



WP3 – DEVELOPMENT OF A READY-TO-USE SMART FARMING PLATFORM FOR CROP PROTECTION MANAGEMENT

June 2024



The NOVATERRA project has received funding from the European Commission's Horizon 2020 Grant Agreement Number 101000554.



REVIEW OF TASKS COMPLETED

- Task 3.1 Advanced spectral monitoring and pattern recognition of disease pests
- Task 3.2 Development of an advanced Decision Support System (DSS) for disease and pest monitoring and control in Olives and Vineyard
- Task 3.3 Development of a holistic methodology for a smart canopy characterization
- Task 3.4 Development of a machine learning based system for canopy characterization
- Task 3.5 Development of a smart platform for a holistic spray application process
- Task 3.6 Pilot testing of the developments



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KPI committed in the project proposal

KPI.9	Task 3.1	Disease presence verification in every image	accuracy greater than 75%	Case study report
KPI.10	Task 3.1	Vision system can withstand real-time operation scenarios	prediction capacity of minimum 6 fps.	Case study report
KPI.11	Task 3.2	DSS is able to support a relevant number of pests and diseases	Minimum 5 pests and diseases supported	Case study report
KPI.12	Task 3.5	Reduction of pesticide losses to the ground using the smart platform for spray management	At least 15% reduction of pesticide losses to the ground	Case study report
KPI.13	Task 3.6	Reduction of amount of pesticides using the new technologies for pesticide application	Reduction of amount 15% in average compared to current practices	Case study report
KPI.14	Task 3.6	Reduction of the risk of environmental contamination using the new technologies for pesticide application	Drift reduced at least 25%	Case study report



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WP3

TASK 3.1

Develop a disease/pest detection algorithm
based on spectral monitoring and pattern
recognition



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Objective of T3.1

- The general objective of this task was to configure a multispectral sensor with relevant spectral filters in regions of the electromagnetic spectrum, which maximized the detection of peacock spot and powdery mildew by artificial intelligence methods.
- Leader: AUA

Spilocaea oleaginea (Peacock spot) in olive groves



Powdery mildew in vineyards



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Working Protocol Developed

MODEL TRAINING IN LAB CONDITIONS



IMEC SNAPSCAN 150 bands (470-900 nm)
Used for spectral image acquisition

Principal Component Analysis (PCA)
Used for finding the most discriminating wavelengths

Chosen wavelengths (VIS - NIR)

- Visible Range (460 nm, 540 nm, 640 nm)
- NIR range (700 nm, 725 nm, 825 nm)

MODEL VALIDATION IN THE FIELD



MUSES-9-MS (6 bands, 3 visible & 3 NIR)
Used for field spectral image acquisition



Accuracy

Powdery Mildew **0.77**

Peacock Spot **0.93**



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Conclusions T3.1

- **Main results:** Six specific wavelengths in the VIS-NIR range of the spectrum were identified and a model for disease detection in vineyard and olive groves was built. The model was tested in the field with high detection accuracy rates of 0.77 and 0.95 for Powdery Mildew and Olive Peacock Spot respectively.
- **Deliverable:** Finalized and presented
- **Problems encountered:** No relevant problems in the technical side. Low presence of the disease due to weather conditions in season 2021 and 2022. Extensive presence of Peacock Spot in 2023.

KPI.9	Task 3.1	Disease presence verification in every image	accuracy greater than 75%	Case study report
KPI.10	Task 3.1	Vision system can withstand real-time operation scenarios	prediction capacity of minimum 6 fps.	Case study report





WP3

TASK 3.2

Develop a holistic platform for pests and diseases prediction and crop protection management for olive groves and vineyards



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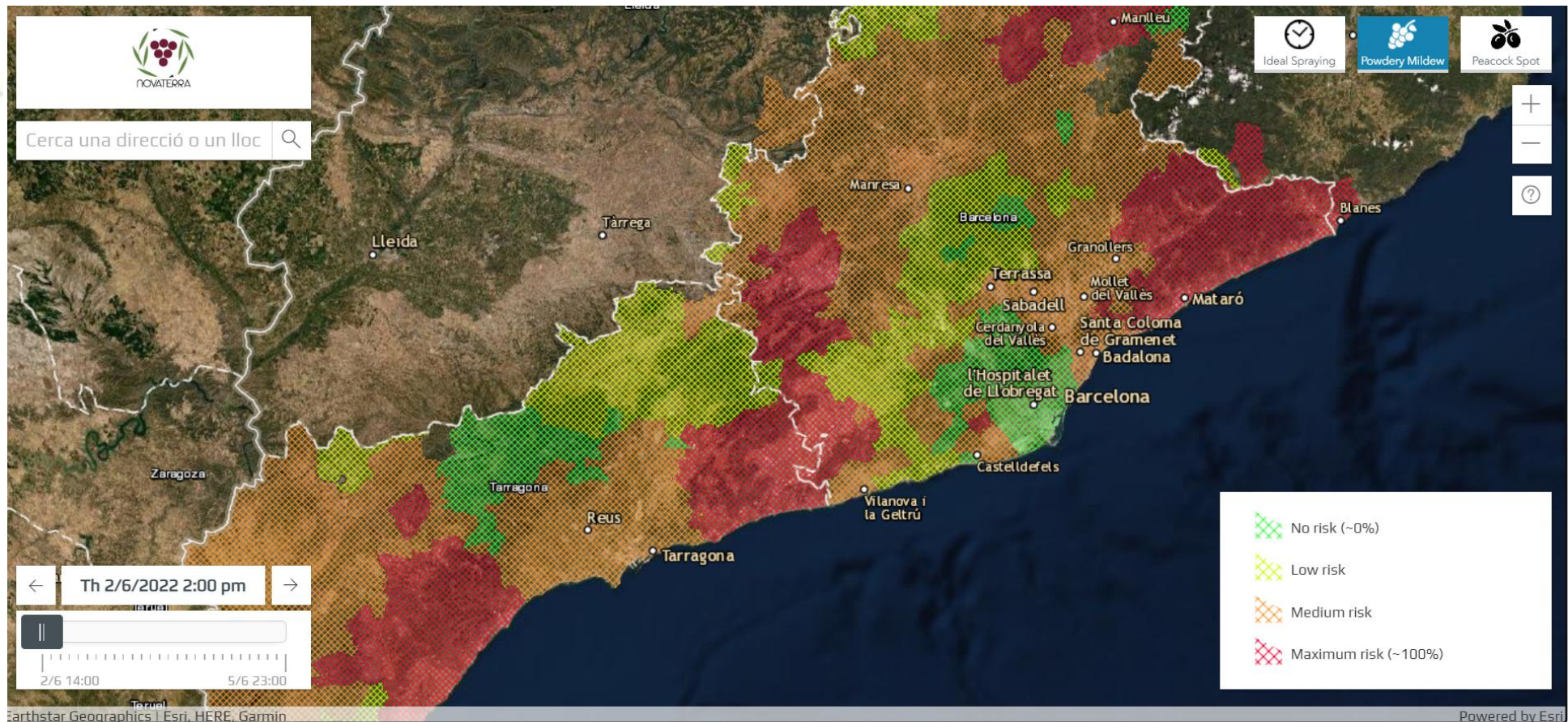


Objective of T3.2

- To develop an advanced DSS for monitoring and predicting main diseases and pests in vineyards and olive groves will be developed taking into account: i) spatial and temporal image data of healthy and diseased plants (task 3.1) and ii) epidemiology models for the prediction of diseases infection or pests development
- The tool is based on OPTIMA DSS, developed by AGENSO that provides alerts for crop diseases in spatiotemporal scale (regional, field and subfield level) and on predictive diseases and pests models provided via web-services by **HORTA**.
- Leader: AGENSO



Results



- Monitoring of more than 3,200 weather stations data. <https://novaterra.agenso.gr/>
- API between DSS (Task 3.2) and Advanced spectral monitoring and pattern recognition of disease pests (Task 3.1)



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• 2023 Results – Significant OLS presence



2023	NOVATERRA DSS	CONVENTIONAL	UNTREATED
Yield (kg/ha)	3462	3478	3085
Potential Income (EUR/ha)	5885.4	5912.6	5244.5
Cost of Treatment (EUR/ha)	502.88	754.26	0
Post-Treatment Profit (EUR/ha)	5382.52	5158.34	5244.5

Plots treated according to NOVATERRA DSS showed a significant increase in potential profit (4.34%) compared to the conventionally treated plot, and an increase in potential profit (2.63%) compared to the untreated plot. Therefore, NOVATERRA DSS seems to be the most financially sustainable solution

WP3 – T3.6 – Validation of the DSS (T 3.2)

Year 2023



- DSS NOVATERRA recommended more treatments than the ADVID method
- DSS NOVATERRA seemed to be displacing risk, identifying risks too early in the season.
- DSS NOVATERRA did not recognize risk at later stages for powdery mildew while wrongly identifying it, again at later stages, for downy mildew
- The DSS NOVATERRA is therefore not validated for the specific conditions of the Douro valley, underperforming the existing ADVID alert system

- NOVATERRA DSS proposed the same treatment dates as Decitrait model for the 6 first treatments. It proposed one last treatment that was not necessary.
- There was no presence of the disease even in untreated plots.

- NOVATERRA DSS could be used to improve calendar based control of Powdery Mildew in low innovative farmers
- A 66% of reduction of the use of pesticides could be achieved this season.
- The DSS gains importance because is not only a matter of applying pesticide, but knowing when it is important to apply it to have the crop protected



SOGRAPE



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WP3

TASK 3.3

Develop a machine learning based system for
optimizing crop spraying

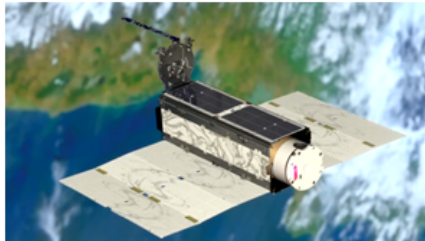


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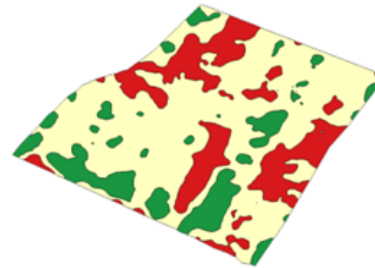


Objective of T3.3

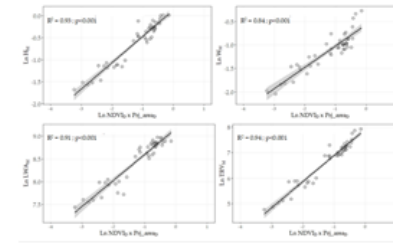
Satellite imagery



Vigor Map (NDVI)

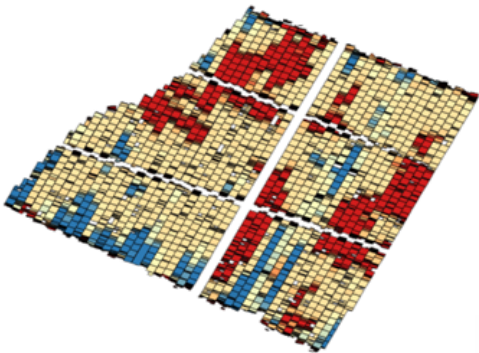


Conversion from Vigor to volume rate

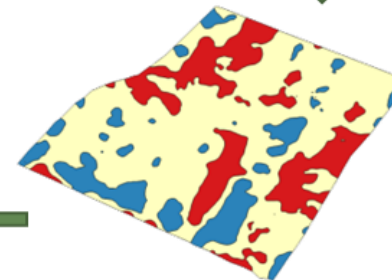


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As applied map
(L/Ha)



Prescription
maps (L/Ha)



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Design and Validation of the prototype



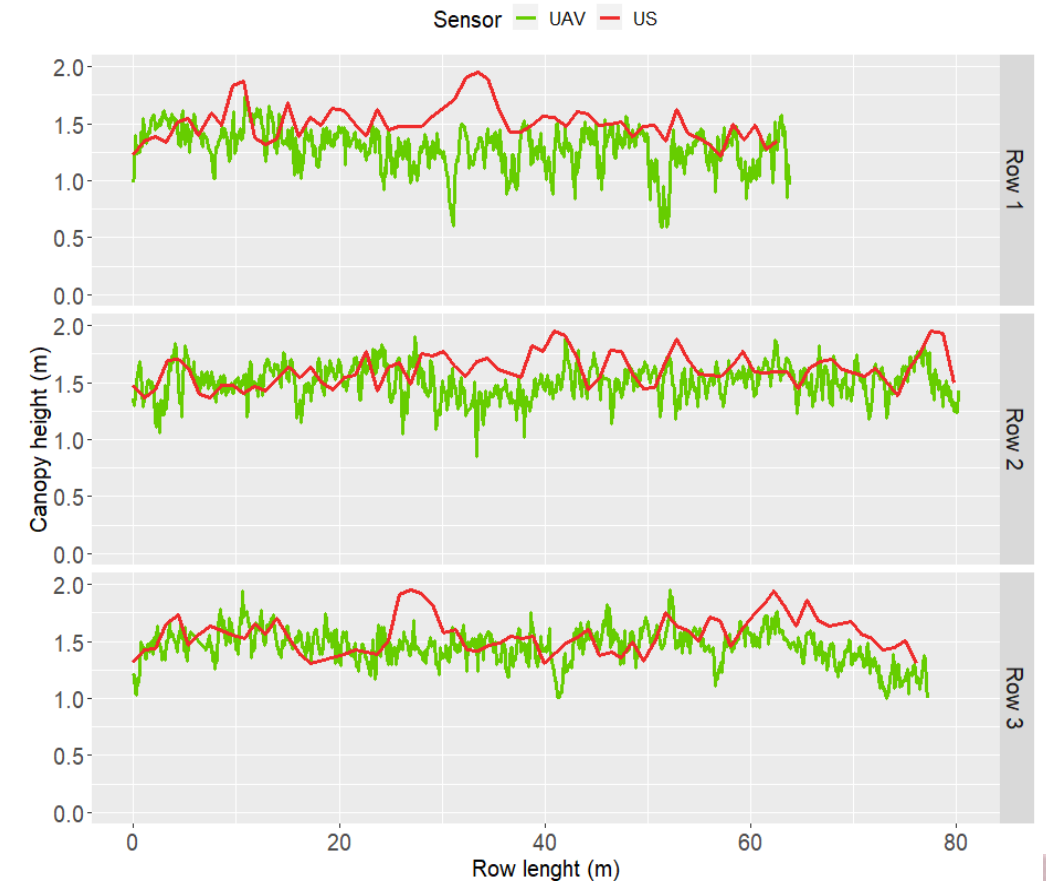
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Design and Validation of the prototype

- **Research paper under work – Computers and Electronics in Agriculture**

Design, implementation and validation of a tractor-mounted equipment for canopy characterization in vineyard



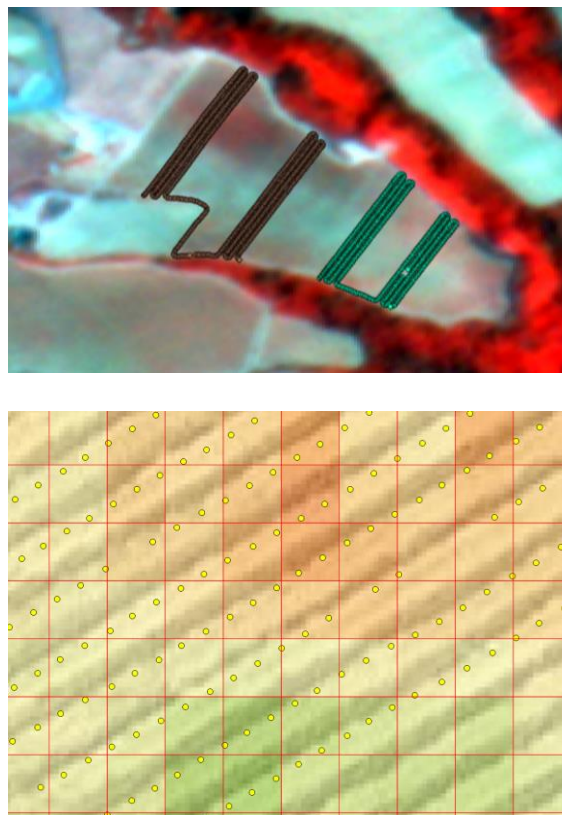
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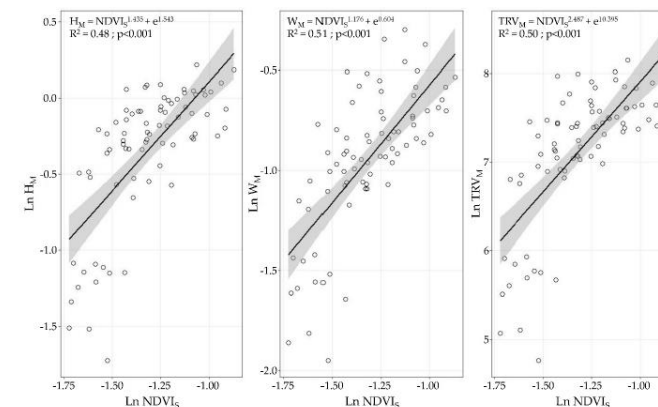
Model generation



2 seasons x 6 field trials
x 15 plots = **>700.000**
measurements



For every pixel in every satellite
image, a relationship between
spectral and ground sensor data is
performed



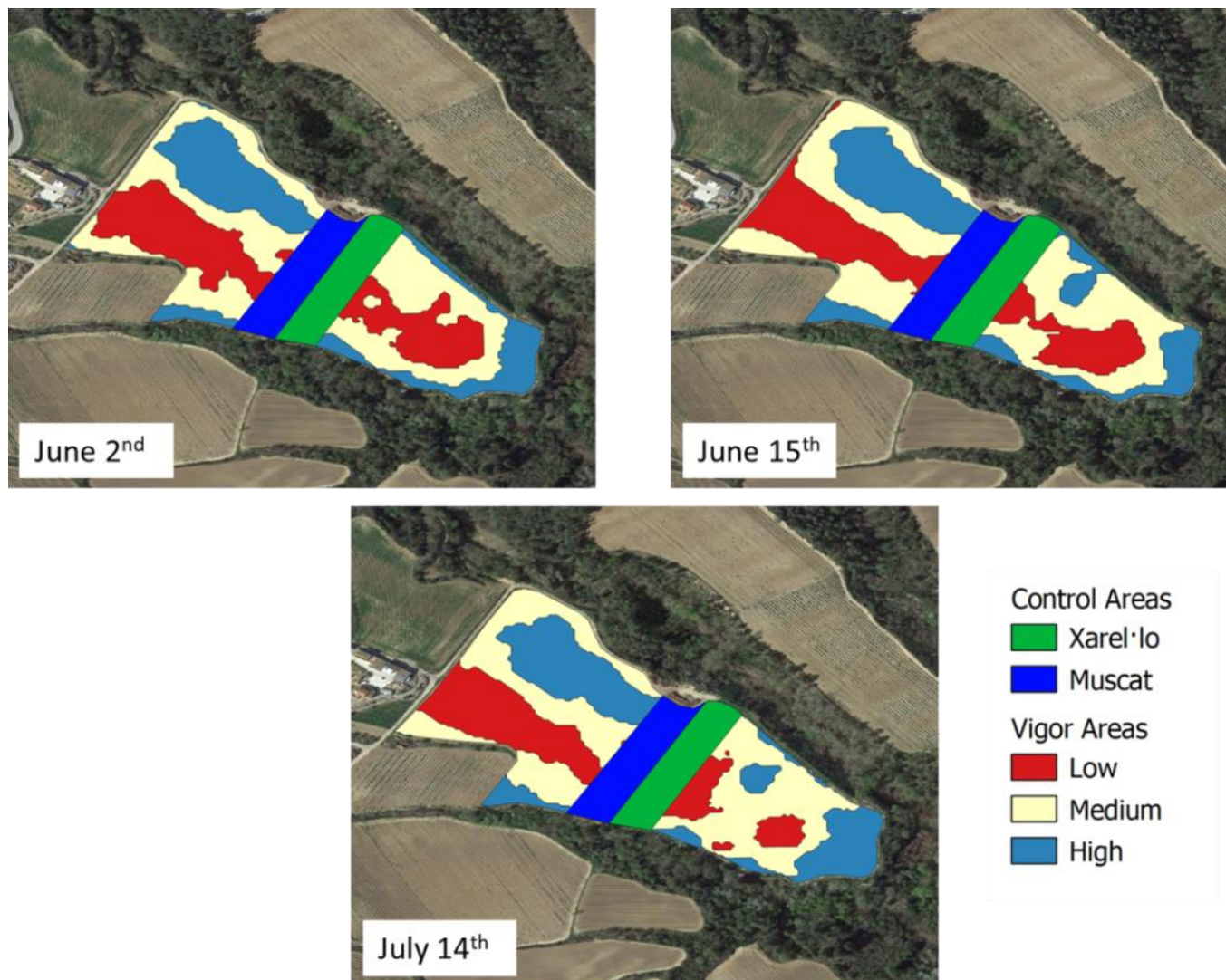
Any point of the image is given a
PPP volume rate to be applied
with an error of 20 l/ha



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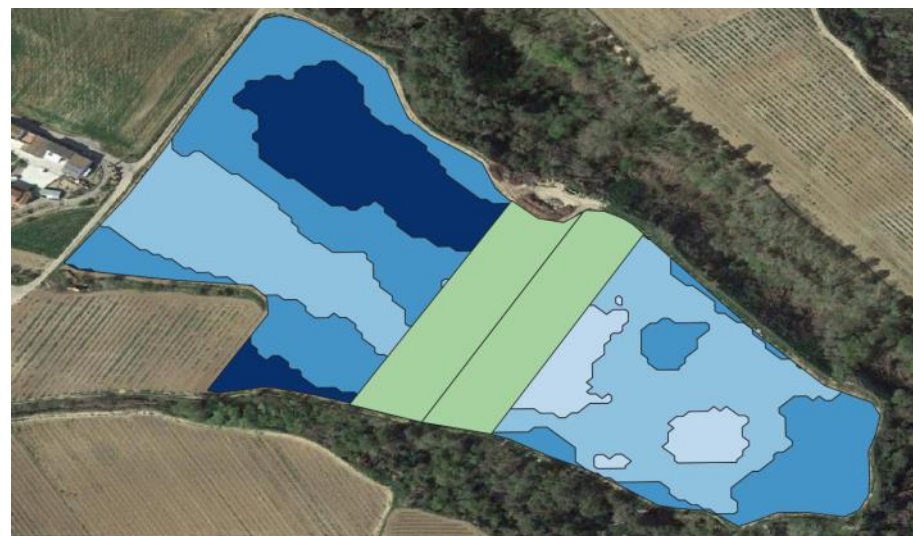
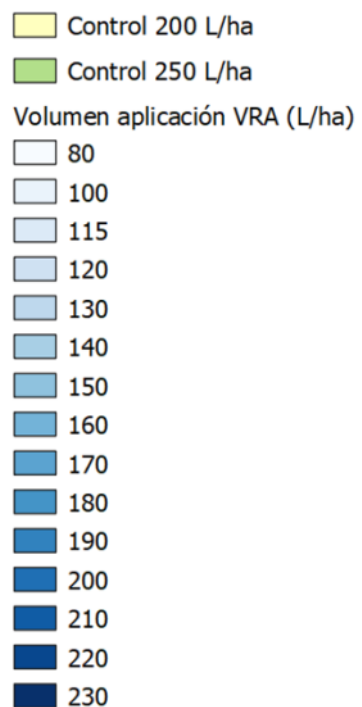
WP3 – T3.6 – Validation of the automatic VRA protocol (T 3.3)



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WP3 – T3.6 – Validation of the automatic VRA protocol (T 3.3)



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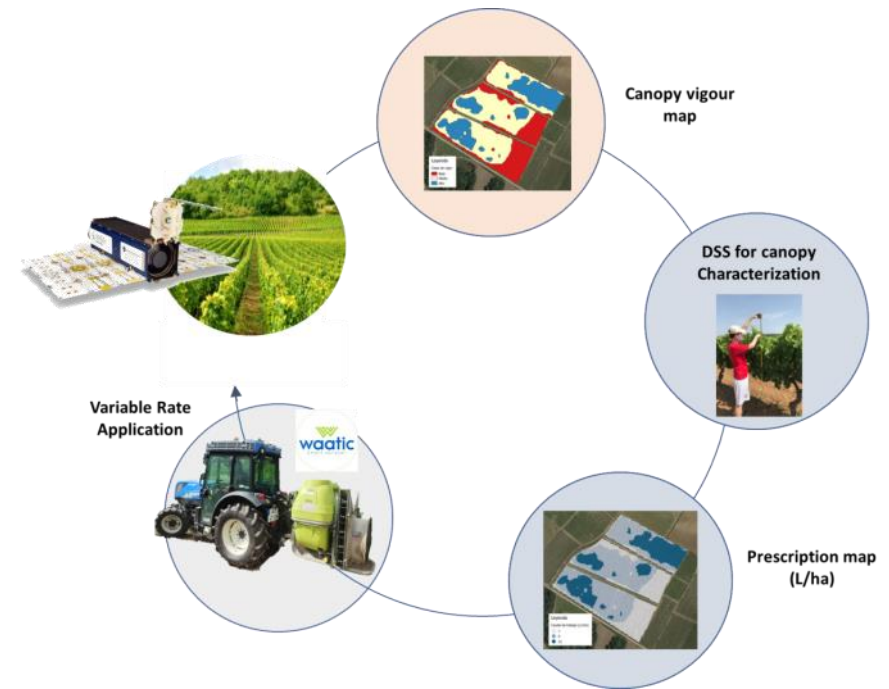
Savings in water and product obtained after using VRA in season 2023 in Xarel·lo plot			
	Water (L)	Copper (kg)	Sulphur (kg)
CONV	2296	15,3	38,3
VRA	1548	10,3	25,8
Savings	-33%	-33%	-33%



Savings in water and product obtained after using VRA in season 2023 in Muscat de Fortignan.			
	Water (L)	Copper (kg)	Sulphur (kg)
CONV	1701	11,3	28,4
VRA	962	6,4	16,0
Savings	-43%	-43%	-43%

KPI.13	Task 3.6	Reduction of amount of pesticides using the new technologies for pesticide application	Reduction of amount 15% in average compared to current practices	Case study report
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WP3 – T3.6 – Implementation of VRA in mountain viticulture (T 3.3)



The NOVATERRA project has received funding from the European Commission's Horizon 2020 Grant Agreement Number 101000554.



WP3 – T3.6 – Implementation of VRA in mountain viticulture (T 3.3)



Variety: Touriga Nacional

Treatments:

- A and B – VRA
- C and D – Conventional

Number of treatments: 5

- 09/05/23
- 24/05/23
- 05/06/23
- 19/06/23
- 03/07/23



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Prescription

Precision 93%



Applied by the sprayer

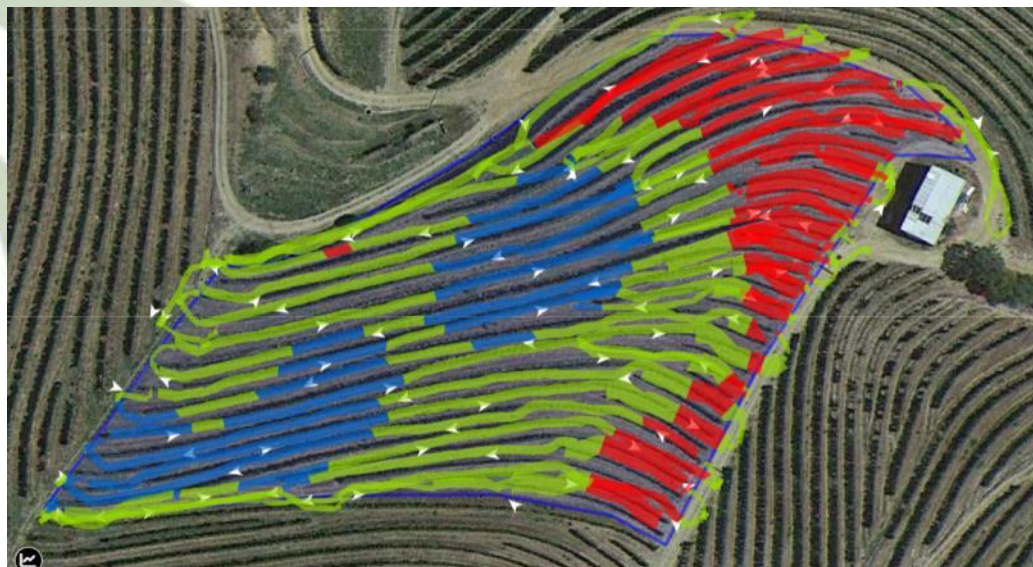


Error >10%





Precision 93%



Prescription



Applied by the sprayer

Error >10%



WP3 – T3.6 – Implementation of VRA in mountain viticulture (T 3.3)



- Savings ranging 6-14% of PPP in the whole season
- No differences were found in pest control capabilities between conventional and VRA systems

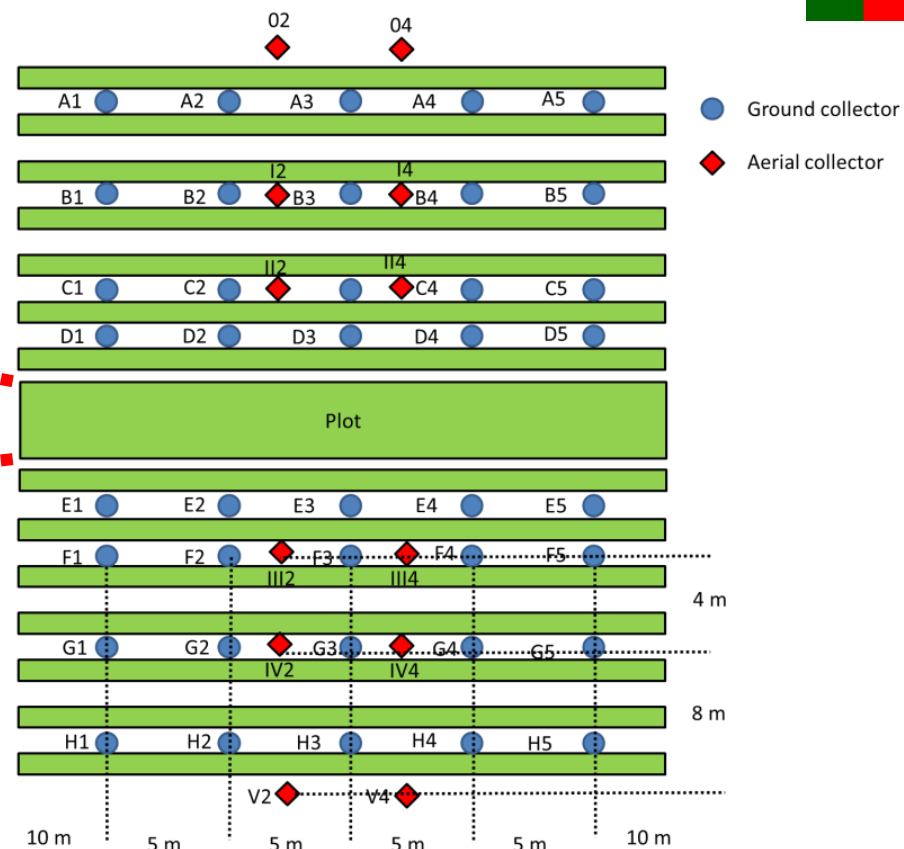
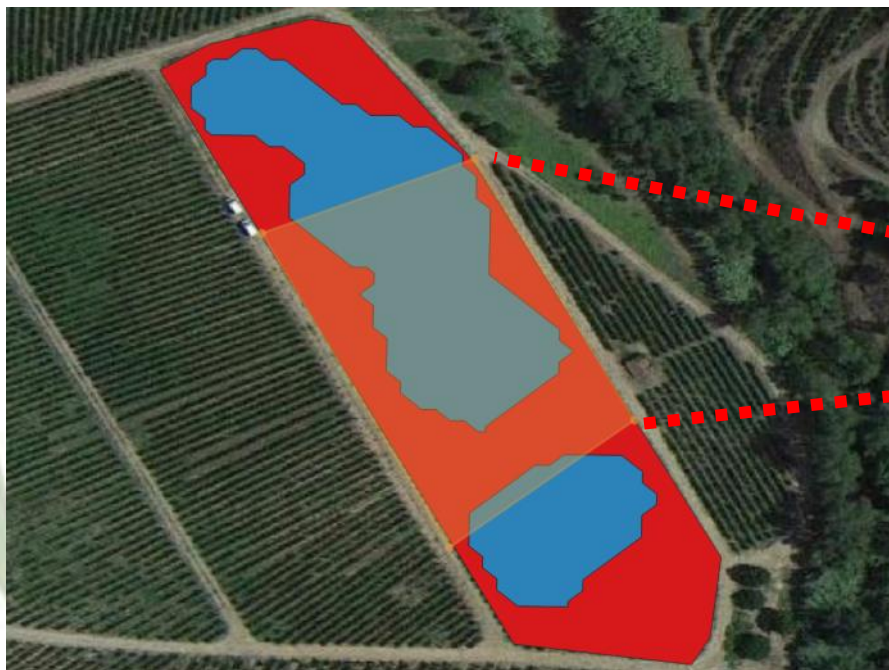
KPI.13	Task 3.6	Reduction of amount of pesticides using the new technologies for pesticide application	Reduction of amount 15% in average compared to current practices
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WP3 – T3.6 – Drift assessment of VRA in mountain viticulture (T 3.3)



Volume rates used in the two dates of experiments			
	Vigor class	Volume rate June 13 th (L/ha)	Volume rate July 17 th (L/ha)
VRA	High	320	360
	Low	270	300
CONV	-	400	400



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WP3 – T3.6 – Drift assessment of VRA in mountain viticulture (T 3.3)

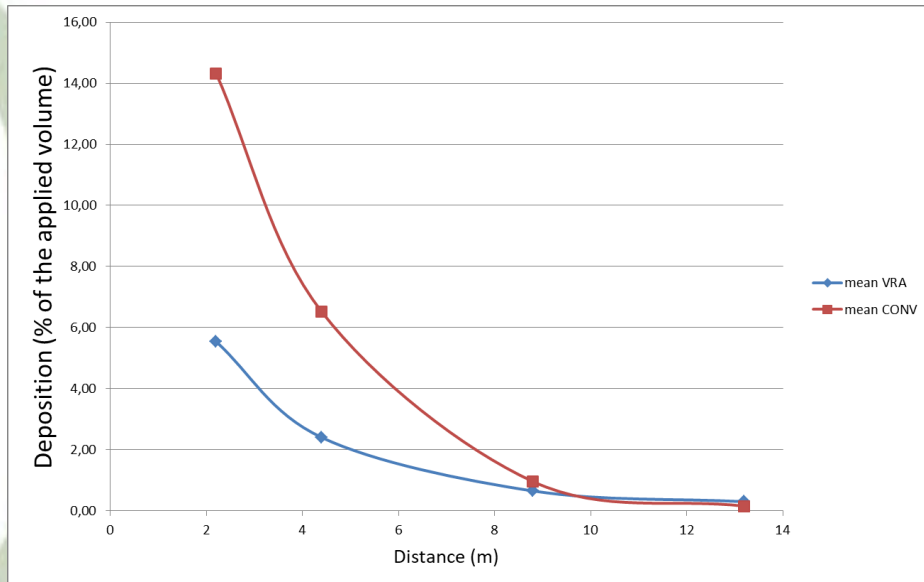


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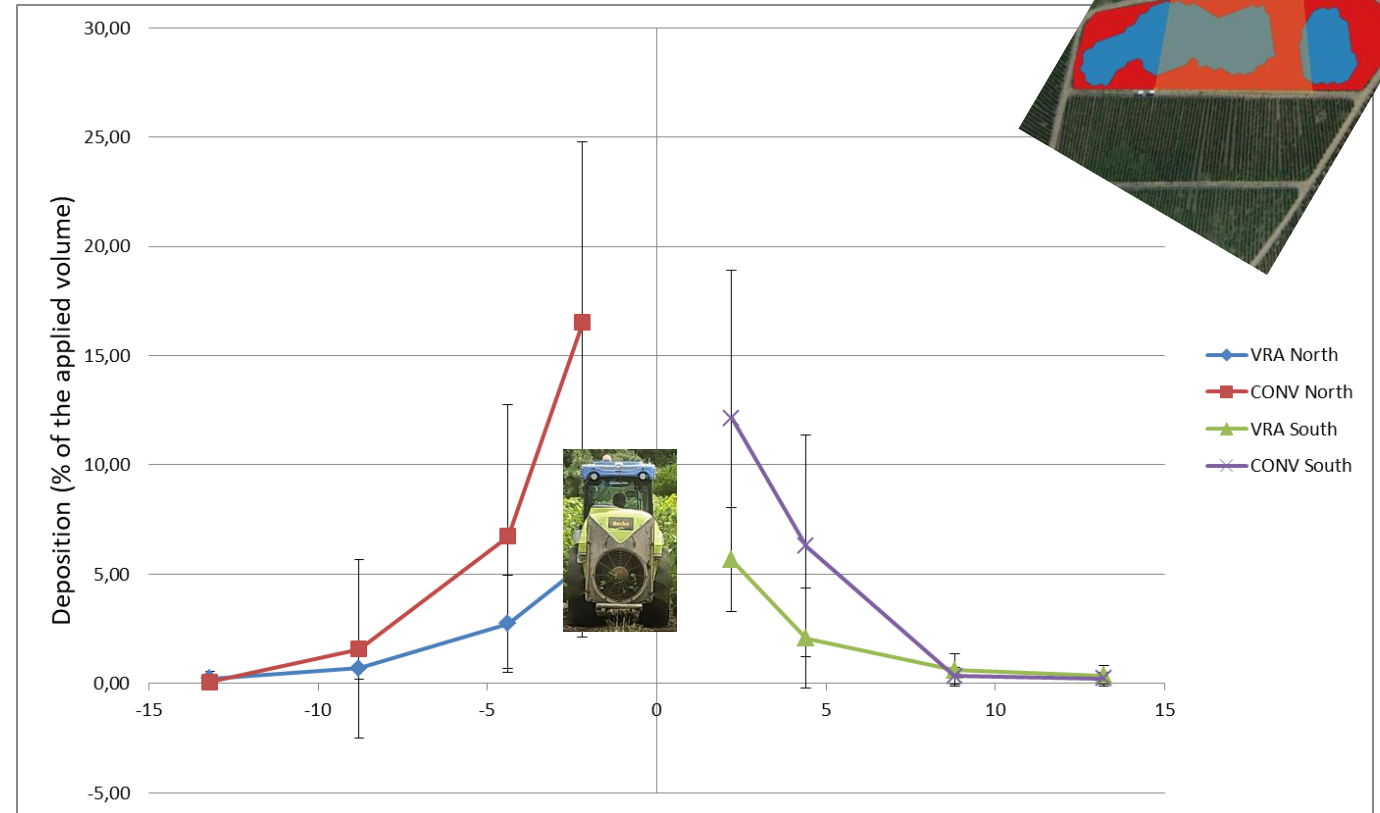
WP3 – T3.6 – Drift assessment of VRA (T 3.3)

Total ground losses in season 2023 (sum of ground losses from both sides and dates)



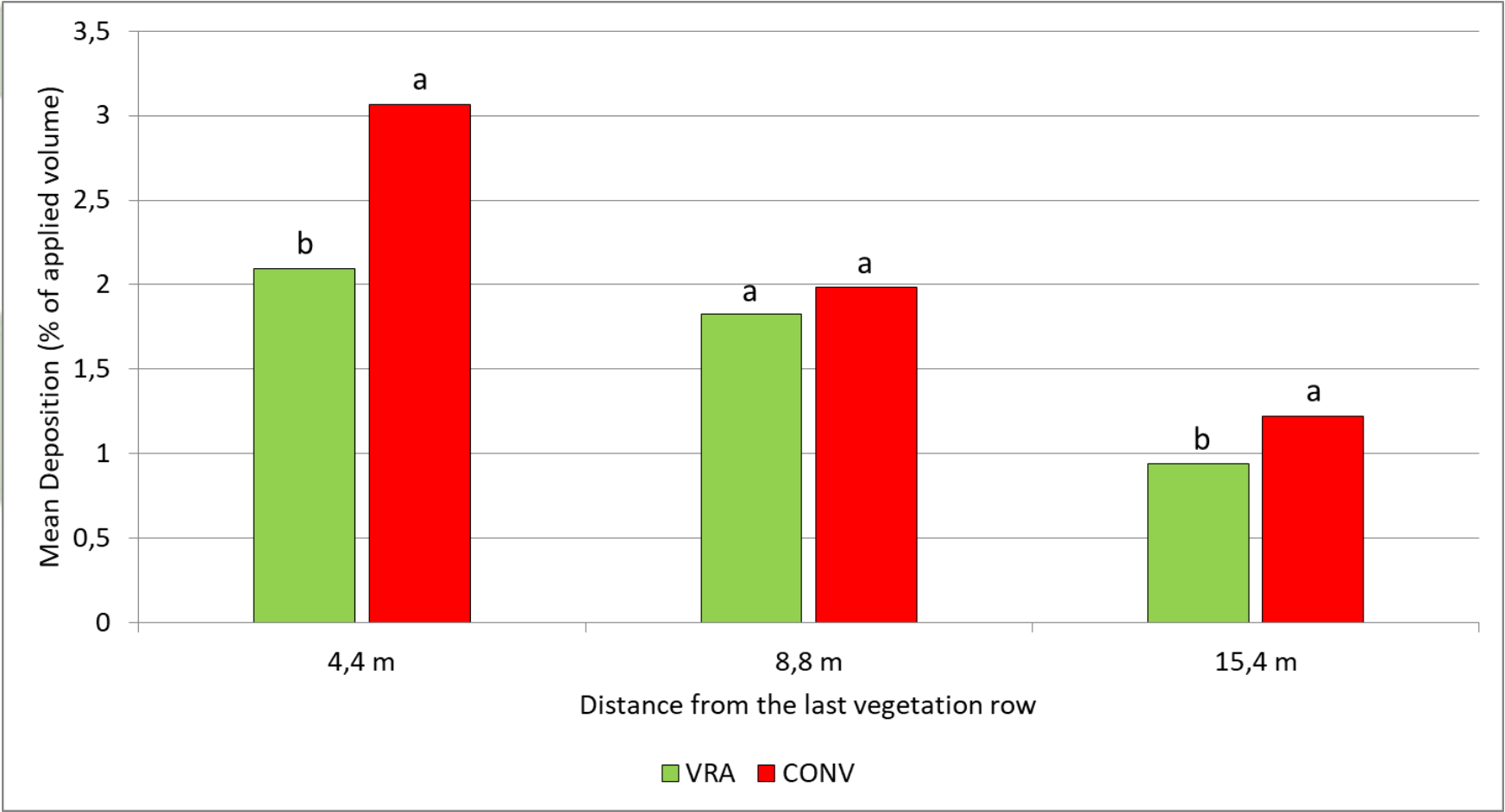
Aggregated data			
Distance	mean VRA	mean CONV	Reduction
2,2	5,54	14,33	61%
4,4	2,40	6,51	63%
8,8	0,65	0,96	32%
13,2	0,30	0,15	0%

Total ground losses per side in season 2023 (sum of ground losses)



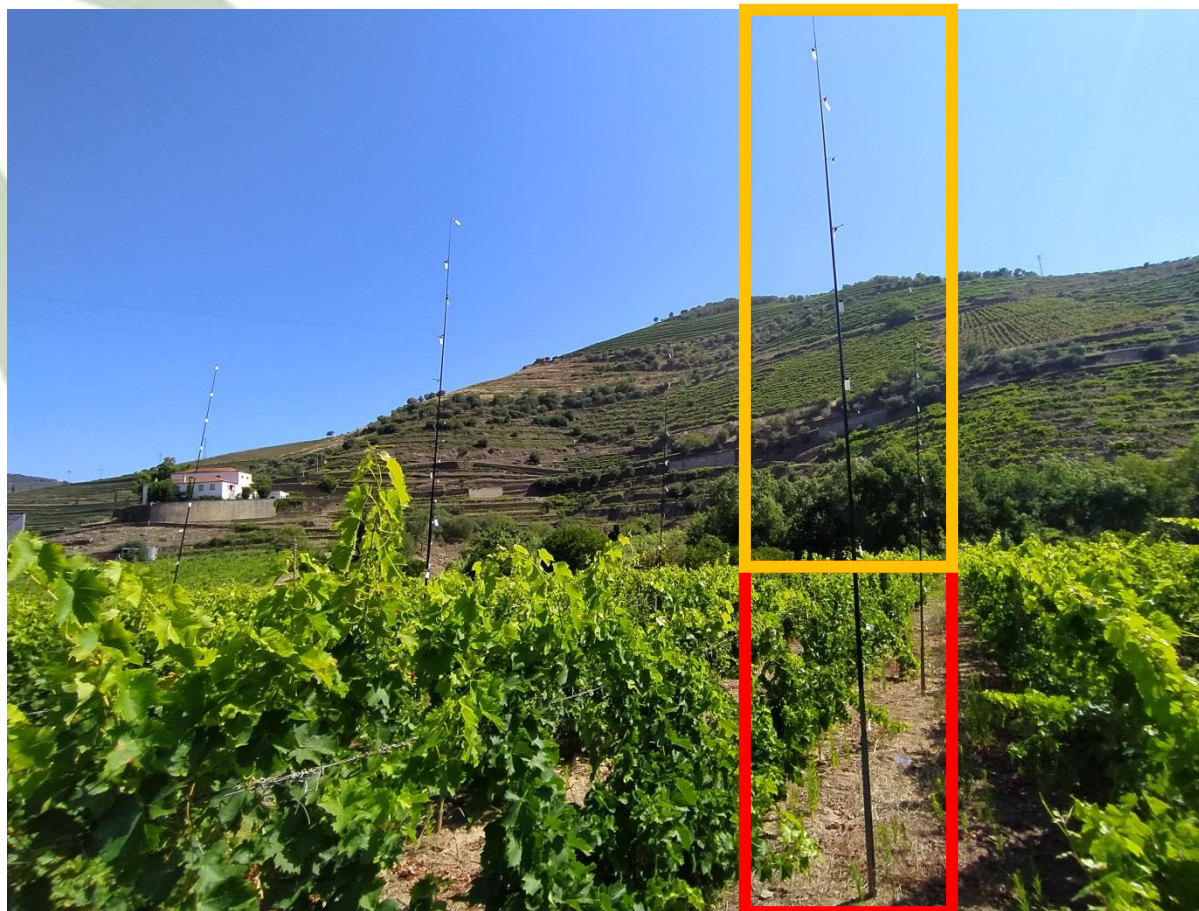
KPI.12	Task 3.5	Reduction of pesticide losses to the ground using the smart platform for spray management	At least 15% reduction of pesticide losses to the ground	Case study report
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Total airborne drift losses in season 2023 (average of airborne losses from both sides and dates)

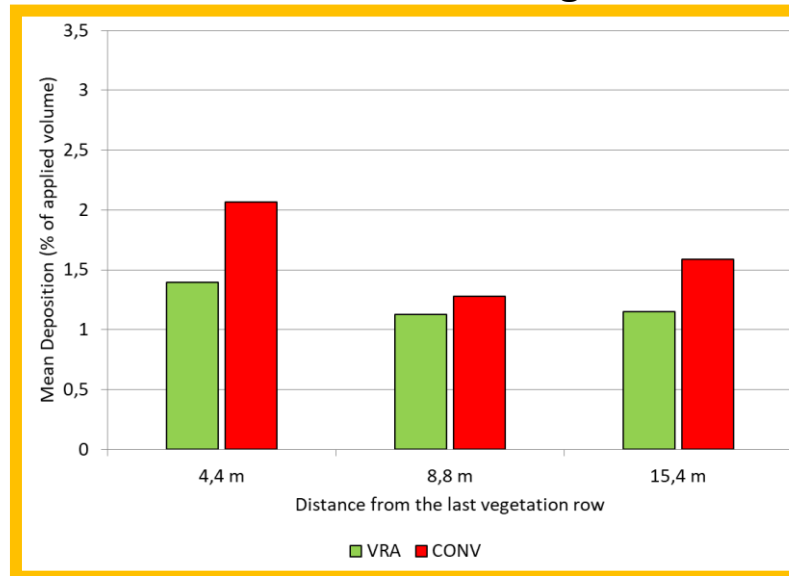


Distance	% Reduction
4,4	32%
8,8	8%
15,4	10%

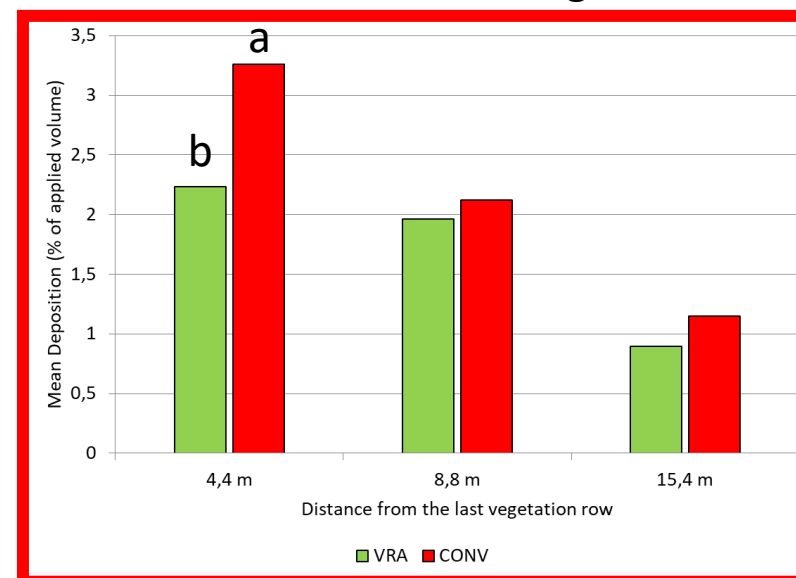
KPI.14	Task 3.6	Reduction of the risk of environmental contamination using the new technologies for pesticide application	Drift reduced at least 25%	Case study report
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From 0 – 1.5 m high



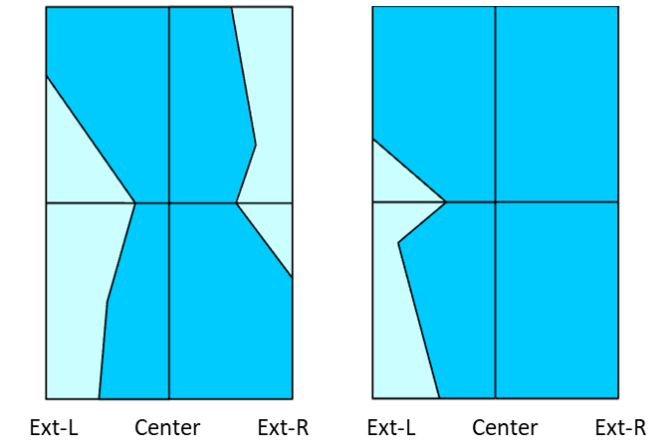
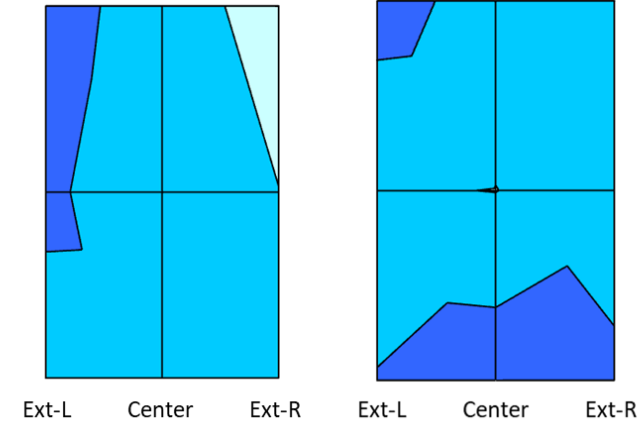
From 1.5 – 6 m high



VRA

Low V

Low V



WP3 – T3.6 – Pilot testing of the new technologies for optimised pesticide application



- **Research paper planned**

Variable Rate Technology in mountain viticulture, satellite based canopy map validation and biological efficacy assessment

- **Research paper planned**

Drift and ground losses reduction using VRA

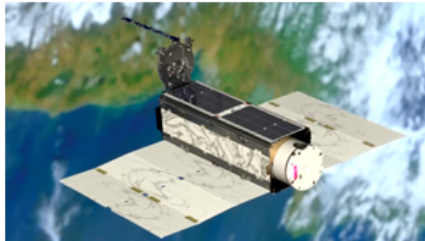


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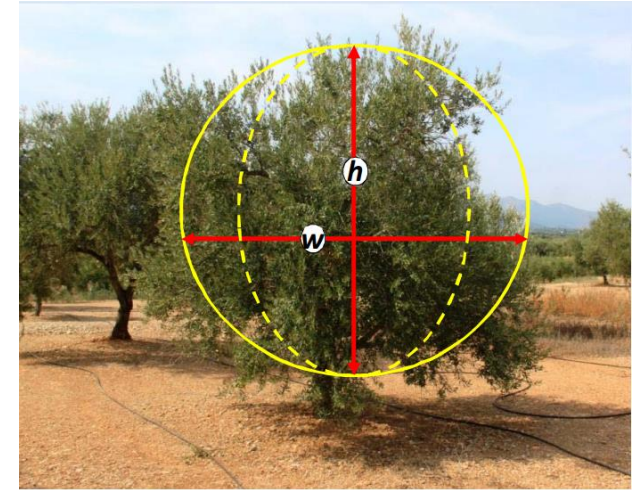
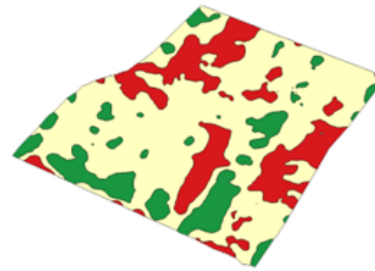


Objective of T3.3 – Olive trees

Satellite imagery

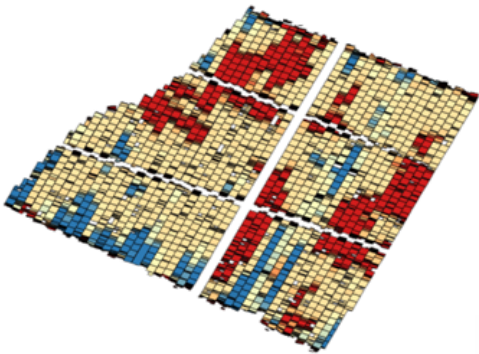


Vigor Map (NDVI)

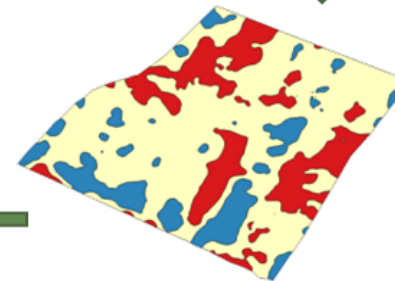


Evaluate Canopy Characteristics

As applied map
(L/Ha)



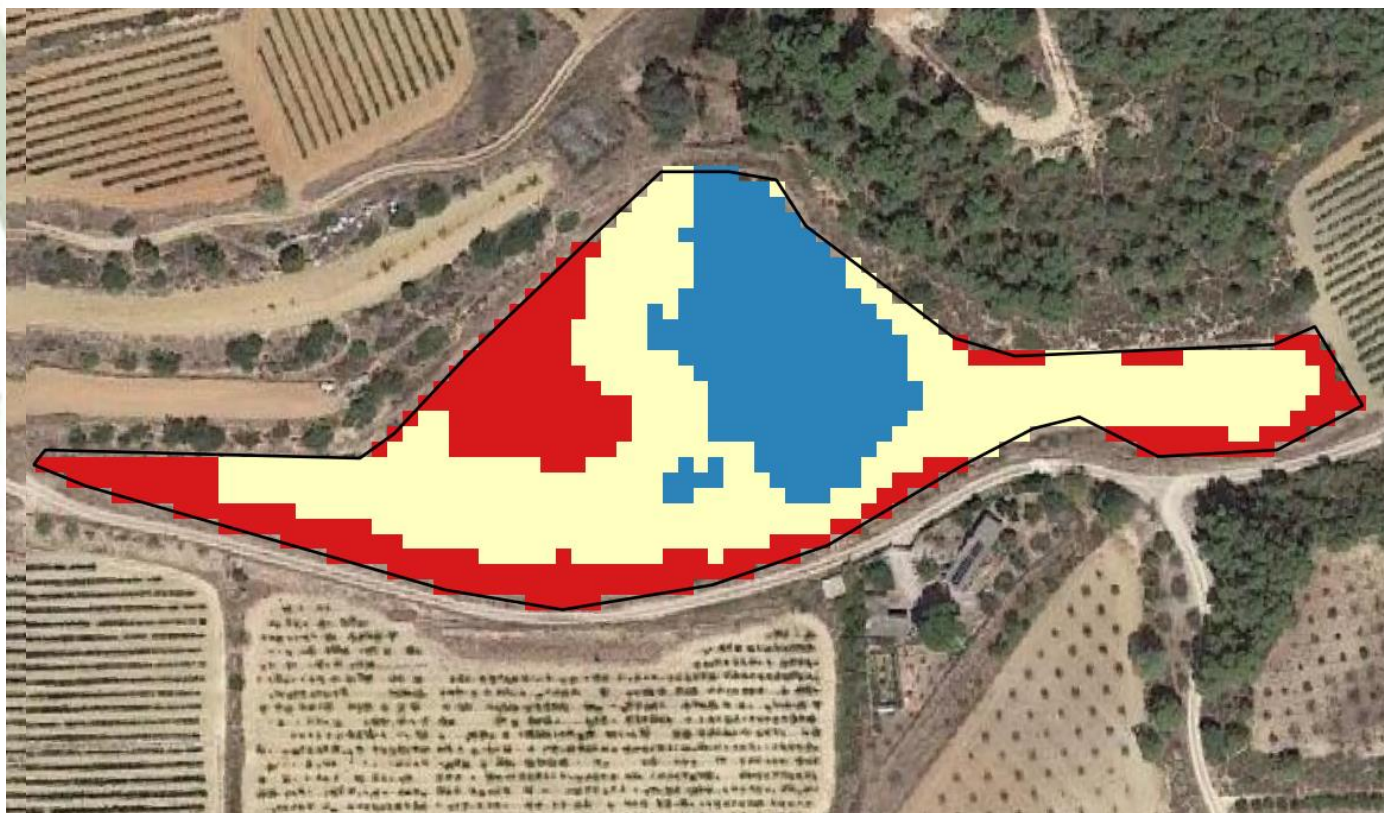
Prescription
maps (L/Ha)



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WP3 – T3.3 – Development of a holistic methodology for a smart canopy characterization – Results in olive trees



	Tree volume (m3)
1	6,5
2	11,8
3	16,6



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WP3

TASK 3.4

Develop a machine learning based system for
optimizing crop spraying



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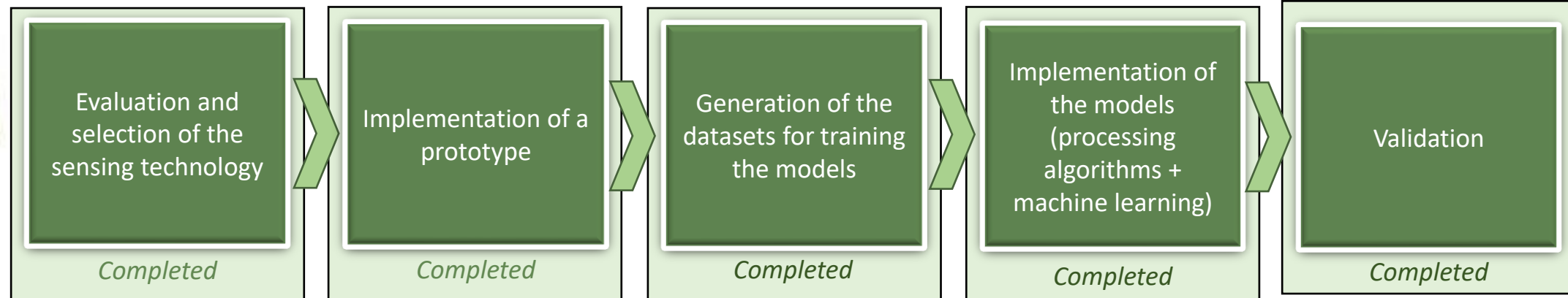


Objective of T3.4

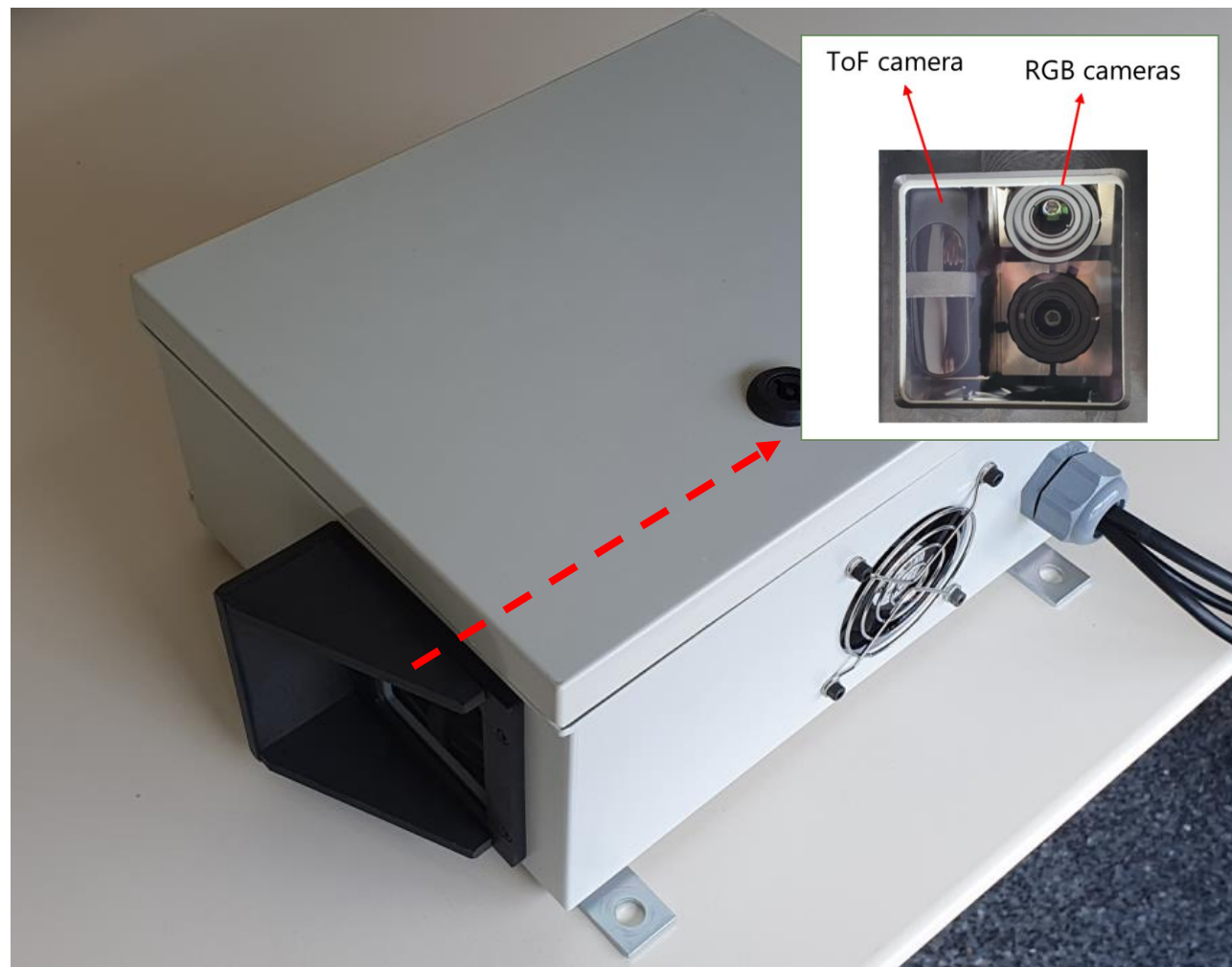
- To develop an automatic system for on-ground georeferenced characterization of the canopy of grapevine and olive trees.
- It would allow a smarter PPPs application, as it will enable to determine the optimal spraying parameters depending on the actual vegetation characteristics at each point of the plot (higher spatial resolution than the prescription maps generated in task 3.3).

Progress status:

M6



Optical sensor developed



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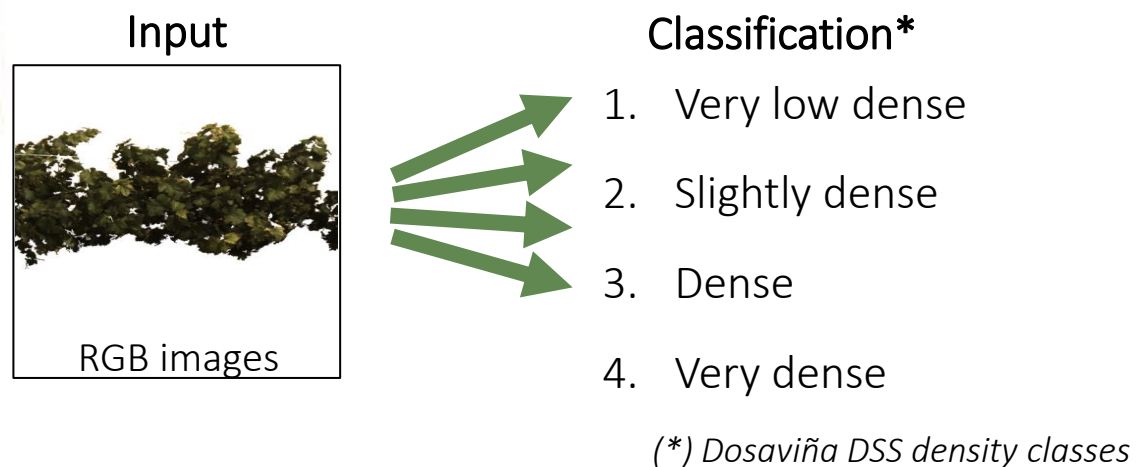
Results of the Machine Learning model

VINYARD – Height evaluation

Mean absolute error (manual) = 12 cm
Mean absolute error (Sensors) = 14.8 cm

VINYARD – Density evaluation

Validation accuracy = 65%



OLIVE – Height evaluation

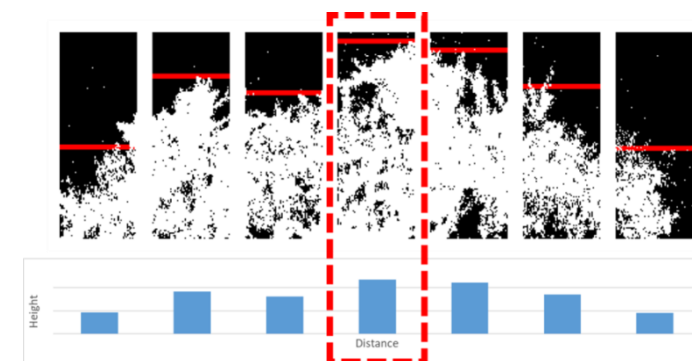
- Super-intensive

Mean absolute error = 11.6 cm

- Traditional

Mean absolute error HEIGHT = 18.4 cm

Mean absolute error WIDTH = 18.4 cm

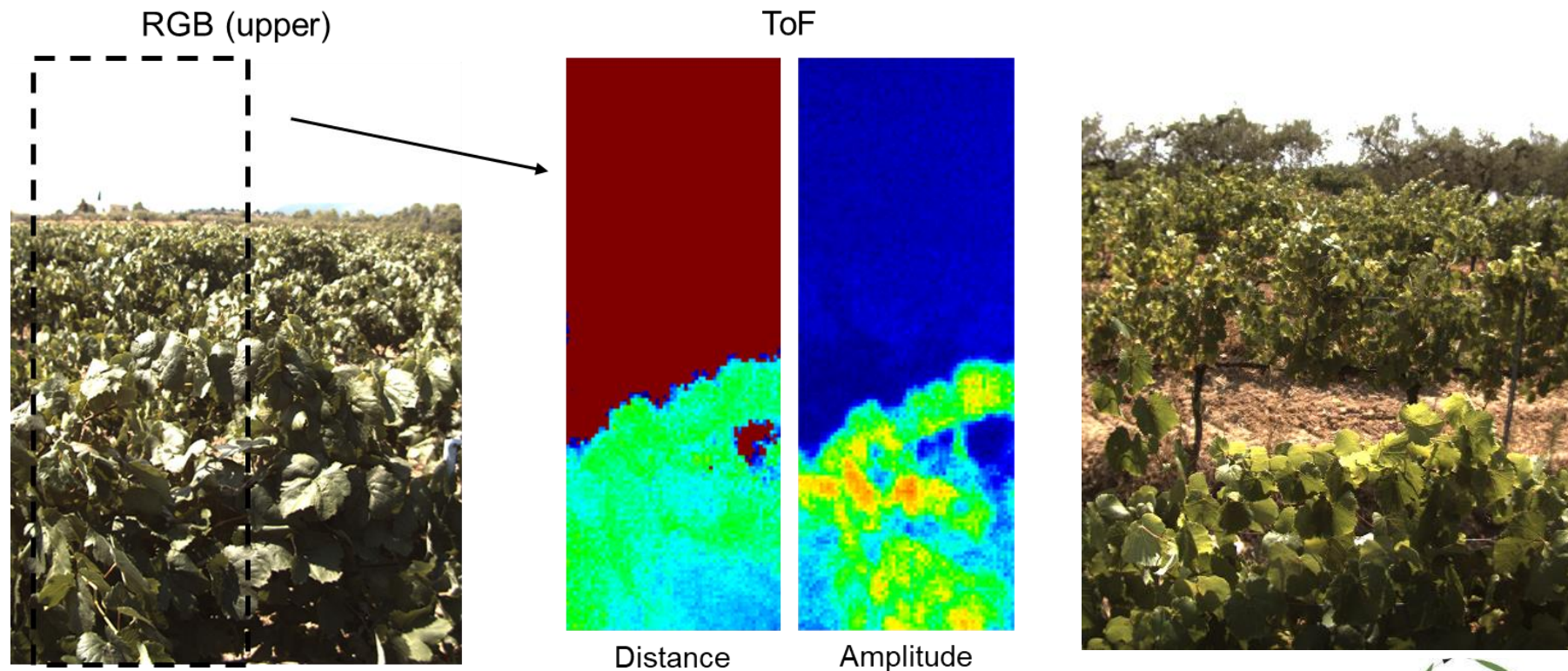


WP3 – T3.6 – Pilot testing of the new technologies for optimised pesticide application



- Research paper under work

Low cost system based on artificial vision and machine learning for the automatic on-ground characterization of the canopy in vineyard and olive groves



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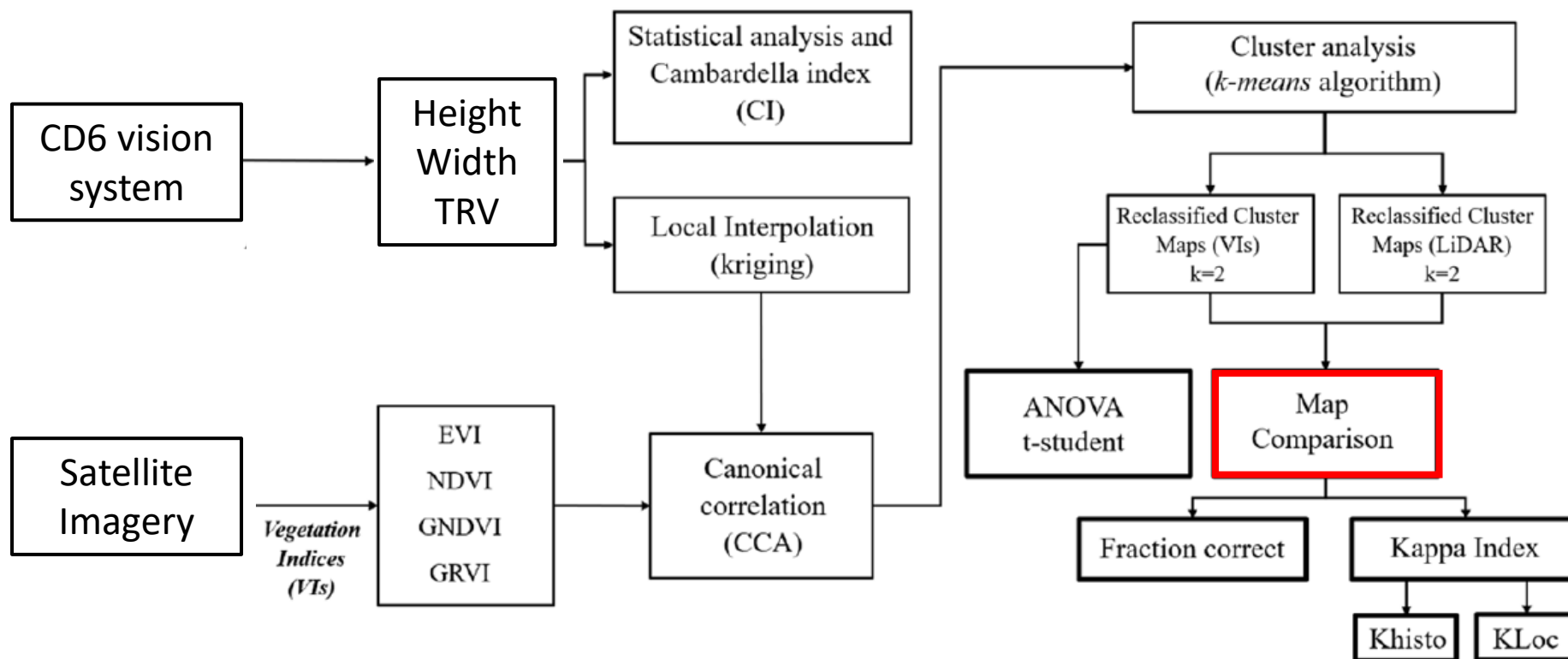


WP3 – T3.6 – Pilot testing of the new technologies for optimised pesticide application



- Research paper under work – Computers and Electronics in Agriculture

Compare the maps generated with ground-based vision system vs. satellite based maps



Modified from Sandonís-Pozo et al., 2022



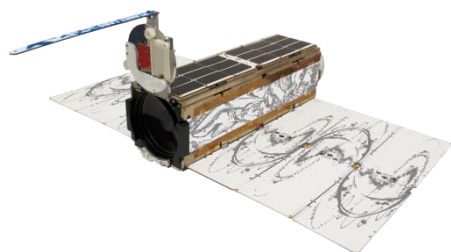
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WP3 – T3.6 – Pilot testing of the new technologies for optimised pesticide application



- Preliminary results



TRV



NDVI



Dia 1

Dia 2

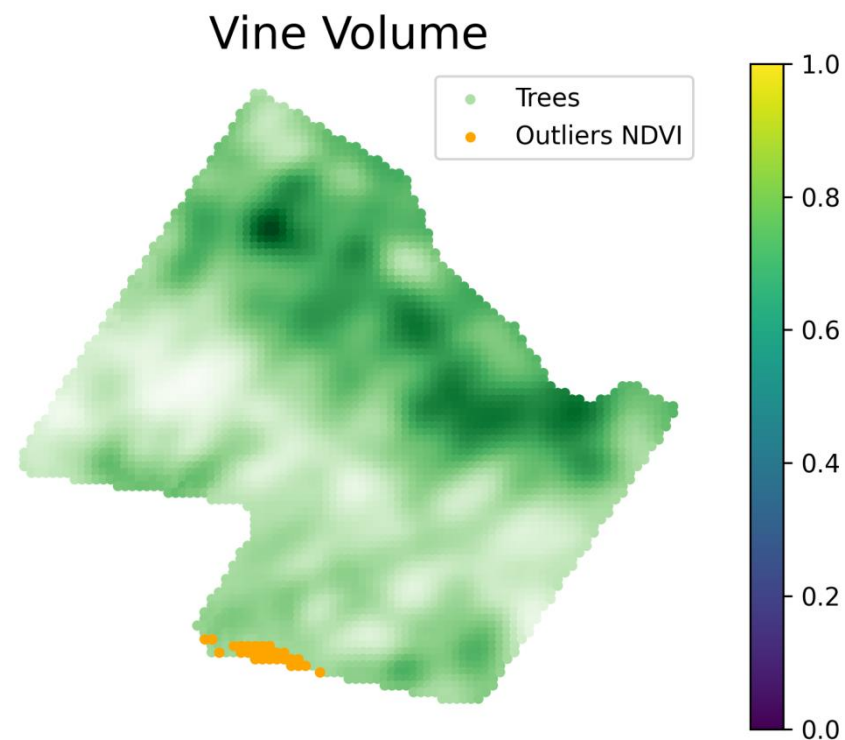
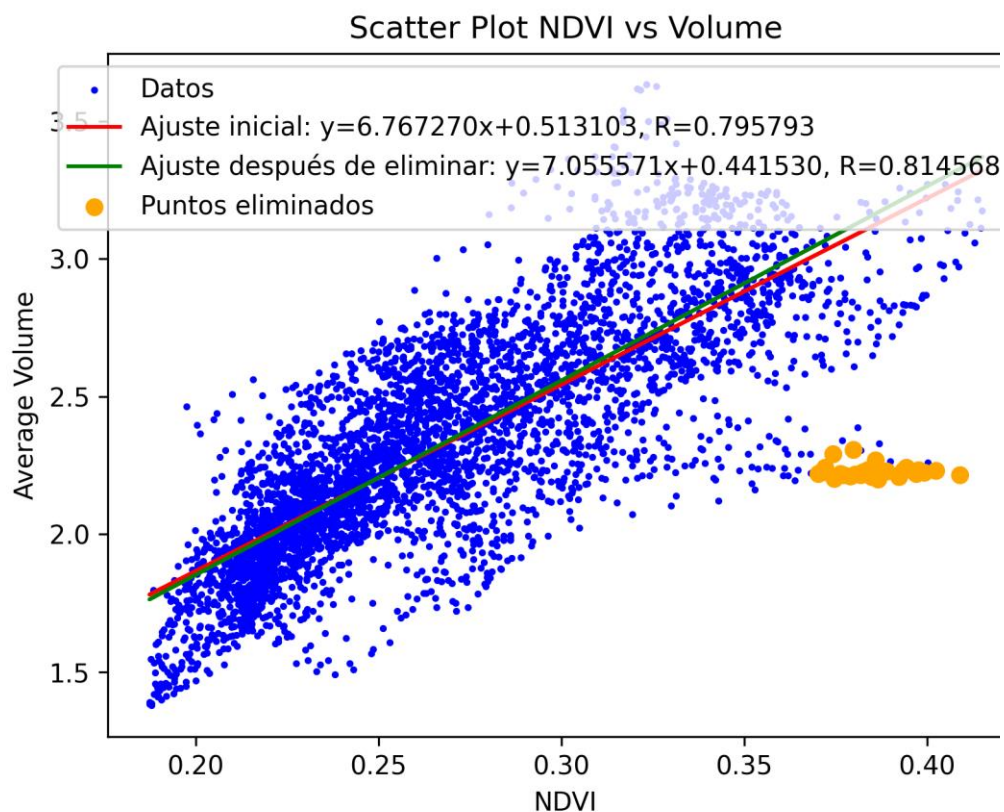
Dia 3



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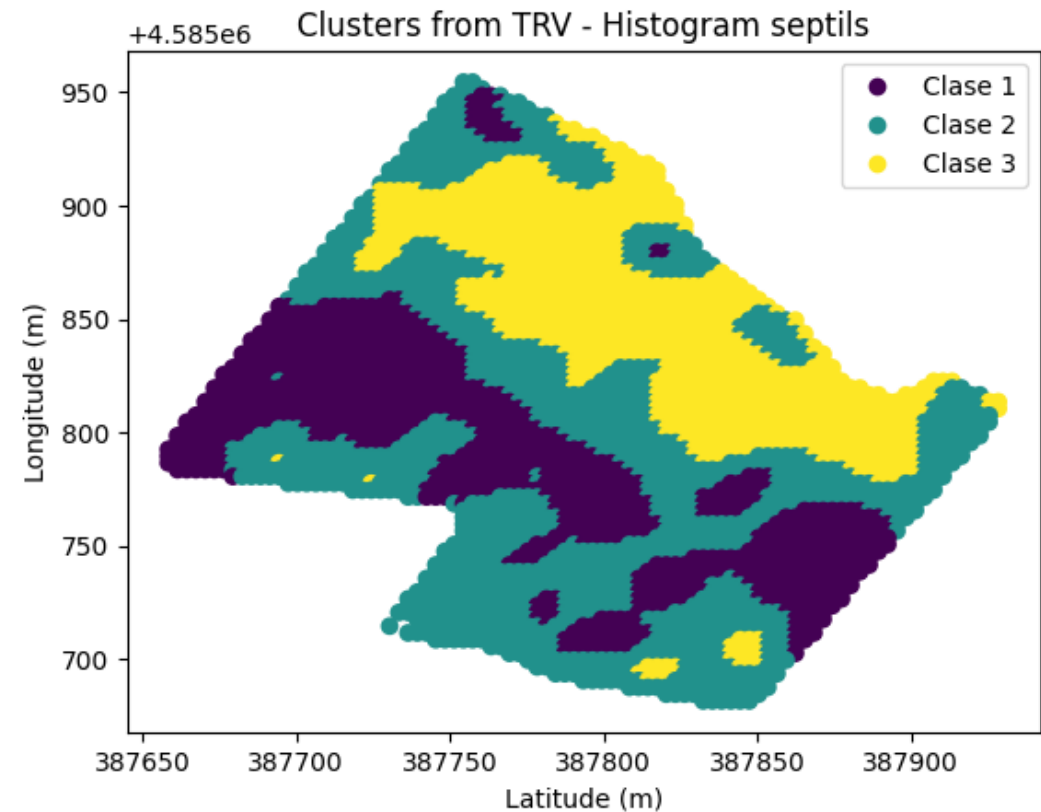
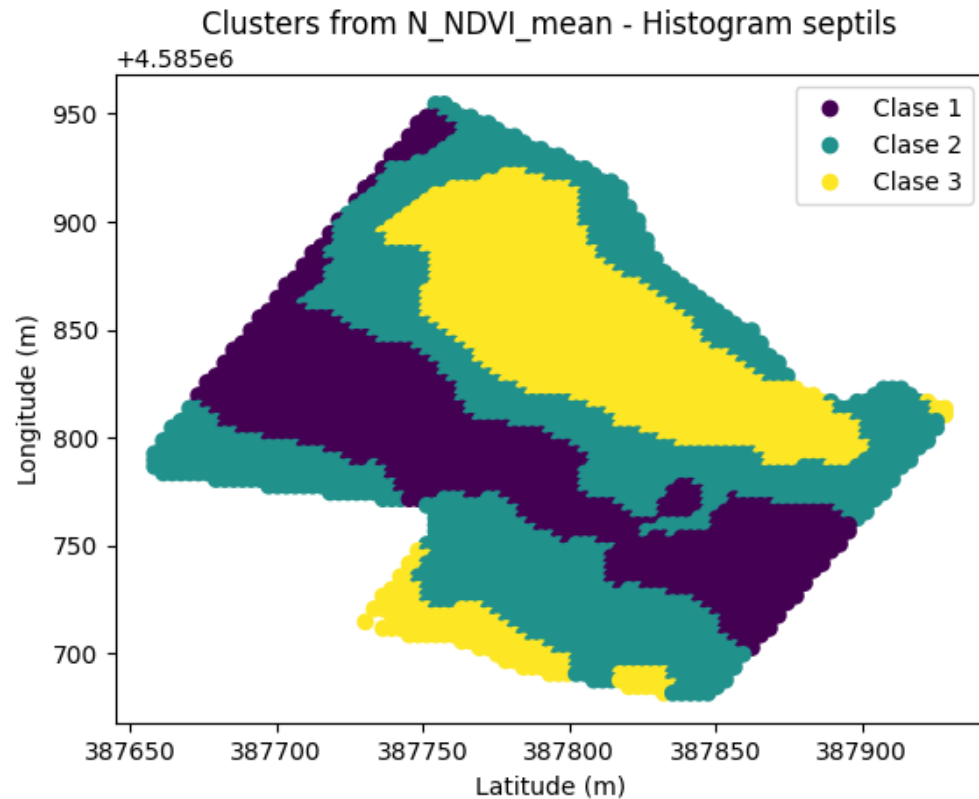
WP3 – T3.6 – Pilot testing of the new technologies for optimised pesticide application



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WP3 – T3.6 – Pilot testing of the new technologies for optimised pesticide application



MEASURE OF SIMILIARITY IN NEARLY 75% OF THE PIXELS IN THE THREE GROWTH STAGES



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WP3

TASK 3.5

Develop an advanced Decision Support System for
olive trees and grapevines' pests and diseases
management



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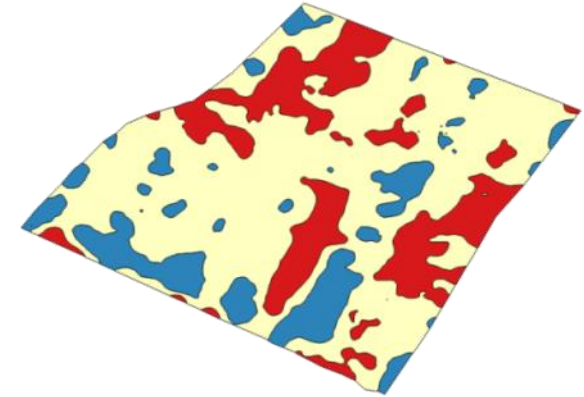


Concept

Weather forecast data

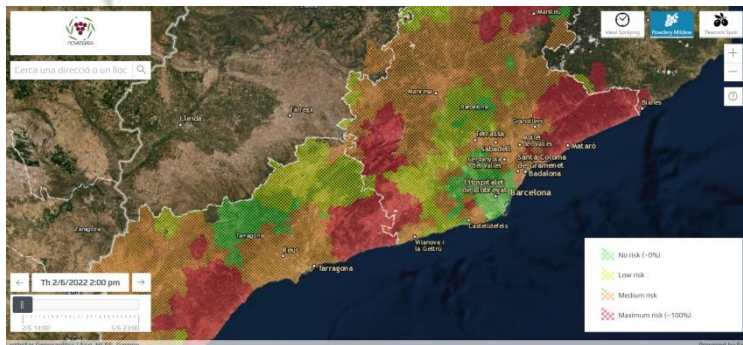


Satellite based prescription maps



Smart
platform

Risk of pest/disease



As applied data from smart sprayer



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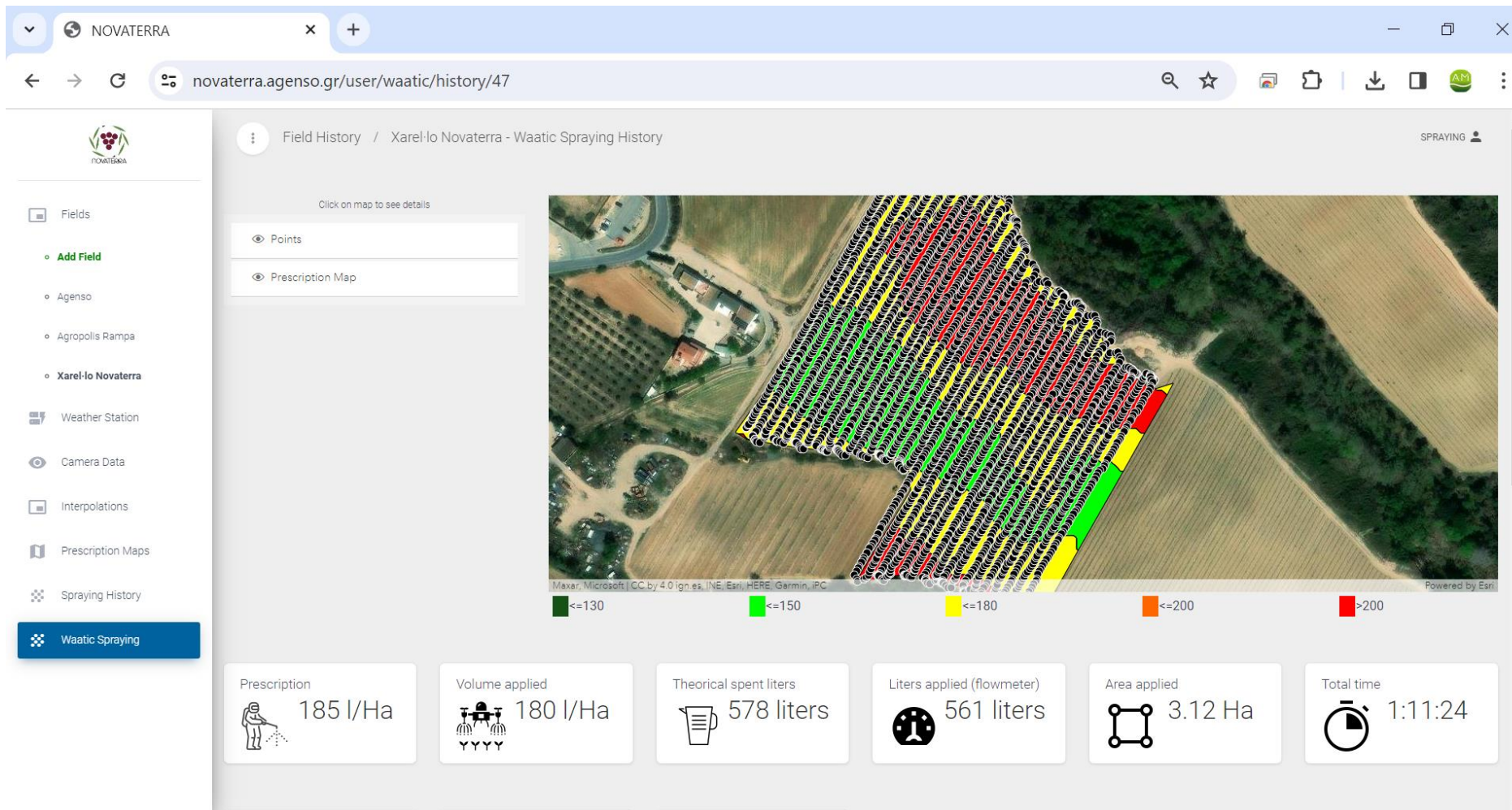
WP3 – T3.5 – Development of a smart platform for a holistic spray application process



The NOVATERRA project has received funding from the European Commission's Horizon 2020 Grant Agreement Number 101000554.



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WP3

TASK 3.6

Pilot testing of the new technologies for optimised
pesticide application



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WP3

DEVIATIONS FROM GRANT AGREEMENT



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KPI

DEVITATIONS from Grant Agreement

KPI.9	Task 3.1	Disease presence verification in every image	accuracy greater than 75%	Case study report	Achieved
KPI.10	Task 3.1	Vision system can withstand real-time operation scenarios	prediction capacity of minimum 6 fps.	Case study report	Achieved
KPI.11	Task 3.2	DSS is able to support a relevant number of pests and diseases	Minimum 5 pests and diseases supported	Case study report	Achieved
KPI.12	Task 3.5	Reduction of pesticide losses to the ground using the smart platform for spray management	At least 15% reduction of pesticide losses to the ground	Case study report	Achieved
KPI.13	Task 3.6	Reduction of amount of pesticides using the new technologies for pesticide application	Reduction of amount 15% in average compared to current practices	Case study report	Achieved
KPI.14	Task 3.6	Reduction of the risk of environmental contamination using the new technologies for pesticide application	Drift reduced at least 25%	Case study report	Achieved





WP3 – DEVELOPMENT OF A READY-TO-USE SMART FARMING PLATFORM FOR CROP PROTECTION MANAGEMENT

June 2024



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