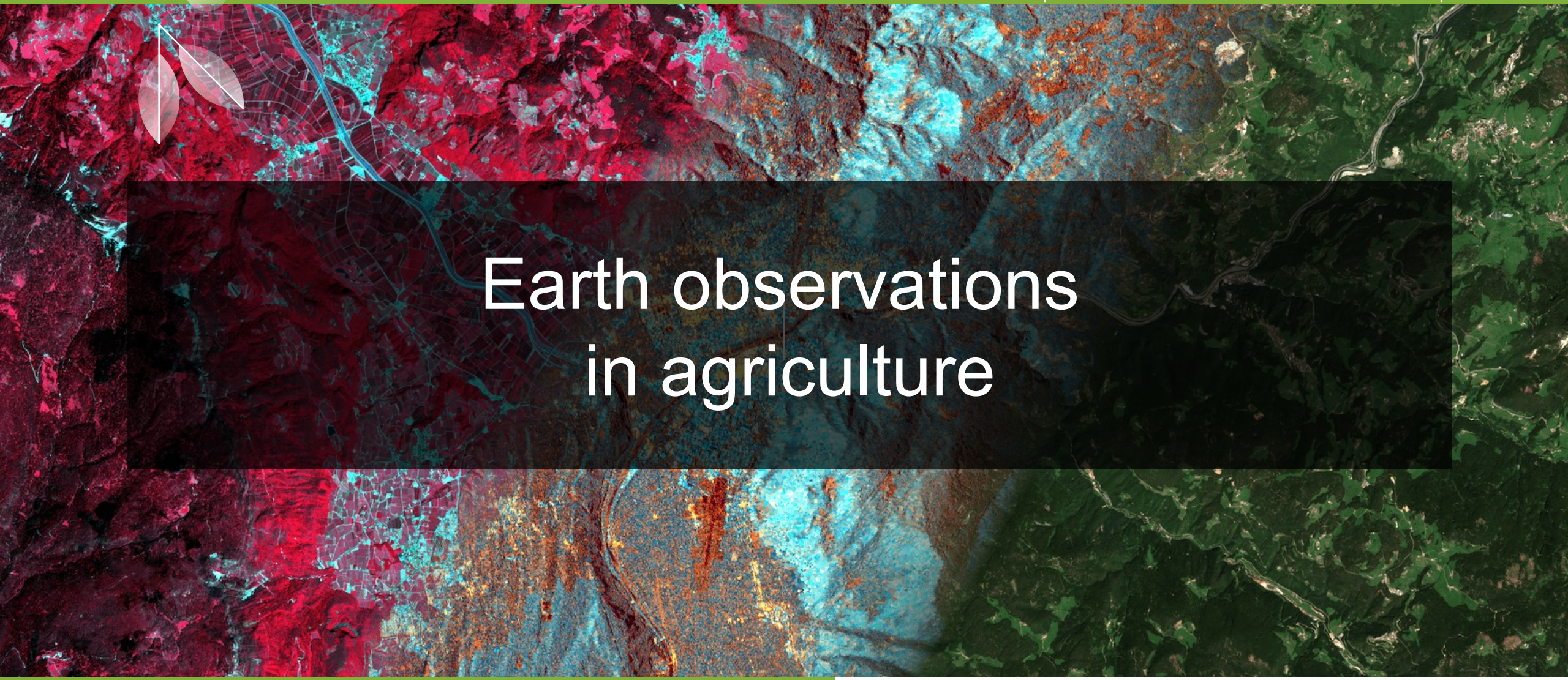

Earth observations in agriculture

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Land productivity [kg/ha]

Water productivity [kg/m^3]

Water Productivity

European Green Deal

Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, the European Green Deal will transform the EU into a modern, resource efficient and competitive economy, ensuring:

- no net emissions of greenhouse gases by 2050
- economic growth decoupled from resource use
- no person and no place left behind

The EU's goals are:

- to ensure food security in the face of climate change and biodiversity loss
- reduce the environmental and climate footprint of the EU food system
- strengthen the EU food system's resilience
- **lead a global transition** towards competitive sustainability from farm to fork

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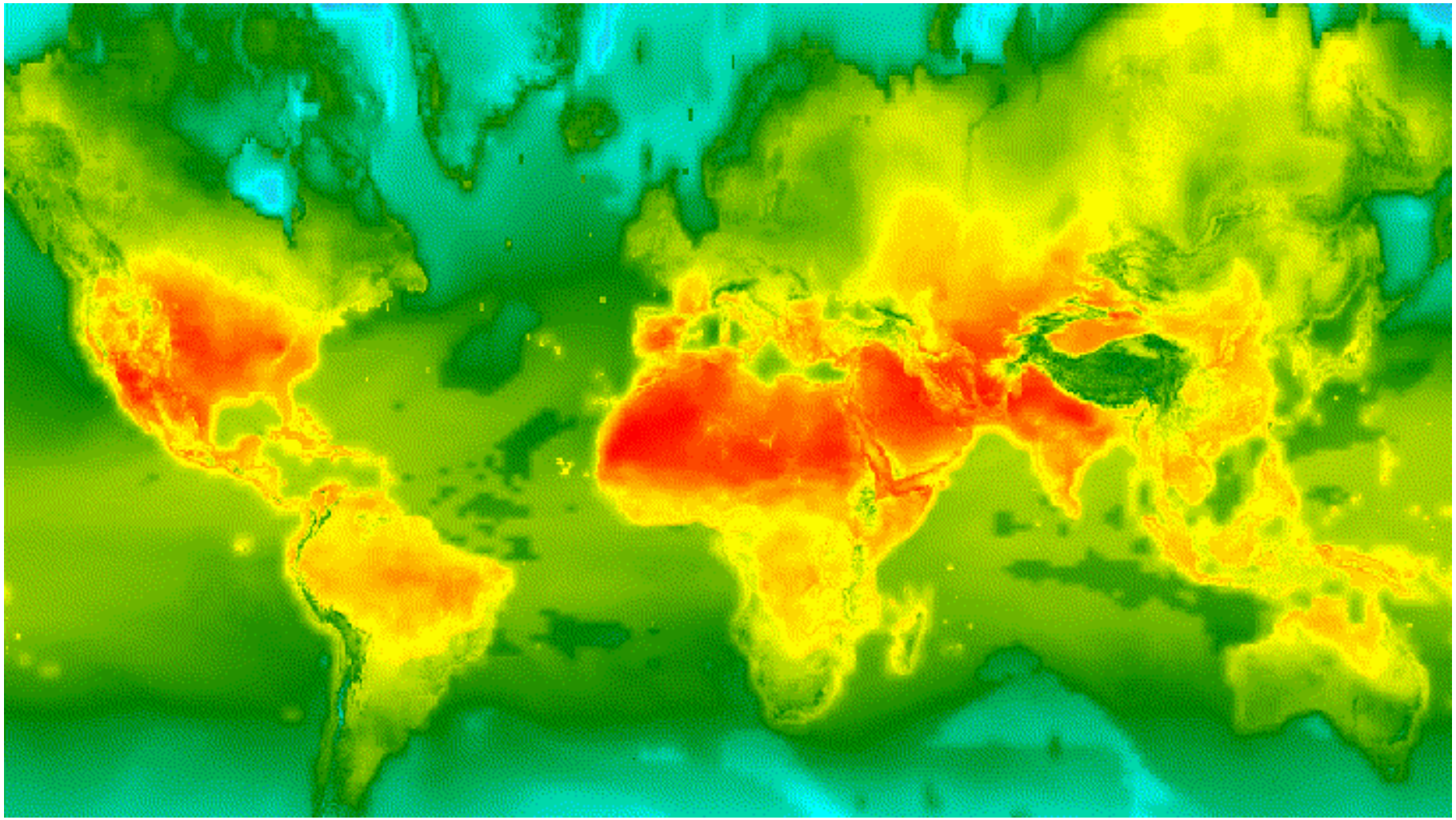


Source Google Earth Engine - ERA 5, 2m air temperature

Monitor / halt deforestation

GLOBAL FOREST WATCH

MAP DASHBOARD HELP ABOUT BLOG OTHER TOOLS ENGLISH

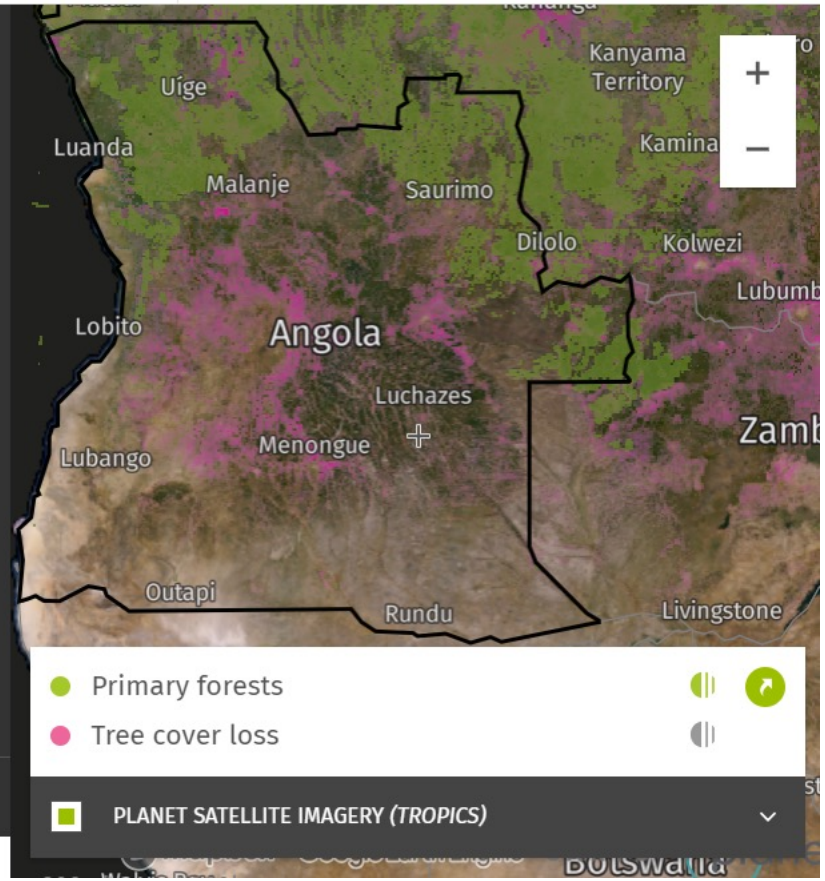
SHARE DASHBOARD

Angola

Select a region

In 2010, **Angola** had **53.8 Mha** of tree cover, extending over **43%** of its land area. In **2022**, it lost **267 kha** of tree cover, equivalent to **103 Mt** of CO_2 emissions.

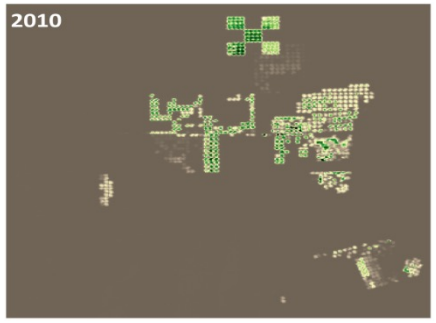
SUMMARY LAND COVER FOREST CHANGE LAND USE FIRES CLIMATE

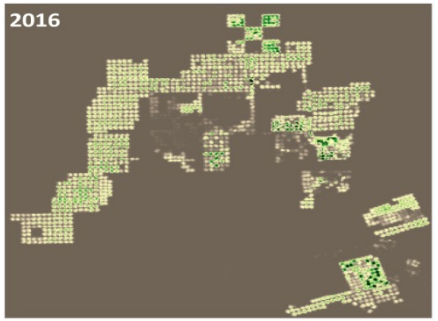


Reduce carbon emissions

- Change in biomass production
- land use change detection
- Agricultural inputs
- Decarbonisation

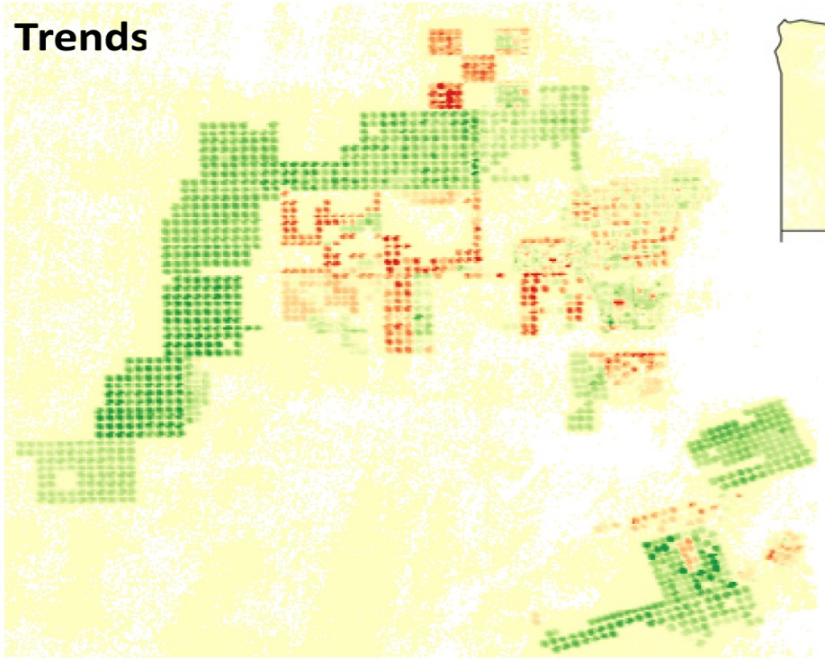
Image credit: petrmalinak

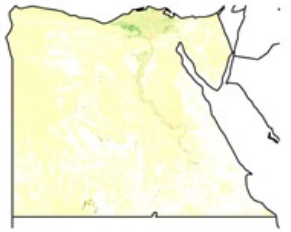




Biomass production (kg/ha/year)

0
1500
3000
4500
6000
7500
9000





Biomass production trends 2010-2016 (kg/ha/year)

-1000 (strong decrease)
-500 (decrease)
0 (no trend)
500 (increase)
1000 (strong increase)

Inputs

Satellite data

Solar radiation

NDVI ('greenness')

Surface albedo

Land surface temperature

Meteorological data

Air temperature

Relative humidity

Wind speed

Transmissivity

Static inputs

Physical constants

Crop model parameters

Model

Photosynthetically active radiation

Light use efficiency, f_{PAR} *Plant species dependent*

Potential biomass production

Radiation stress *Damage from radiation*

Temperature stress *Too cold or hot*

Humidity stress *Vapor pressure too low*

Moisture stress *No sufficient soil moisture in root zone*

Biomass production

Partitioning model *Isolate above ground dry matter, stalk*

Stalk dry matter

Summed over time *Incorporating thermal threshold*

YIELD

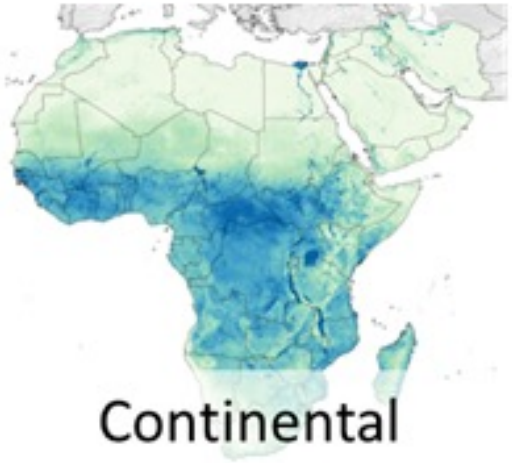
Water Consumption

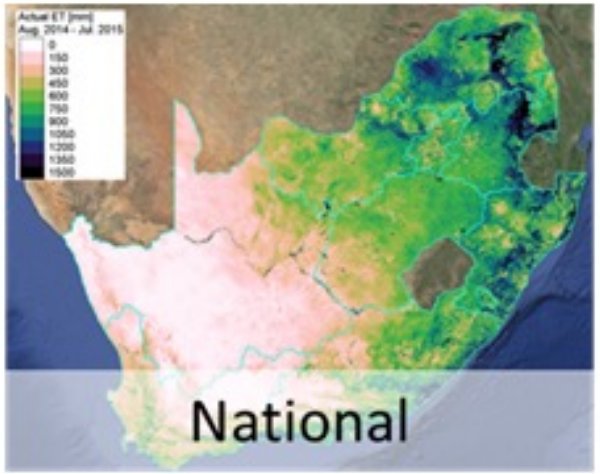
Evapotranspiration (ET)

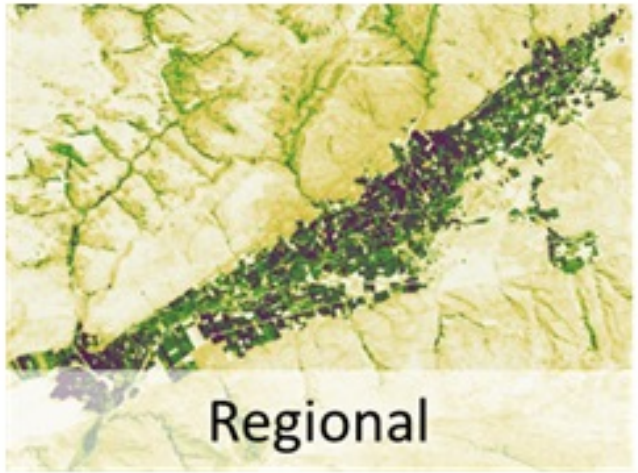
mm/day

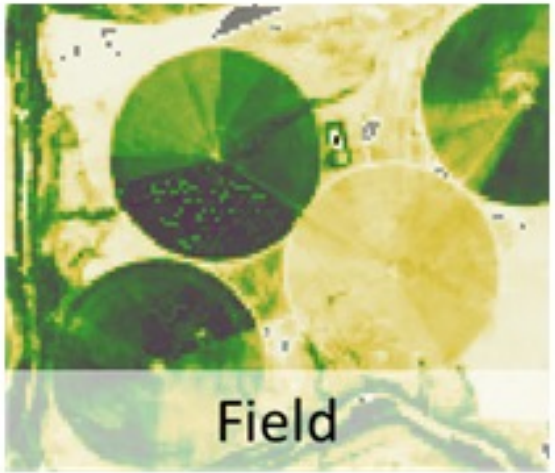
Plant Biomass Production

kg/ha/day







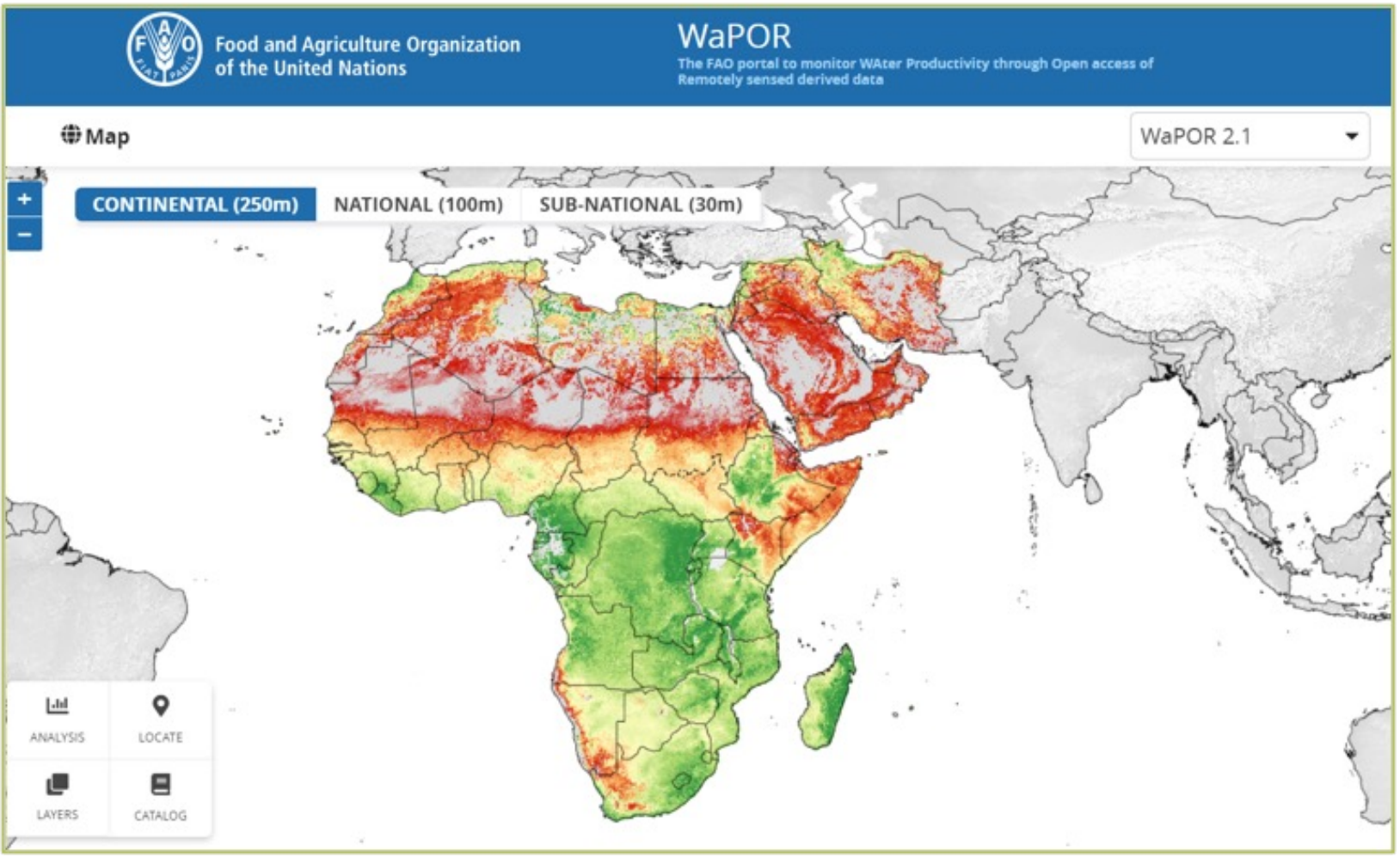


Quantified For every Pixel

(approx 10-250m)

WaPOR

Water Productivity open access portal (FAO)

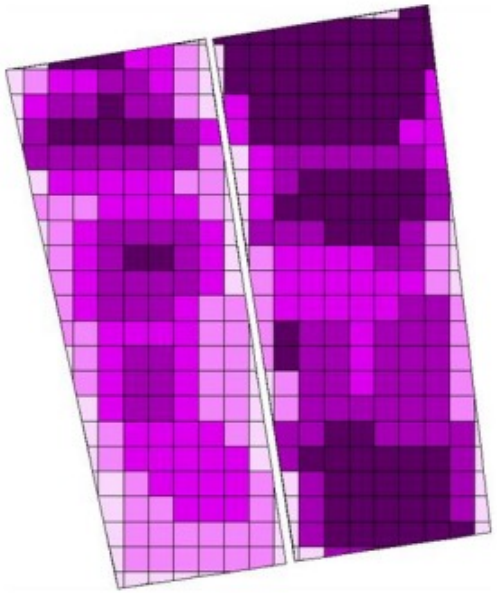


Free data, accessible to anyone

10 satellite-based data components at 250m, 100m and 30m resolution

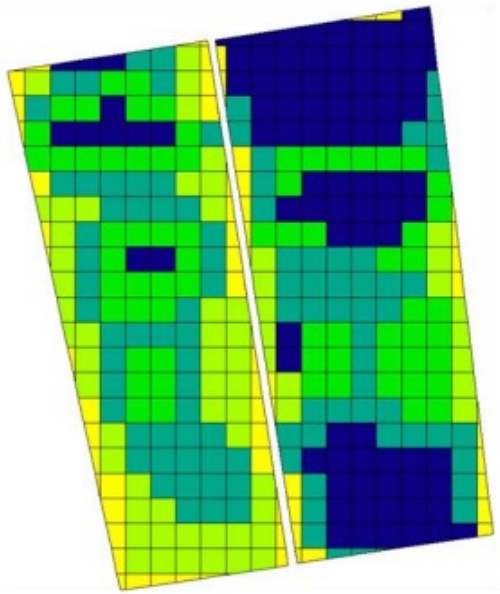
Reduction of chemical applications

Biomasa (kg/ha/sem)



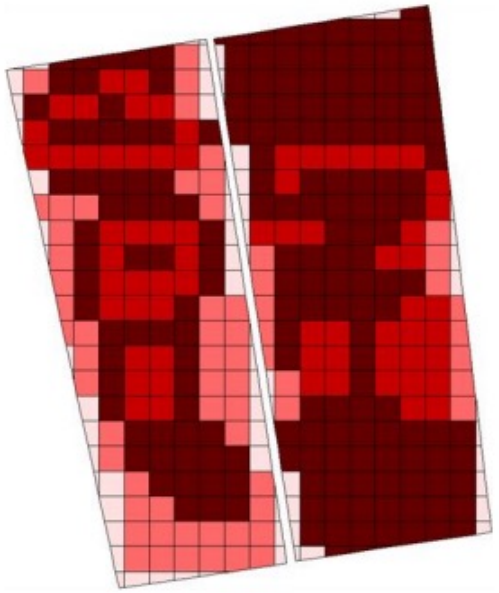
500 (0.8 ha. - 7.4%)
501 - 800 (2.0 ha. - 18.0%)
801 - 1200 (2.5 ha. - 23.0%)
1201 - 1400 (2.9 ha. - 25.8%)
1401 - 1600 (2.9 ha. - 25.8%)

TCH



77.5 (0.8 ha. - 7.4%)
77.5 - 123.93 (2.0 ha. - 18.0%)
123.93 - 171.07 (2.3 ha. - 20.5%)
171.07 - 185.72 (3.1 ha. - 28.2%)
185.72 - 210.53 (2.9 ha. - 25.8%)

Dosis Bonus L/ha

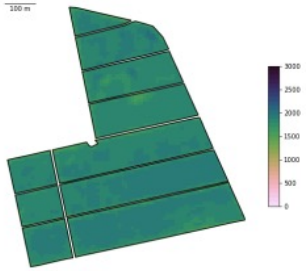


Bonus (Man_bonus)
0.6 (0.0 ha. - 0.0%)
0.6 - 0.9 (2.0 ha. - 18.0%)
0.9 - 1.2 (2.3 ha. - 20.5%)
1.2 - 1.3 (6.0 ha. - 54.0%)

Reduction Nitrogen application

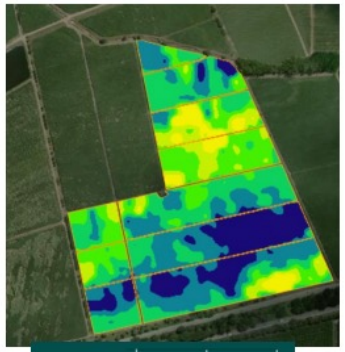
Biomass
LA RESERVA STE 512

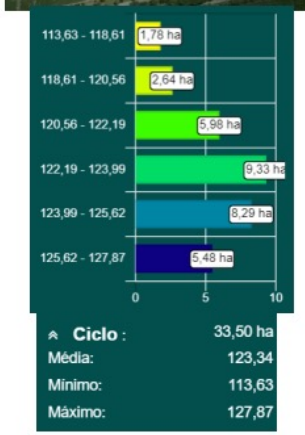
Parcela	131-512	Promedio del lote	1834
Componente de dato	Producción de Biomasa (kg/ha)	Min	1324
Semana	44 (2 nov 2022)	Max	2059
Desviación	78		



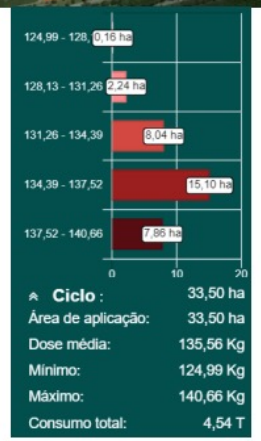
Area: 33.51 ha
Cutting: 2
Yield Tn/ha 2023: 123.39

Yield Tn/ha

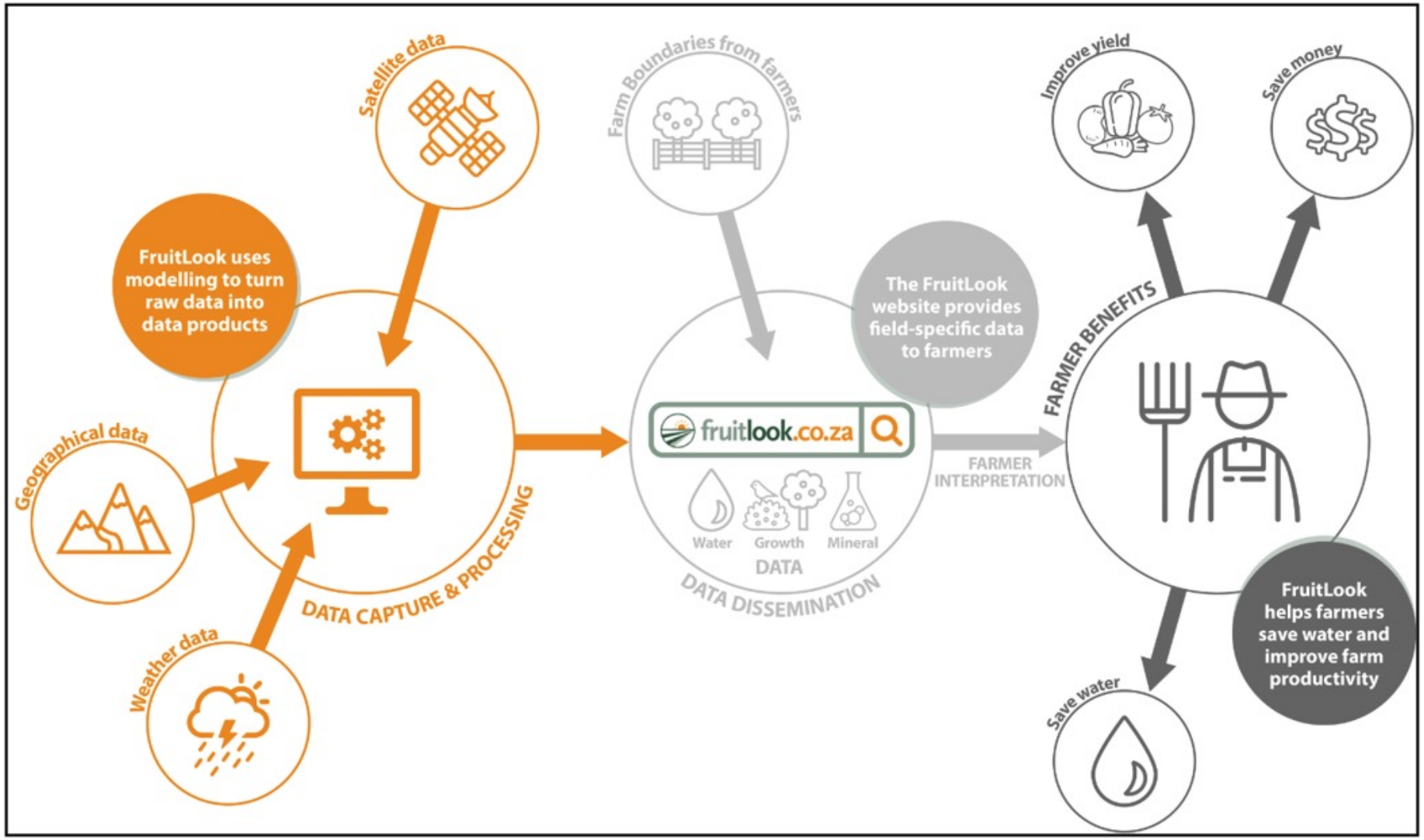




Biomass-adjusted nitrogen recommendation



Area	Nitrogen	Urea	Price Urea (USD) (385 USD/T)
3 ha	125 kg/ha	283 kg/ha	327
8 ha	130 kg/ha	315 kg/ha	970
15 ha	135 kg/ha	326 kg/ha	1,883
7 ha	140 kg/ha	304 kg/ha	819
33 ha			3,999
33 ha	165 kg/ha	359 kg/ha	4,561


Satellite data
Farm Boundaries from farmers
Improve yield
Save money
FruitLook uses modelling to turn raw data into data products
The FruitLook website provides field-specific data to farmers
FARMER BENEFITS
Geographical data
fruitlook.co.za
FARMER INTERPRETATION
Water
Growth
Mineral
DATA
DATA CAPTURE & PROCESSING
DATA DISSEMINATION
Weather data
Save water
FruitLook helps farmers save water and improve farm productivity

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13 million

Hectares for which FruitLook provides weekly data

650+

Active FruitLook users

12

Growing seasons of experience in South Africa

"44% of the respondents experienced a reduction in water use of more than 10% (and 19% saw a more than 20% reduction)"

- FruitLook survey (2020)

"Over almost 4 years of using FruitLook we saved on water with effective water management and went from a 5-hour water cycle to a 3-hour cycle. Our yield has increased with 30%."

-Hendrik Schoeman (Farmer)

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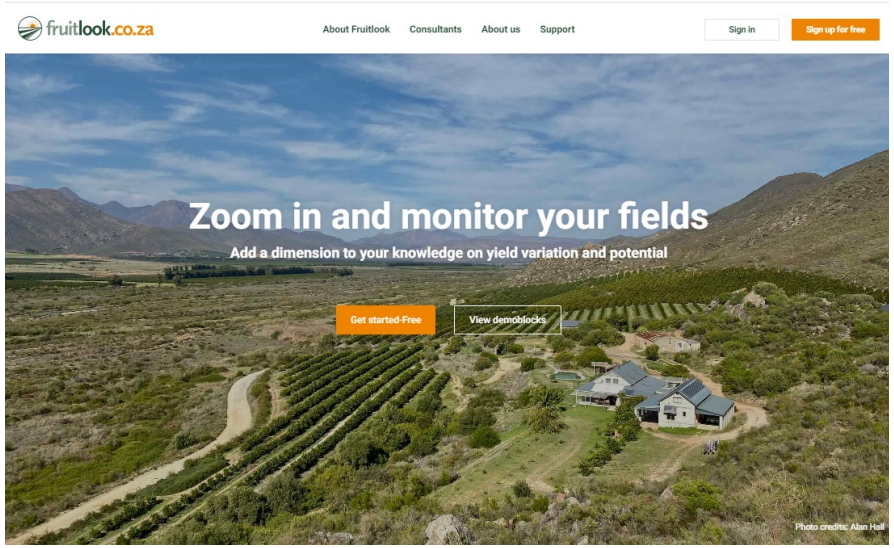

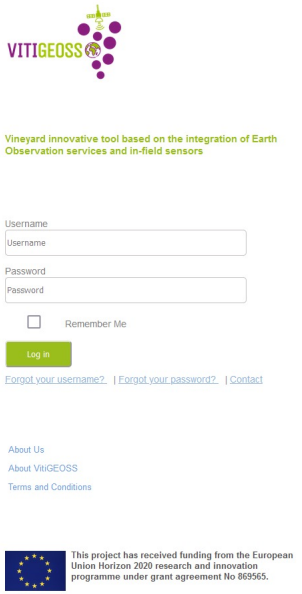

Information services

- Weather and climate forecast
- Phenology monitoring
- Crop status
- Disease management
- Business and sustainability manager

Brief introduction to VitiGEOSS project

eurac research
Institute of Atmospheric Pollution Research
National Research Council of Italy
European Commission


VITIGEOSS

Motivation of VitiGEOSS

Innovative solutions to be more efficient and sustainable

- Europe is the world's largest wine producer, and viticulture is the largest economic activity in Southern Europe.
- Agriculture plays a crucial role in climate change, being responsible for more than 20% of CO_2 emissions.
- Sustainable agriculture aims to develop new practices to meet the current and future needs of society, while reducing the negative effects of climate change.

20%
CO_2 emissions from agriculture [EPA, 2010]

60%
Of wine production comes from the EU *[European Commission, 2014]*

20%
Of the total jobs in agriculture in the EU are related to wine *[CEEV, 2005].*

3M
employed in the EU are in the wine sector *[CEEV, 2005]*

VitiGEOSS project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 869565.

VITIGEOSS

The VitiGEOSS project

Innovative tools for vineyards, based on the integration of Earth observation services and field sensors.

- European Project funded by the program: SC5-16-2019
- Improving the efficiency of vineyard management using data collected by satellites (GEOSS and Copernicus data) and proximity sensors.
- Duration: 3.5 years, start 1/09/2020 end 29/02/2024.
  9 participants from 4 European countries

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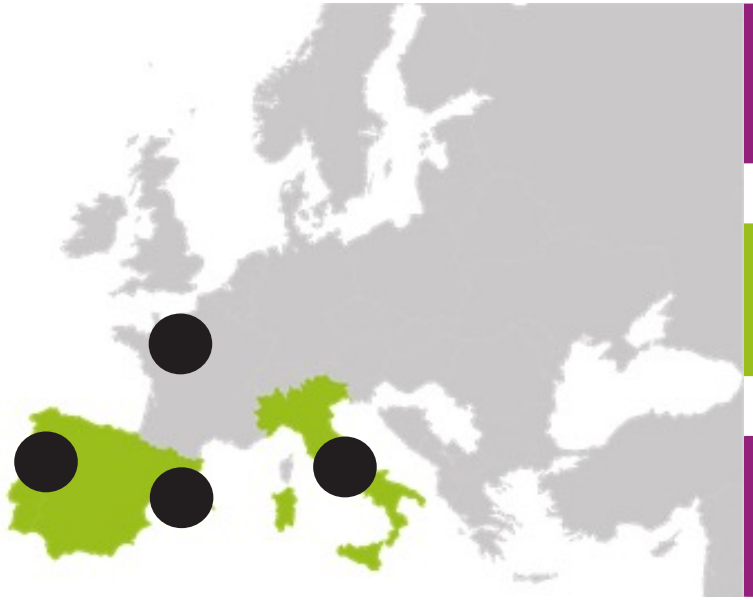
VITIGEOSS

VitiGEOSS consortium



4 Research Centers

3 Wine producers

2 Companies

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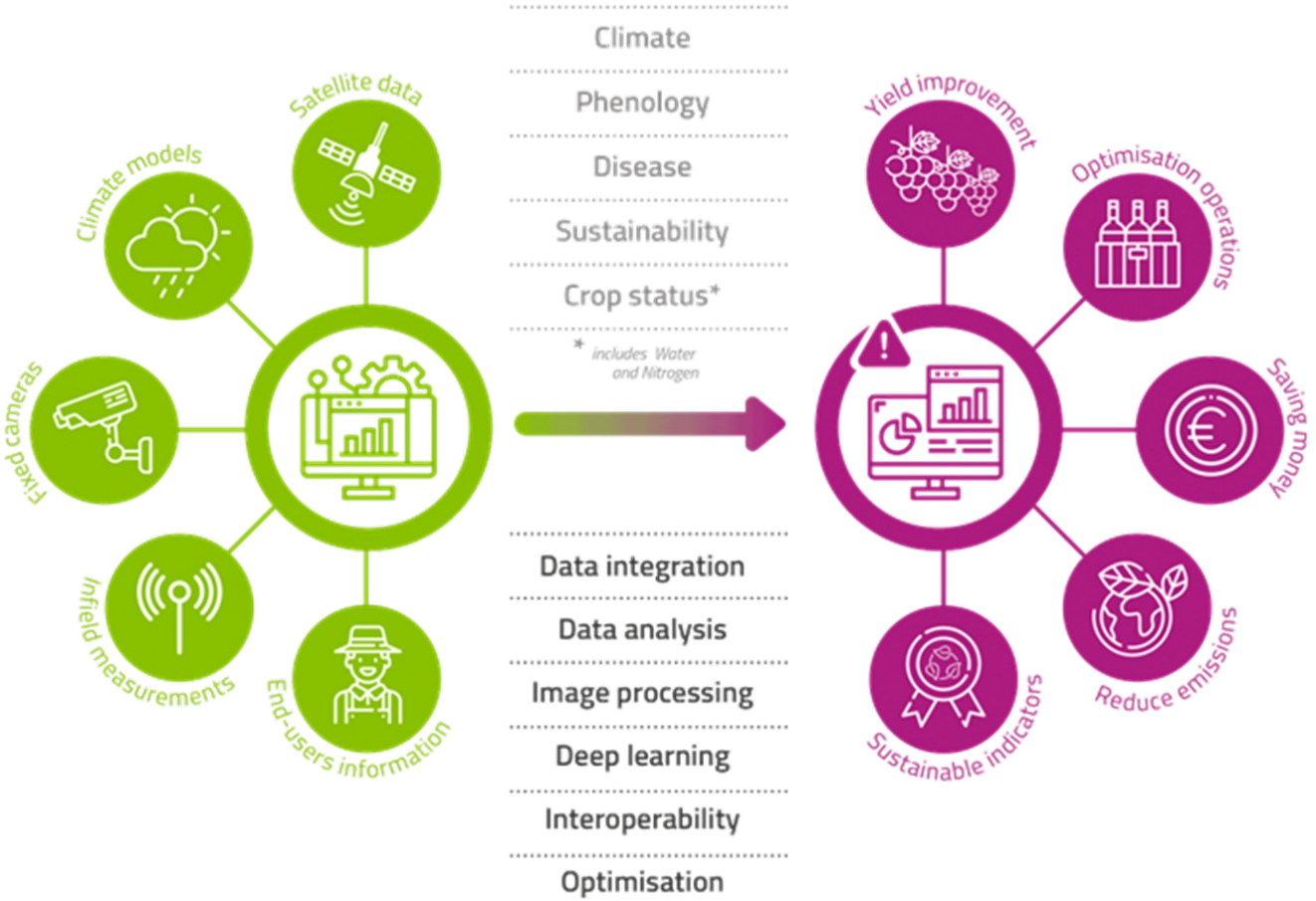
VitiGEOSS concept



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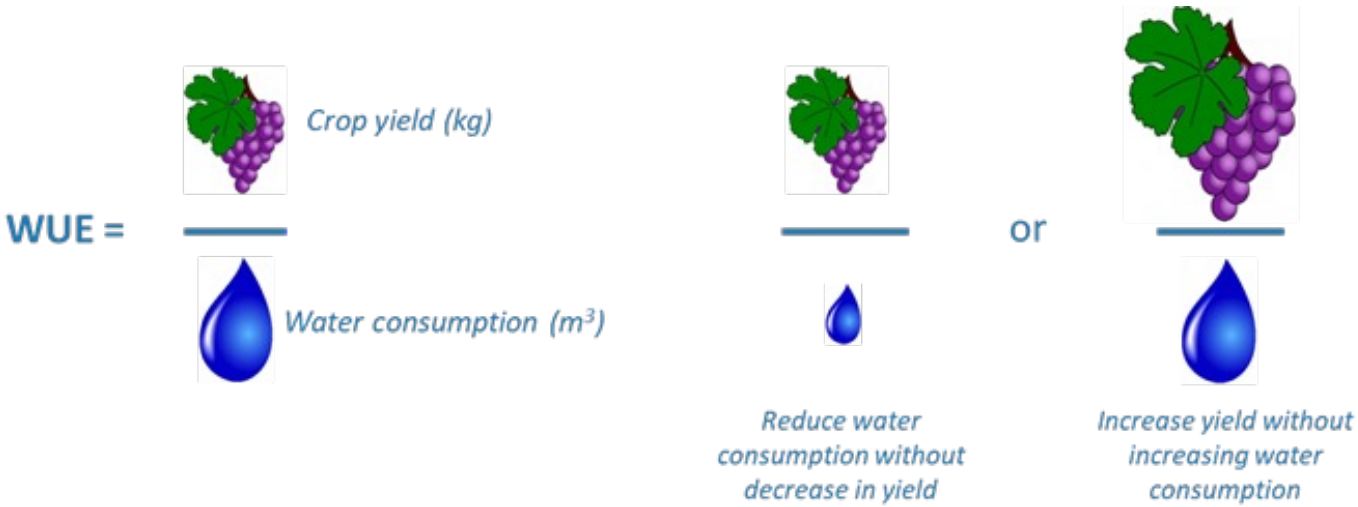
Purpose of VitiGEOSS

- Optimizing decision-making, **better control and monitoring**
- **Recommendations** for improving use of resources and efficiency
- Providing **real-time**, reliable and easily accessible information
- **Predictions** helping to anticipate and face the main risks due to climate change



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Earth Observation in VITIGEOSS

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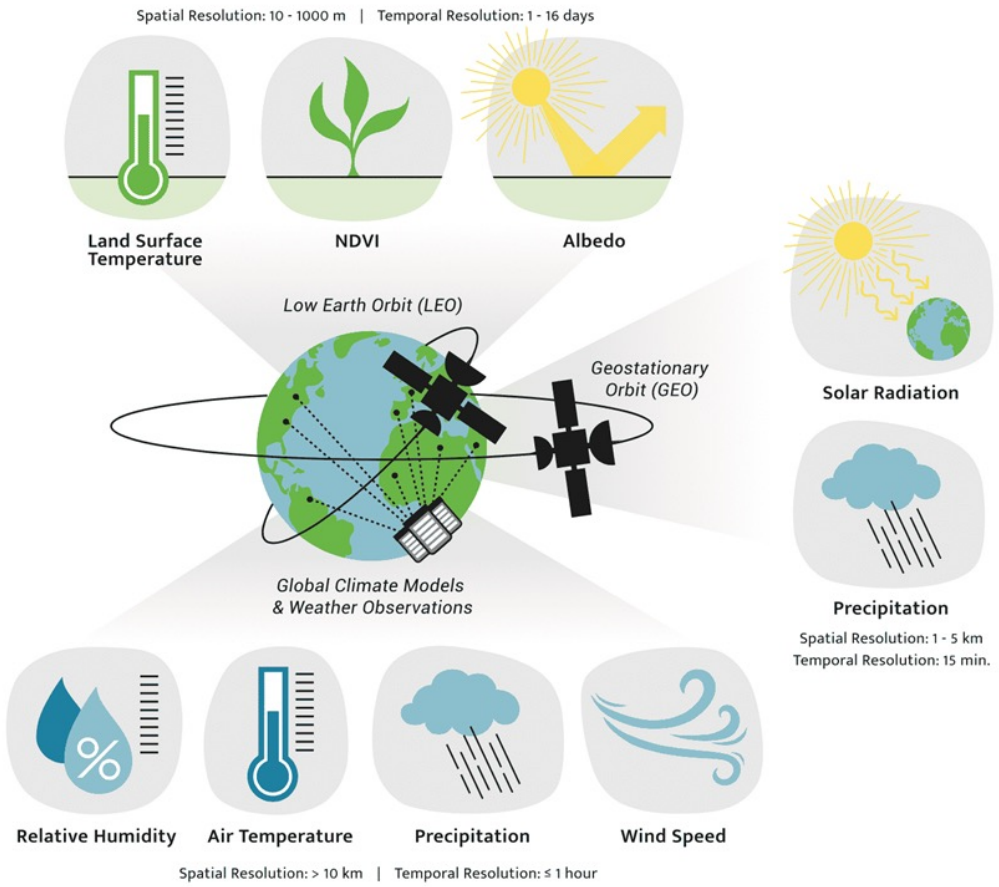
National Research Council of Italy
European Commission

Earth observation data used for:

- Identify vineyard management zones via image **segmentation techniques**
- Detect in-season production **anomalies** via weekly statistical analysis of crop growth
- Inform **crop water demand forecasts** by combination with weather forecasts
- Monitoring and forecasting of **phenology**
- Aerial inspections

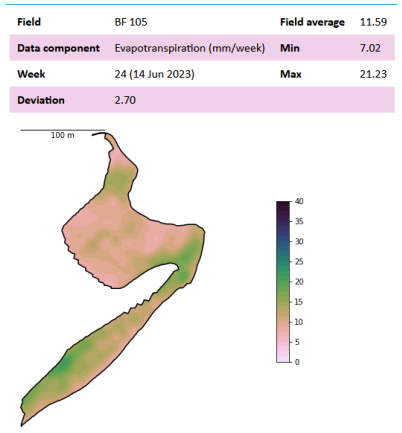
VITIGEOSS

Crop status indicators

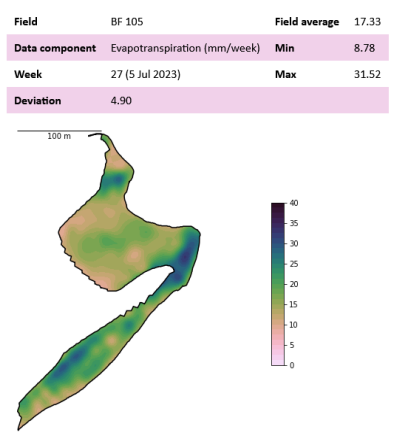


Weekly information on:

- Evapotranspiration [mm/week]
- Biomass production [kg/ha]
- NDVI (Normalized Differenced Vegetation Index)
- LAI (Leaf Area Index)
- Nitrogen content [kg/ha]



Field	BF 105	Field average	11.59
Data component	Evapotranspiration (mm/week)	Min	7.02
Week	24 (14 Jun 2023)	Max	21.23
Deviation	2.70		

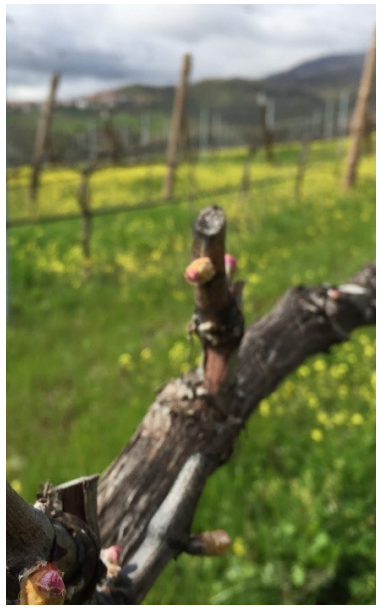


Field	BF 105	Field average	17.33
Data component	Evapotranspiration (mm/week)	Min	8.78
Week	27 (5 Jul 2023)	Max	31.52
Deviation	4.90		

VITIGEOSS

Phenological monitoring

Baggiolini scale



BUDBREAK
(State C - Green tip)

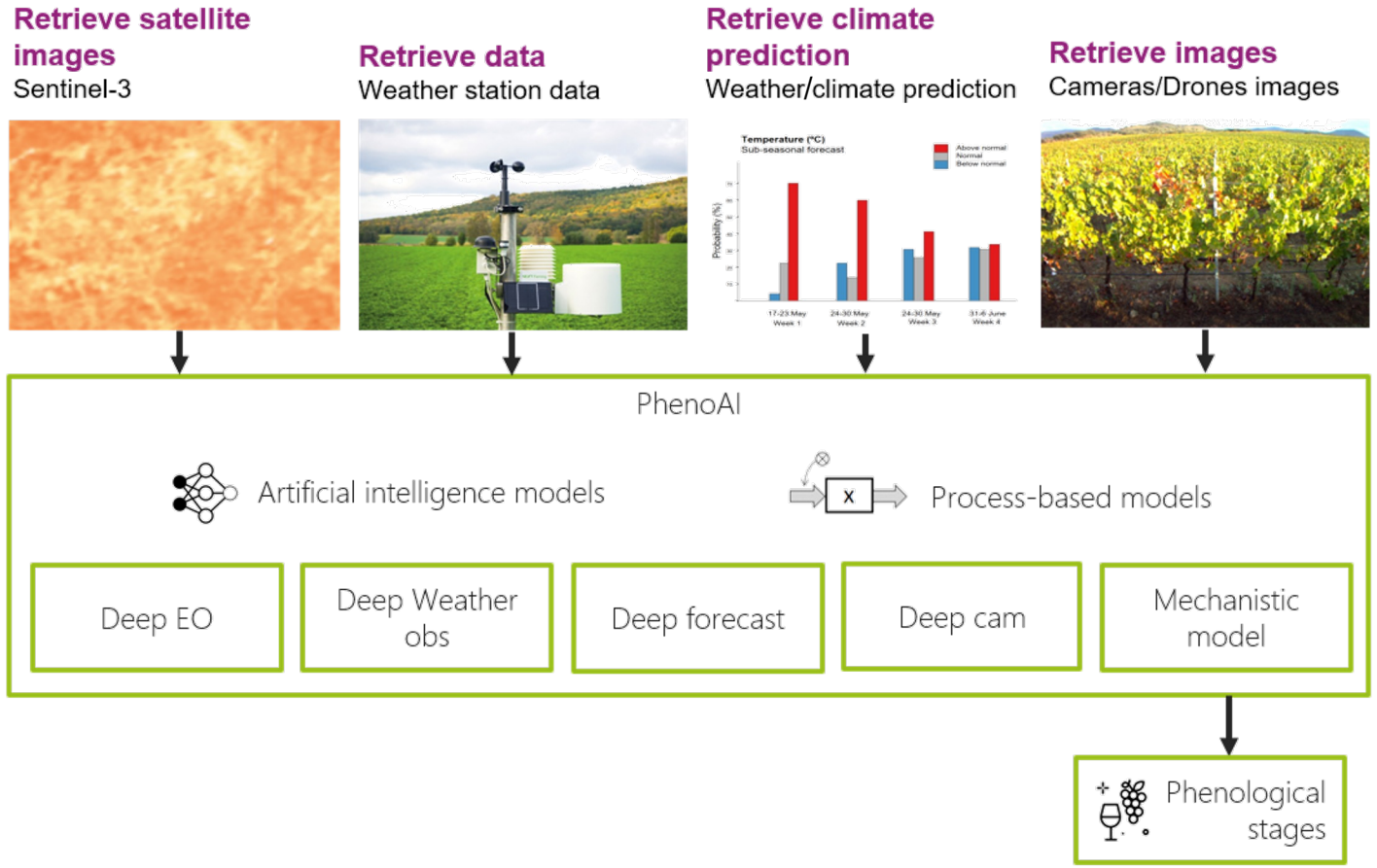
FLOWERING
(Stage I)

BERRY SET
(State J)

VERAISON
(Stage M)

RIPENING
(berry maturity)

Phenological monitoring



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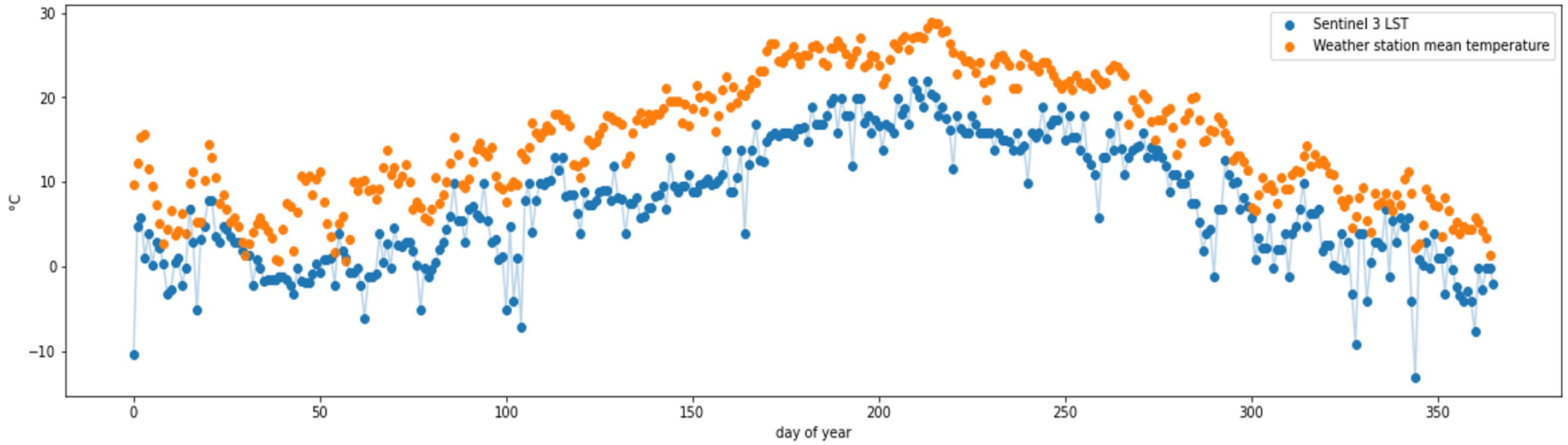
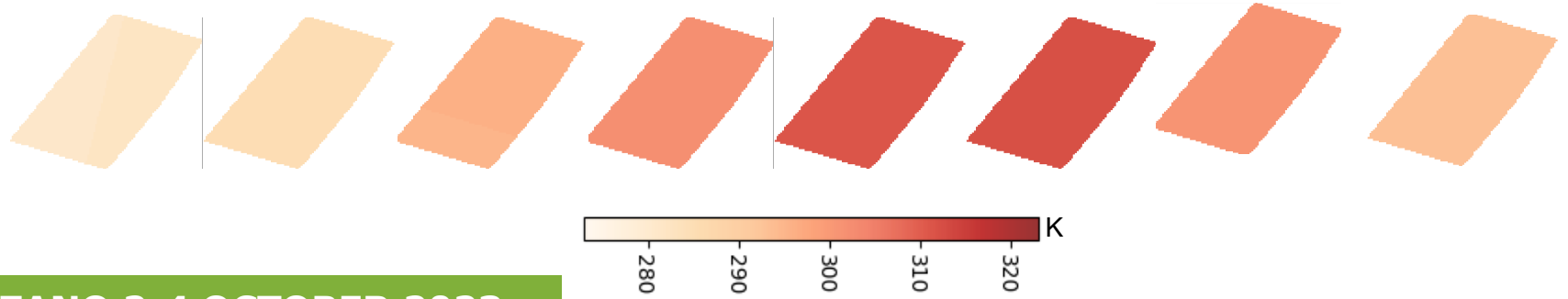
Phenological monitoring



January 2021

December 2021



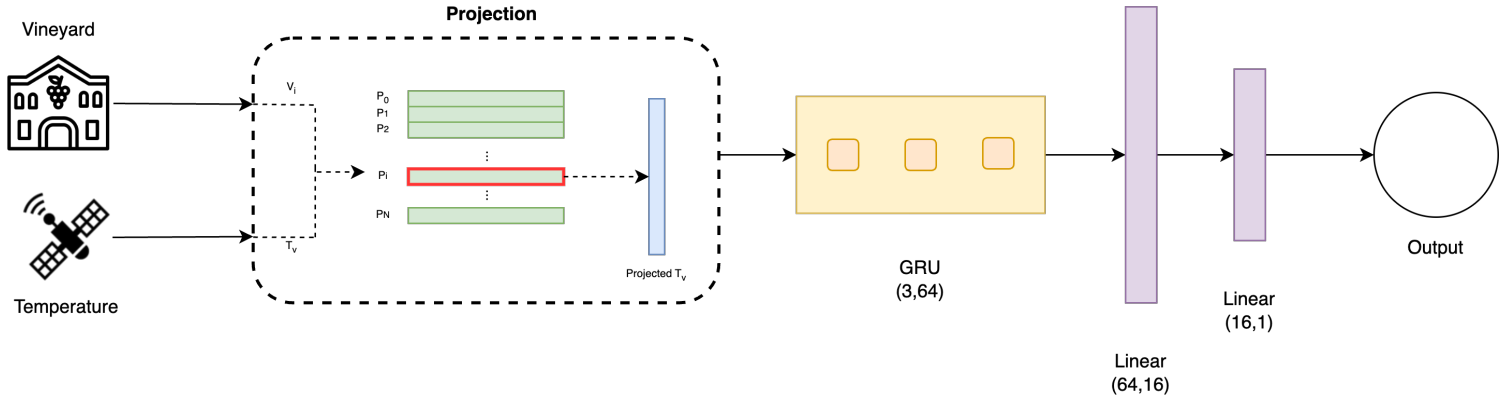
Copernicus Sentinel-3 SLSTR (Bands S7, S8 and S9)

Pros: two measurements per day

Cons: 1km^2 spatial resolution

VITIGEOSS

Phenological monitoring

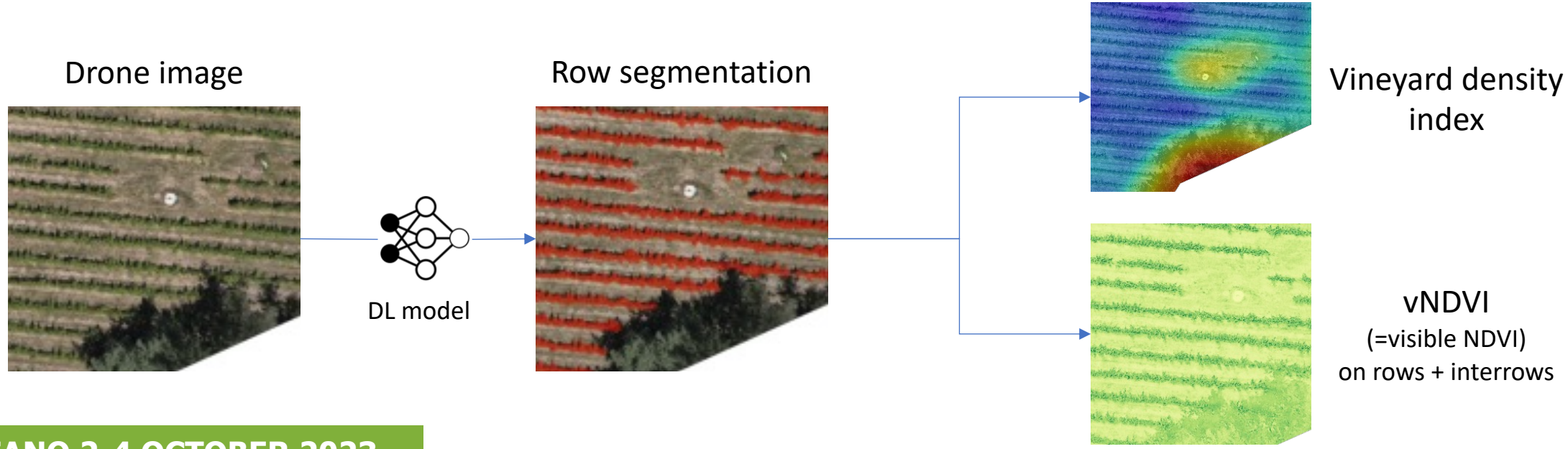


MAE (Mean Absolute Error)	Bud Break	Flowering	Fruit-set	Veraison	Ripening	Average
Deep EO3	**8.13**	**4.37**	**3.99**	**5.47**	**7.82**	**5.96**
Baseline (GDD) (Growing Degree Days)	23.91	20.63	20.91	45.65	62.00	35.48

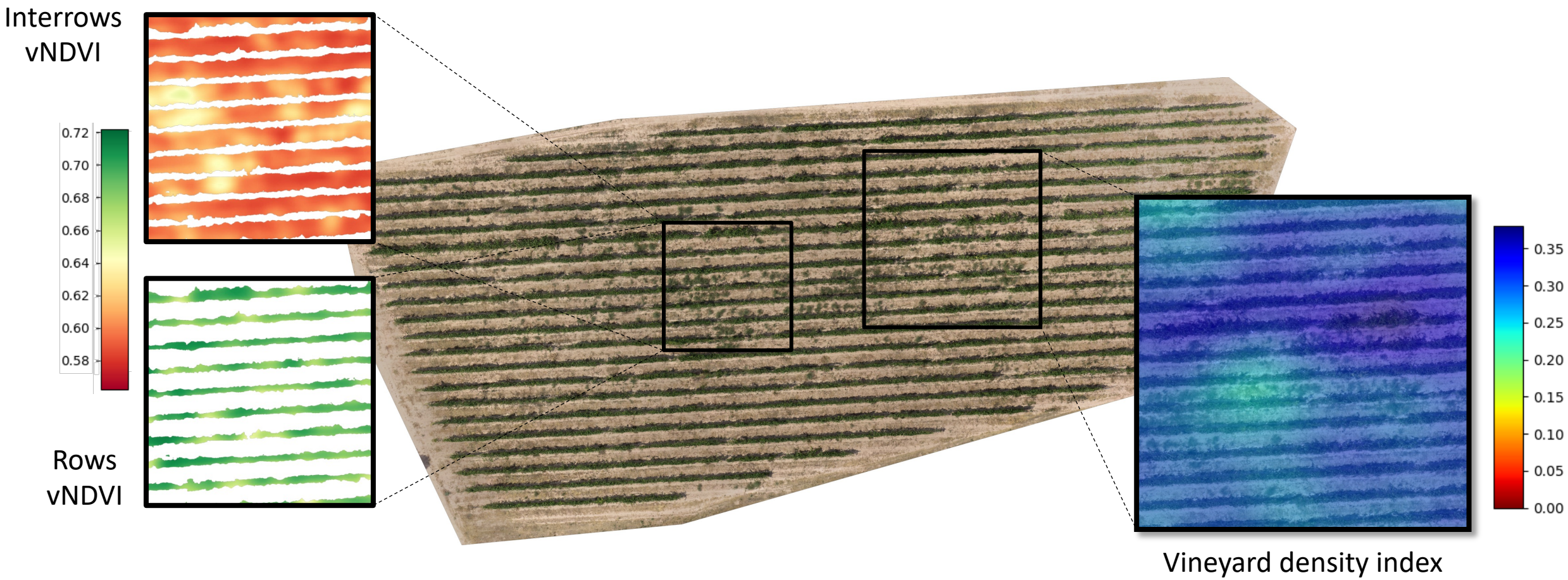
MAE cross-validation 2017-2022

Drone analysis

- Periodic **drone surveys** to acquire RGB vineyard imagery
- **Row segmentation** through deep learning
- **Vegetation indexes** to monitor plant stress and general state of health



Drone analysis: vegetation indexes



Lessons learned

Earth Observation in viticulture

VITIGEOSS

1. Remote sensing can be the best option in some cases

IN-FIELD SENSORS

PRO: hourly measurements, **punctual information**,
accurate measurements (⇒ accurate models)
CONS: expensive, prone to sensors failure

SATELLITE

PRO: **easily scalable**, cheap/freely available
CONS: lower revisit time, lower resolution
(⇒ less accurate models)

1. Remote sensing can be the best option in some cases

IN-FIELD SENSORS

PRO: hourly measurements, **punctual information**,
accurate measurements (⇒ accurate models)
CONS: expensive, prone to sensors failure

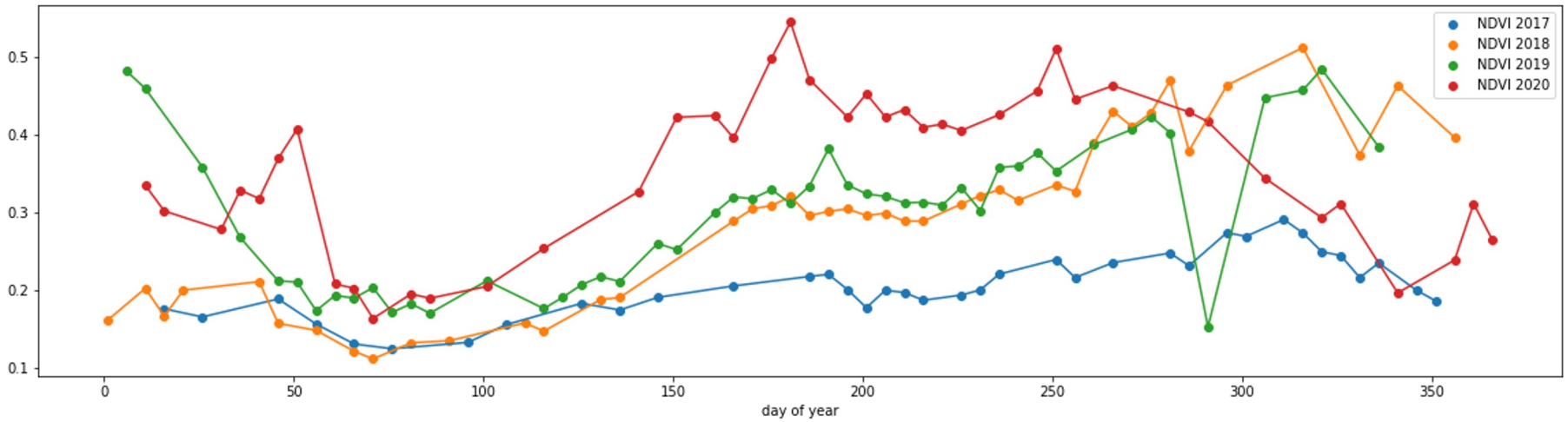
Small/medium-sized vineyards

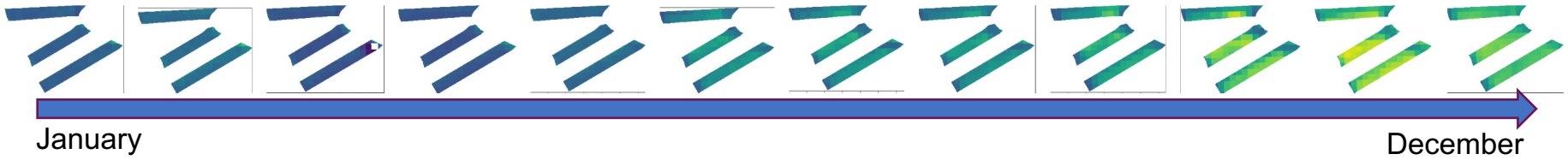
SATELLITE

PRO: **easily scalable**, cheap/freely available
CONS: lower revisit time, lower resolution
(⇒ less accurate models)

Large-sized vineyards

2. Supporting satellite data with other data sources





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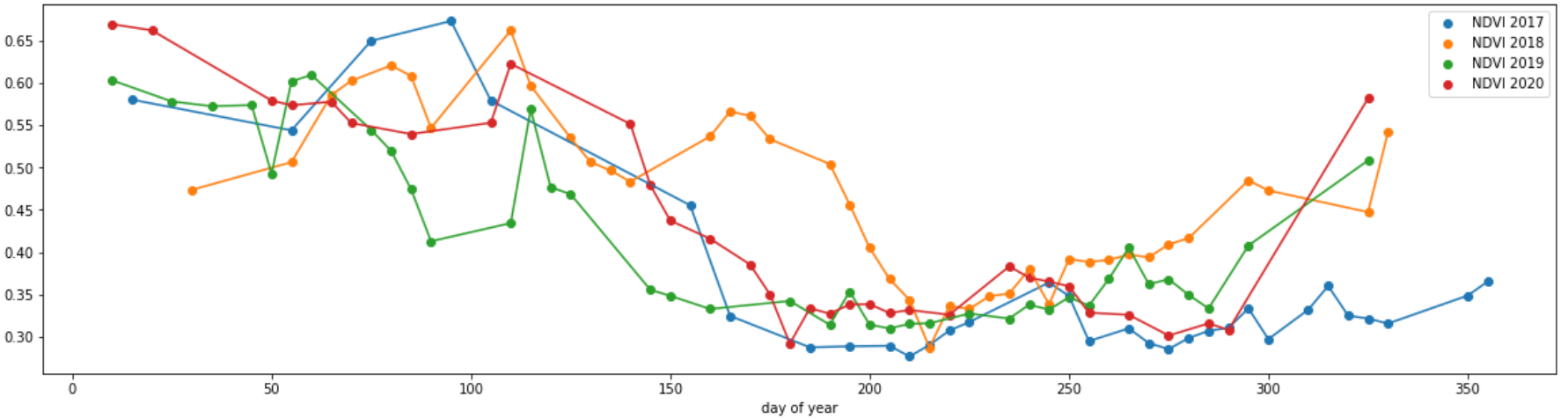

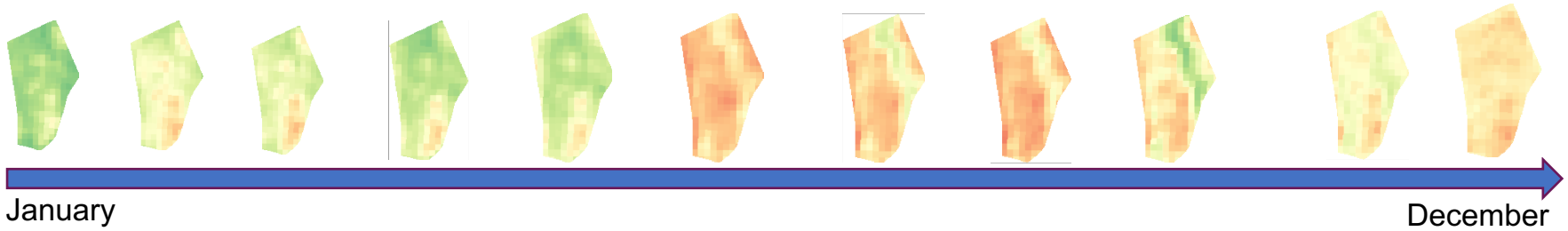

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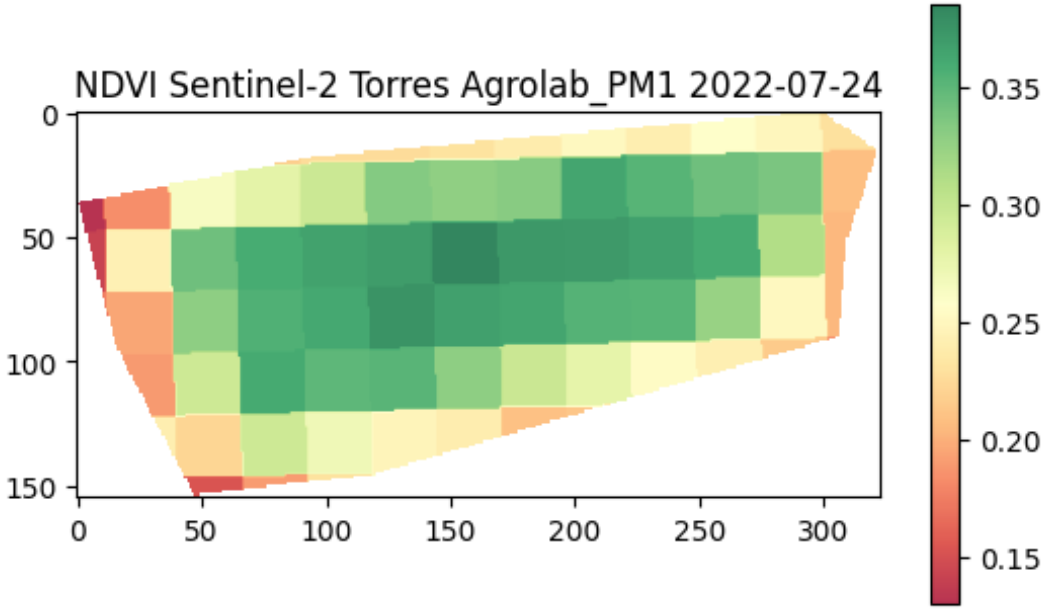
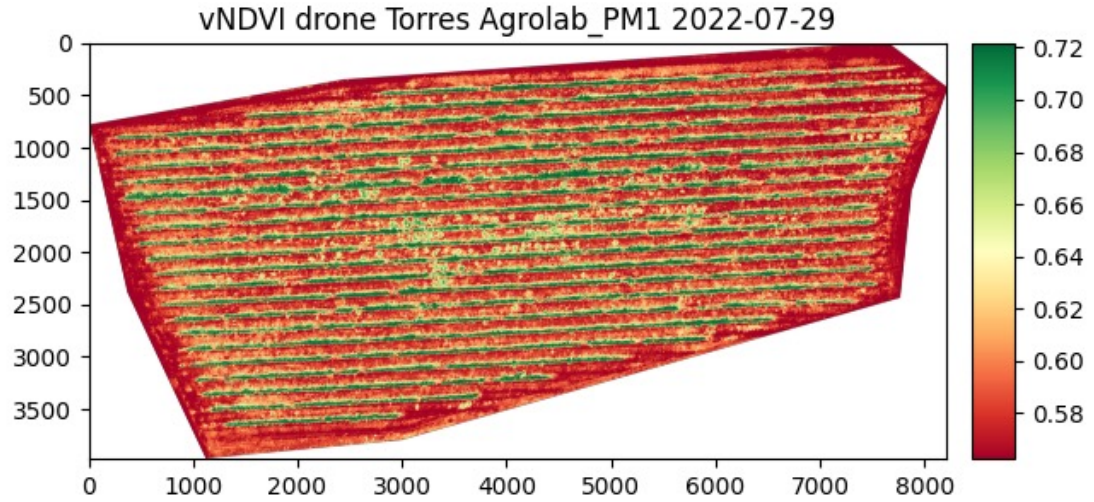


Sentinel-2 RGB-NIR bands resolution:
10 m/px



Drone RGB camera resolution:
1-10 cm/px

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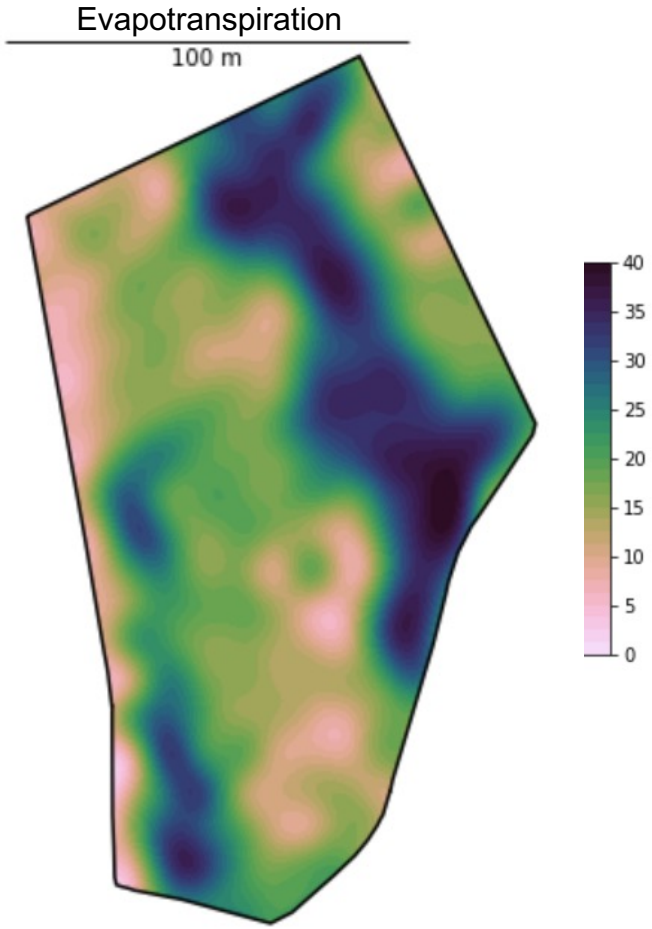
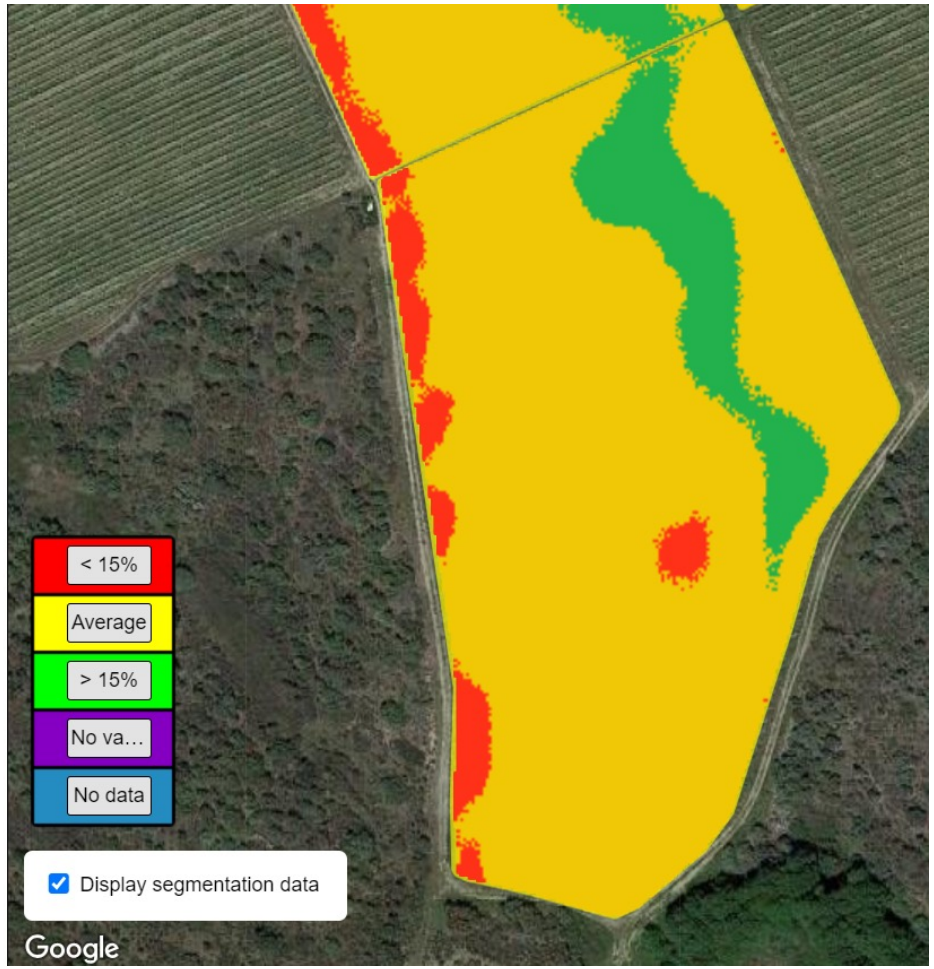
3. Wine growers are not data scientists



Simplify the data visualization, without losing information



EUROGEO WORKSHOP 2023

Data in action: VitiGEOSS platform

BOLZANO 2-4 OCTOBER 2023

eurac research

Institute of Atmospheric Pollution Research
National Research Council of Italy

European Commission

https://platform.vitigeoss.eu/

*If you would like to **test the platform** or **become a user** until the end of the project, please get in touch on our website vitigeoss.eu or info@vitigeoss.eu*

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EUROGEO WORKSHOP 2023

Let's get to know each other!

BOLZANO 2-4 OCTOBER 2023

eurac research

Institute of Atmospheric Pollution Research
National Research Council of Italy

European Commission

Who do we have in the room?

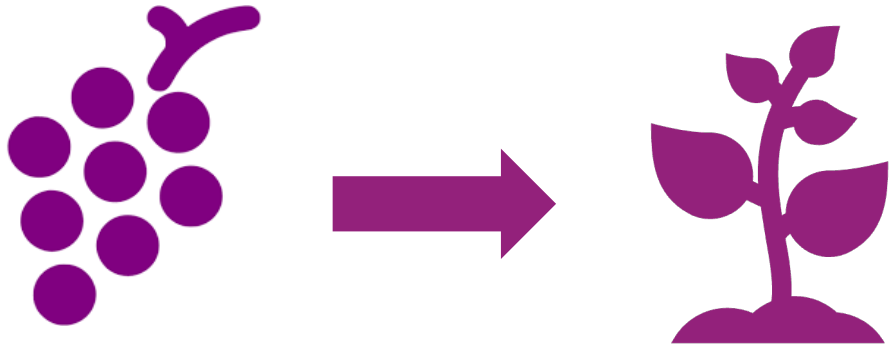
What is your role?

- Researchers
- Technology providers
- Other expertise

Discussion

eurac research
Institute of Atmospheric Pollution Research
National Research Council of Italy
European Commission

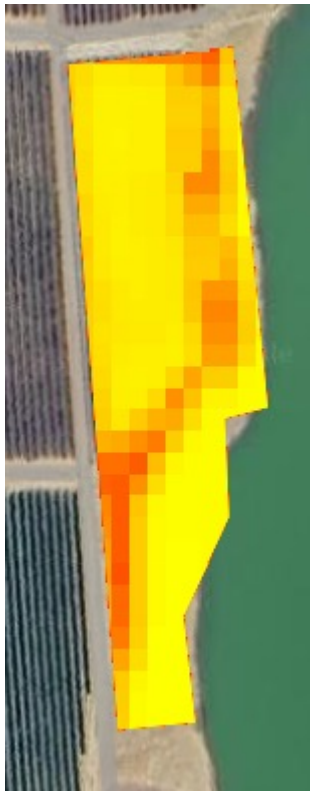
Scale services to other cultivars



Scale services to other cultivars

Sugarcane

Grapes



Apples

Scale services to other cultivars

Almond

Hop

Wheat

Characteristics:

- Extended cultivated area
- Preferably closed canopy
- Susceptibility to environment and weather
- Operations depending on phenological stage

What's the future

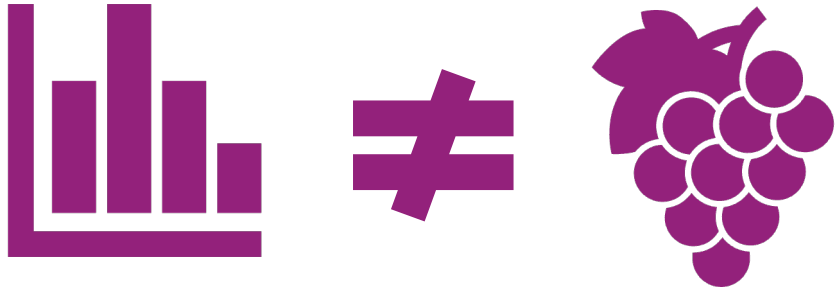
other use cases in agriculture

What's the future

other use cases in agriculture

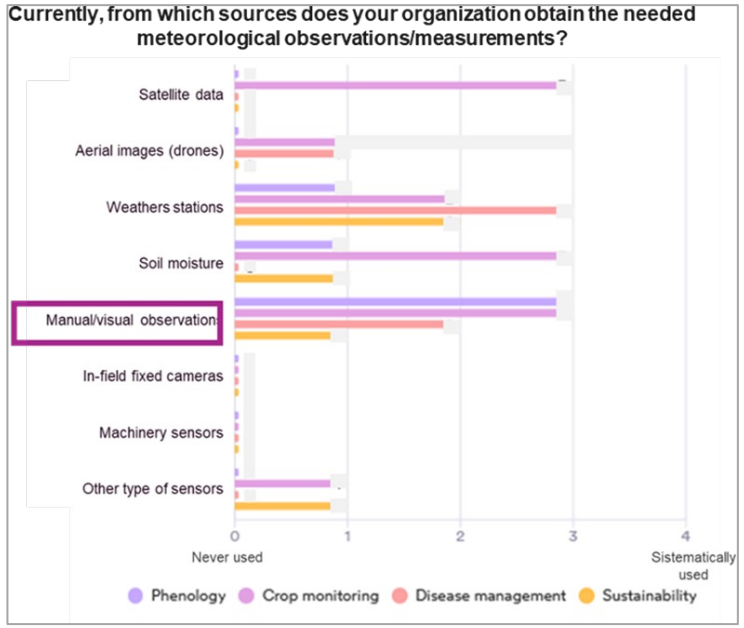
- Water resource management
  - Water consumption estimation
  - Water basins monitoring
- Land suitability
  - Historical analysis of temperature, soil moisture, soil erosion, frost, drought stress
- Field outcome estimation
  - Estimation of gluten and protein content in wheat
  - Yield estimation

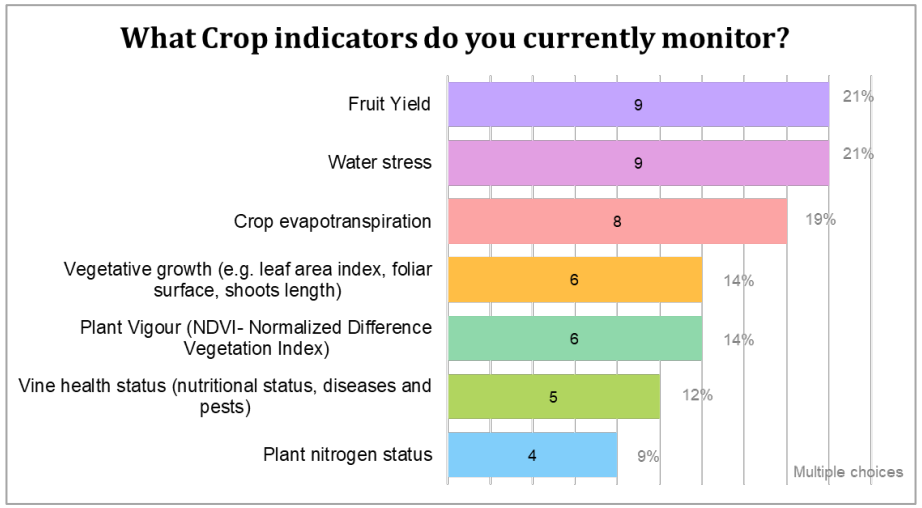
Data scientists are not wine growers

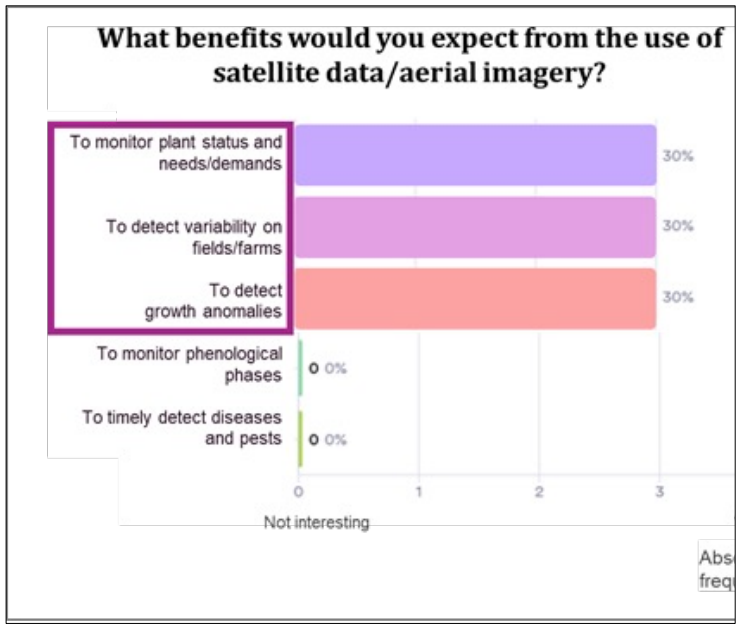


Data scientists are not wine growers: How to work with wine growers

How to include wine growers in the process







Thank you!

To find out more about VitiGEOSS and our future activities, visit our website:
vitigeoss.eu

Get in touch at: **info@vitigeoss.eu**

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