EXPO FLORIADE – 30/09/2022 - AMSTERDAM

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952879

Agenda

- Presentation
- Horizon2020 Programme
- SolaQua Project
- SISIFO - WebApp
- Business models
- Irrigation & Crop Need
- Irrigation Flow Diagram
- Water Balance
- IoT monotoring systems
- Precision Agronomist
- Contact

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Who am I?

- Marco Fiorentini

- Senior Agronomist
- PhD Student UNIVPM – CONAF
- Co-Founder Automatic Farm Solution

- Precision Agriculture
- Remote sensing
- R & Python
- Artificial Intelligence

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Horizon 2020 Project

Framework Program for research and innovation

- N. Project 952879
- 1.757.211,00 €
- 36 months starting from 1 October 2020
- 6 countries involved

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SolaQua Project - Nutshell

SolaQua

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Increasing the share of renewable energy in Europe

Bringing the "Photovoltaic Irrigation" market to life.

Combine

"Photovoltaic Technology"

"Hydraulic Engineering"

"High-efficiency water management to optimize irrigation"

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Traditional systems vs SolaQua

Stand Alone system

- Small power, less than 40 kW
- Used to irrigate small plots.
- Could irrigate large areas, only when coupled with national grid or batteries.
- Economically impractical because of their high price.

SolaQua

- Stemming from previous experience with the European project MASLOWATEN.
- UPM has developed a solution to overcome technical and economic problems.
- Saving more than 70% of the cost of electricity.

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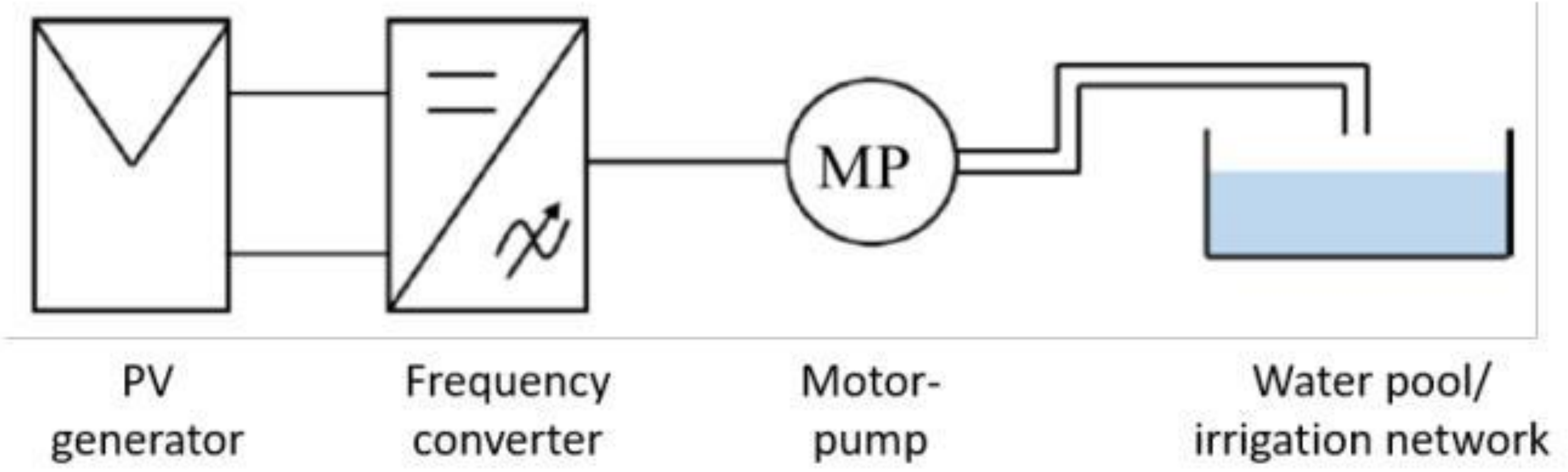
Main component



1. It should be integrated with the pre-existing irrigation system
2. Match photovoltaic production and meet the water needs of crops.
3. Be robust against fluctuations in PV output due to passing clouds
4. Ensure its operation for at least 25 years

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1. Integrate with existing irrigation systems

- A significant part of the potential market for photovoltaic irrigation will be the retrofit of existing irrigation systems powered by the national grid or diesel generators

Retrofit

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2. Matching Electrical Production and Crop Demand

1. PV energy, water availability, and crop water needs change throughout the year.
2. When designing a PV irrigation system, both solar energy and water resources should be considered.
3. High energy requirement for irrigation in summer months, when there is higher PV production.
4. Low energy requirement for irrigation in the winter months and then supply of that energy in the national grid

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2. Matching Electrical Production and Crop Demand

North-South horizontal axis tracker as it has four main advantages:

- It maximizes the pumping of water into the irrigation system during the summer period
- The daily irradiation profile is practically flat
- The tracker system allows the daily irrigation period to be extended when compared with the static system.
- Requires less rated power to pump the same volume of water than static PV structures

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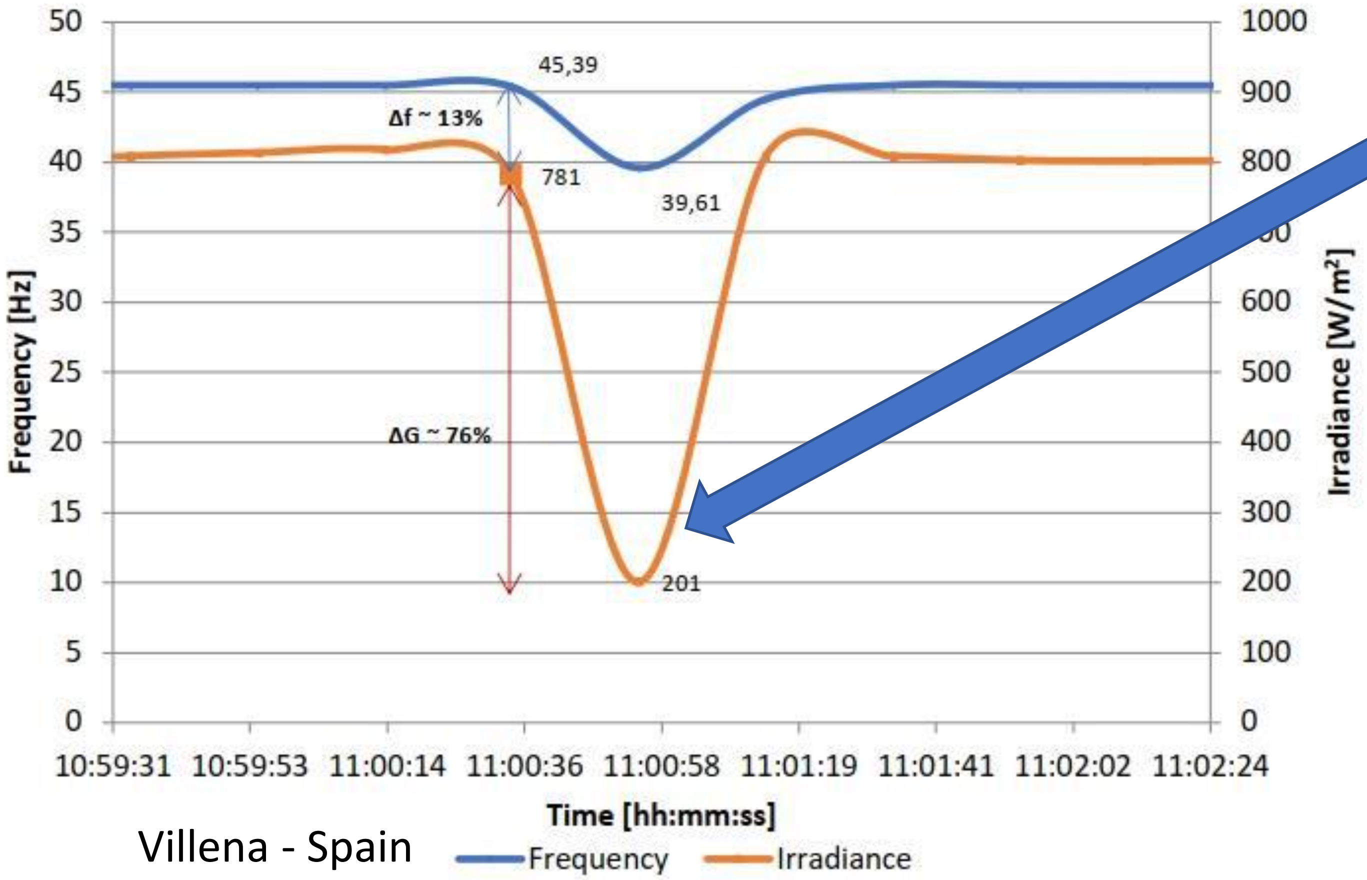
3. Resist fluctuations generated by the passage of clouds



Villena - Spain

- Ensure economic feasibility for large power systems that do not integrate batteries.
- The rapid intermittency of PV power due to the passage of clouds can result in instability and sudden motor shutdown leading to a surge that threatens the integrity of hydraulic and electrical components.
- These instabilities have been resolved through the implementation of specific control procedures and algorithms.

PATENTED

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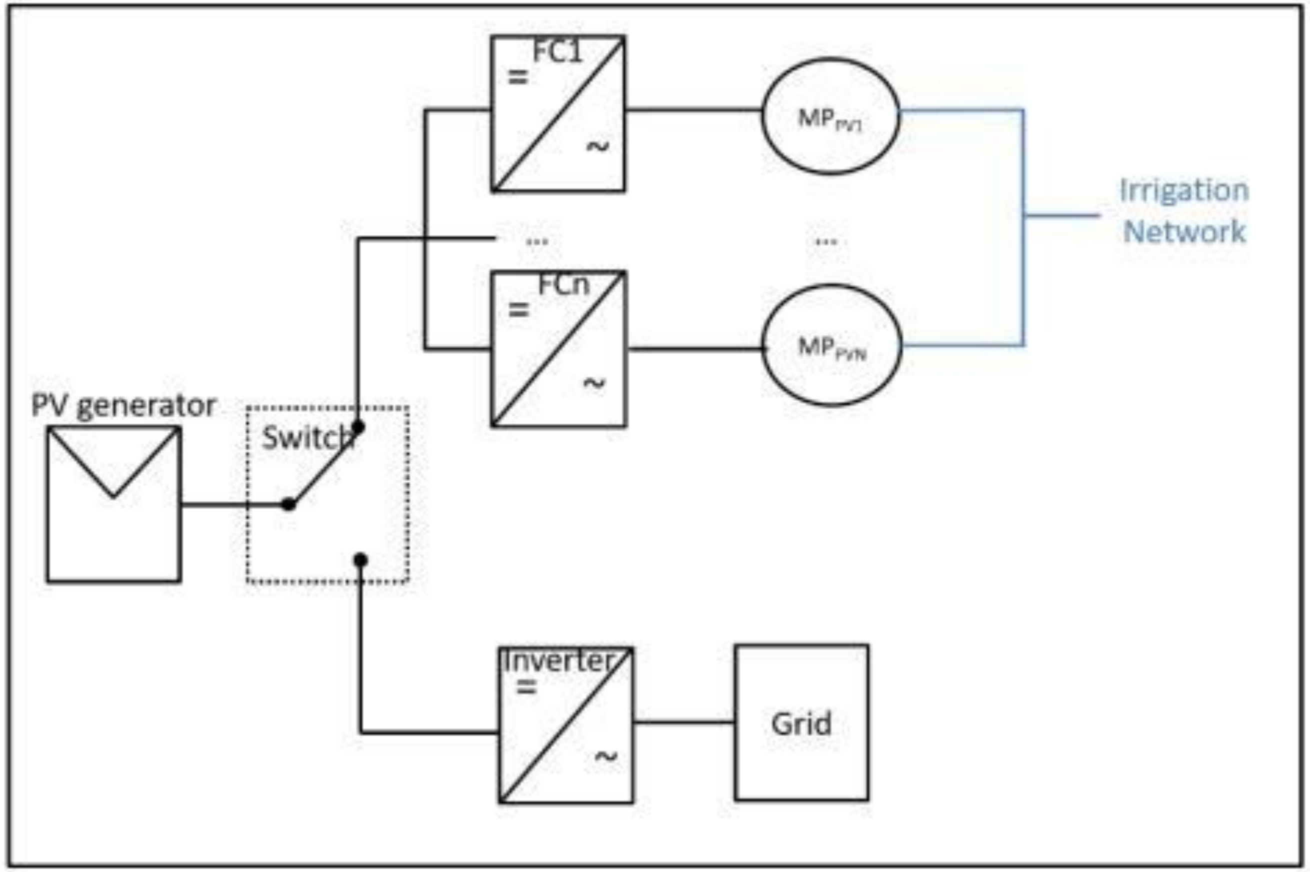
FAQ – Frequently Asked Questions

- It is possible to sell the produced energy when the irrigation system doesn’t work?



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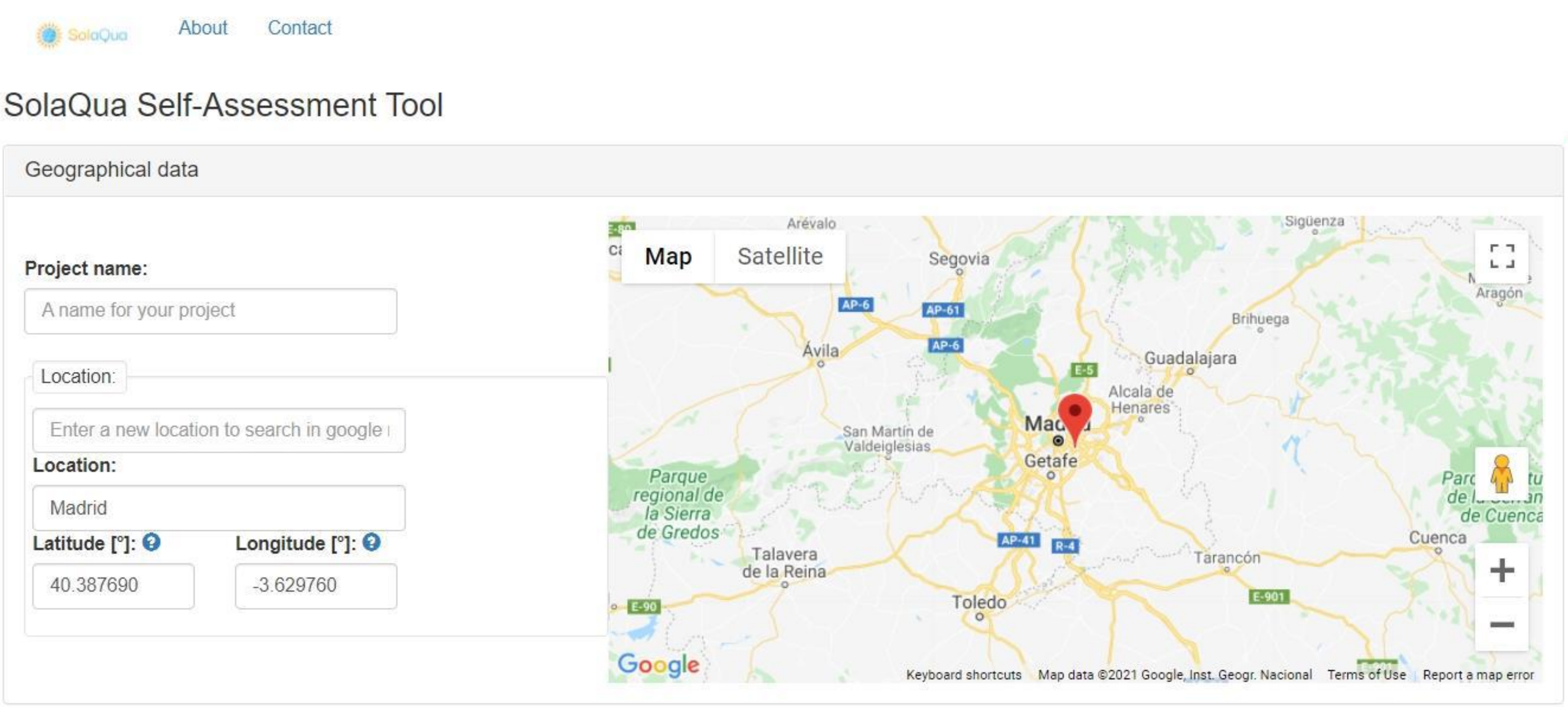
WebApp – Preliminary Pianification

https://www.sisifo.info/en/solaqua/datainput

Input data:

1. Name of project
2. Location



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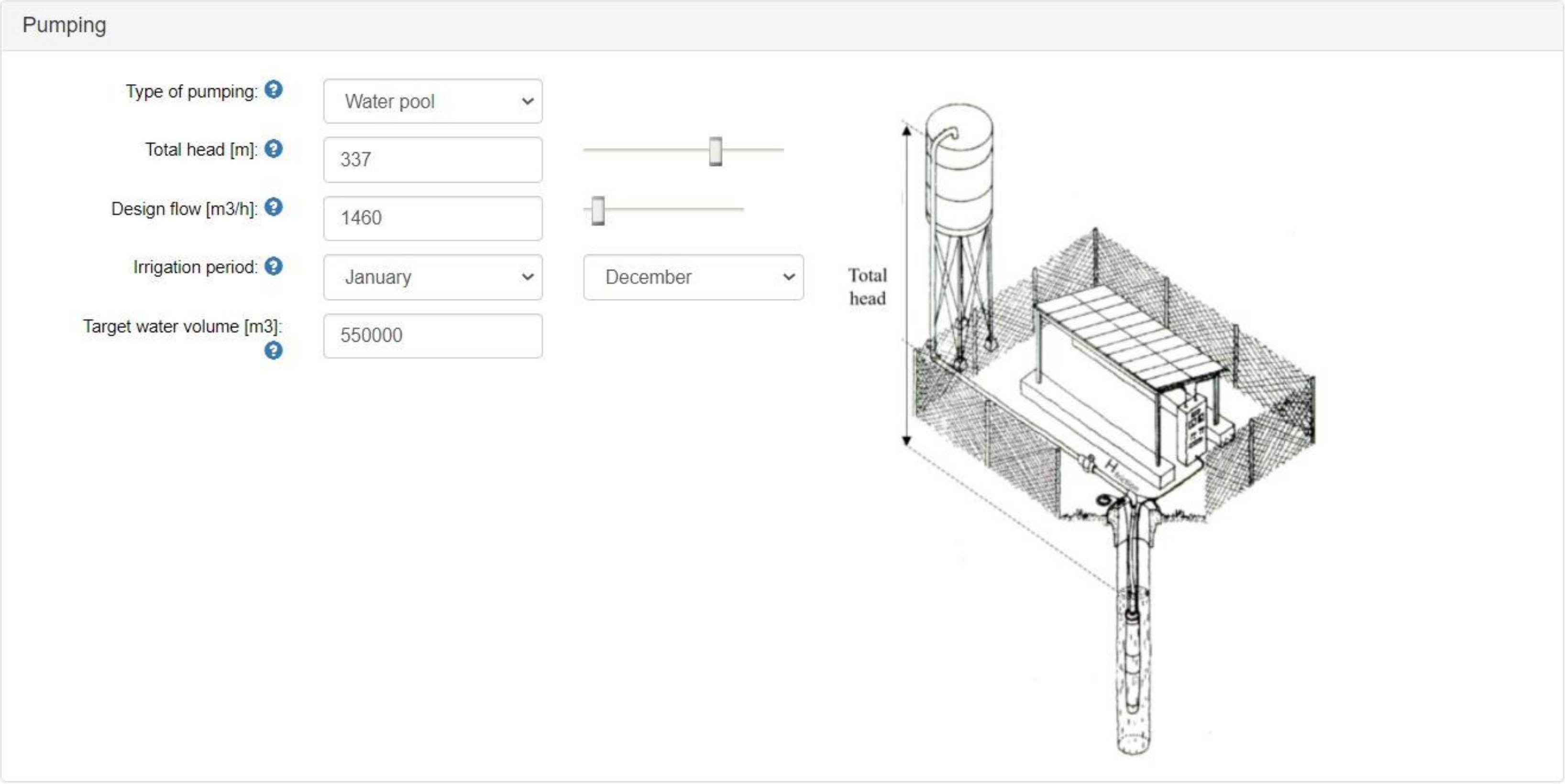
WebApp – Preliminary Pianification

https://www.sisifo.info/en/solaqua/datainput

Input data:

1. Pump type
2. Height above ground
3. m3/h
4. Irrigation period
5. Target water volume



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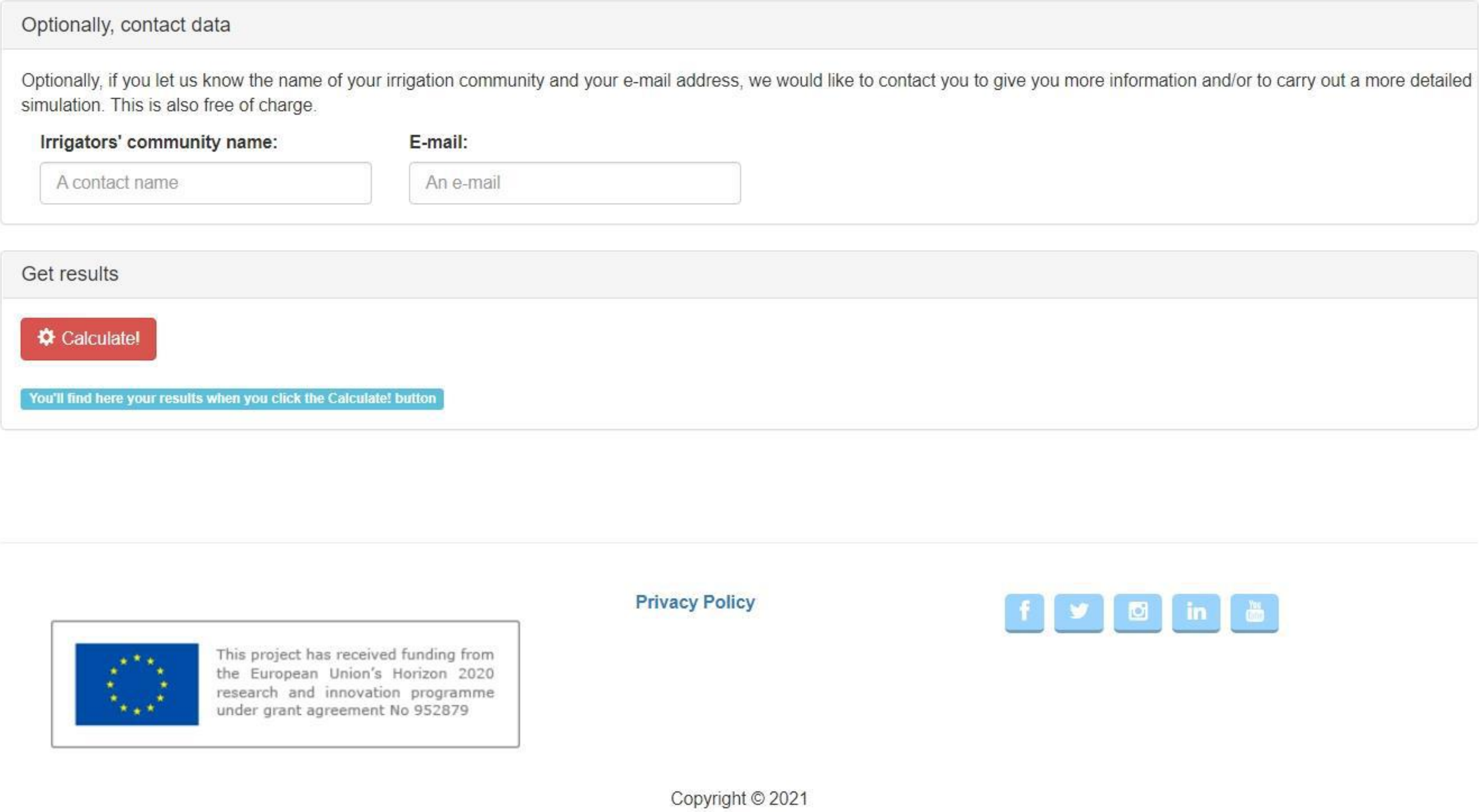
WebApp – Preliminary Pianification

https://www.sisifo.info/en/solaqua/datainput

SolaQua

Input data - Optional:

1. Irrigator Name
2. Email



WebApp – Preliminary Pianification

Below you can find the main results of the PRELIMINARY PLANNING FOR YOUR PV IRRIGATION SYSTEM (PVIS):

- PV peak power: 487.7 kWp
- Yearly energy generated: 602767 kWh
- Yearly water pumped: 550000 m3
- Required surface for the PV generator: 7316 m2

Please, keep in mind that this is a preliminary result for your PV irrigation system. If you want to perform a more detailed simulation, you should use the SISIFO tool, which is freely available at www.sisifo.info. If you want to receive training on how to use the SISIFO tool, please visit www.sol-aqua.eu and apply to participate in one o our training courses.

If these preliminary results are interesting to you and you are seriously considering installing a PVIS, please send us an email to info@sol-aqua.eu for a more detailed project. Under SolaQua project, we want to introduce 100 MW of new PVIS projects!!! If you want to know more about PVIS systems and the SolaQua Project, please visit www.sol-aqua.eu.

Output data:

1. Peak power
2. Annual power production
3. Water pumped per year
4. Required surface area of photovoltaic system

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Business models - PPA

The business model developed is based on PPA (Power Purchase Agreement) and highlights:

- The ability to save up to 70 % electricity from day one onward
- Fixed electrical costs for 20 years
- You also get technical support and maintenance throughout the 20 years

After the 20 years have expired, the farmer can continue with this contract with the cost of 1 euro

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II Part – Example of Smart Irrigation

Marco Fiorentini – CONAF – UNIVPM
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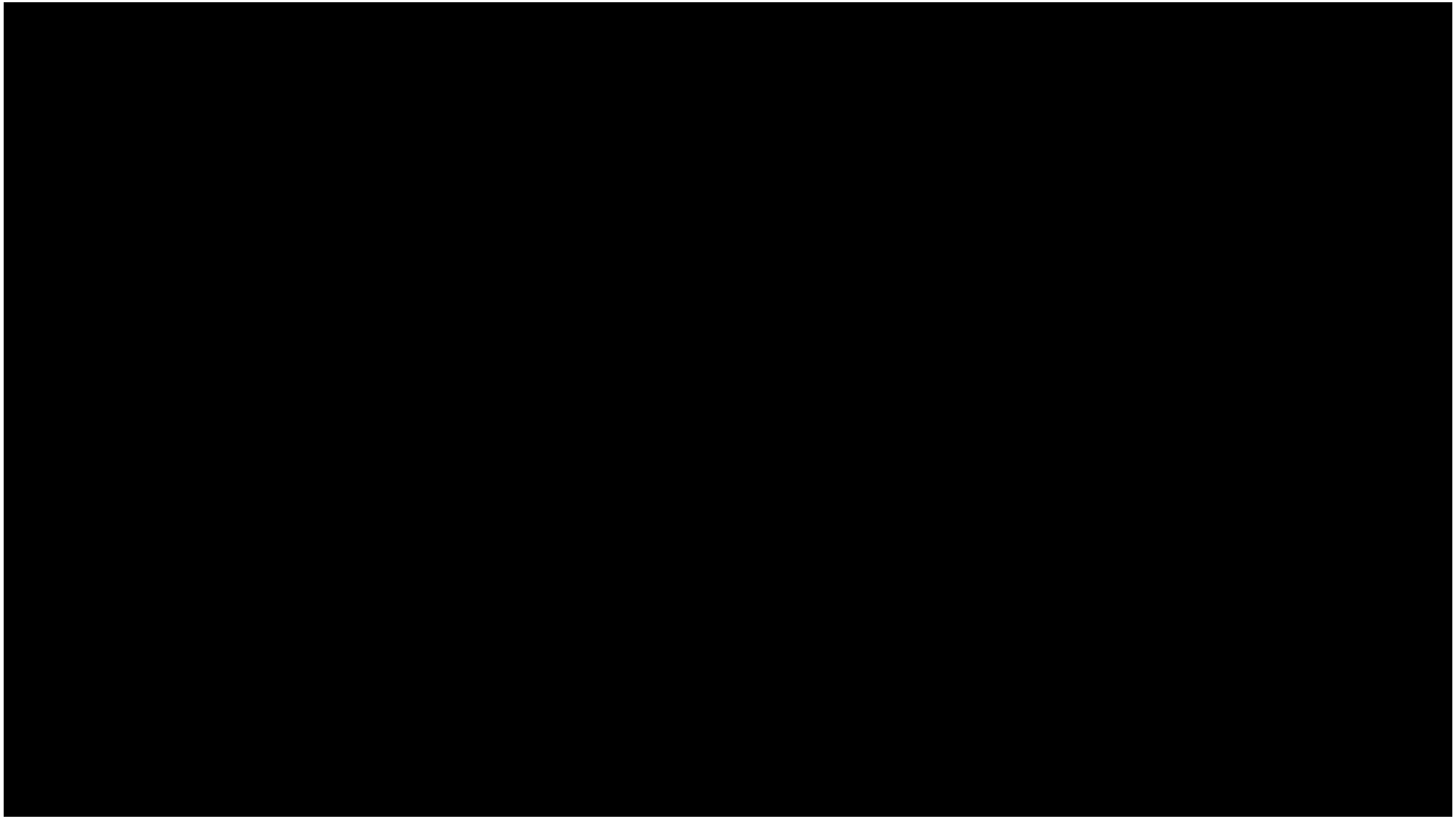
Saudia Arabia – Pivot Irrigation



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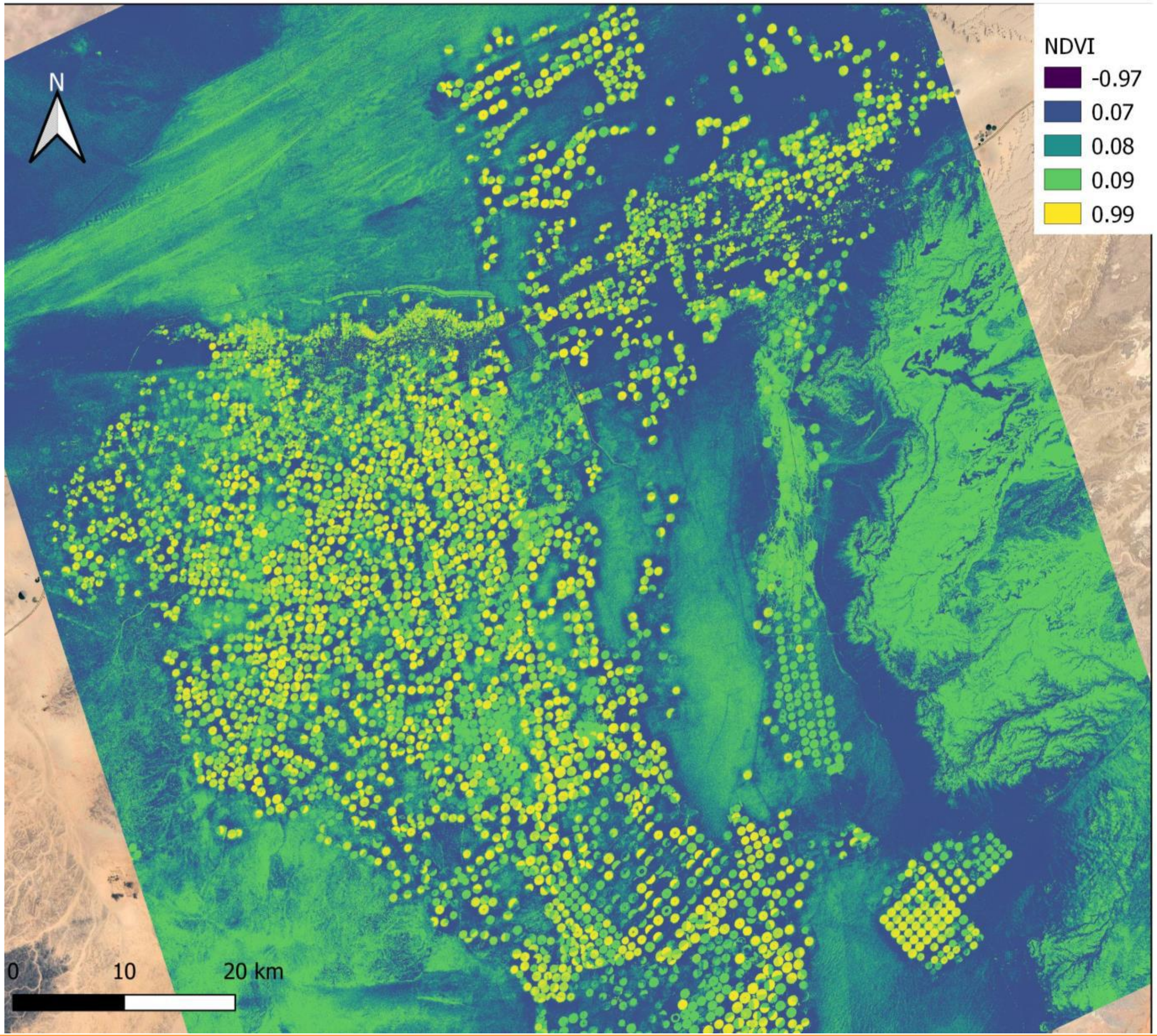
Satellite & Drone – Precision Farming

Arabia
Saudita
Pivot
Satellite



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Satellite & Drone – Precision Farming

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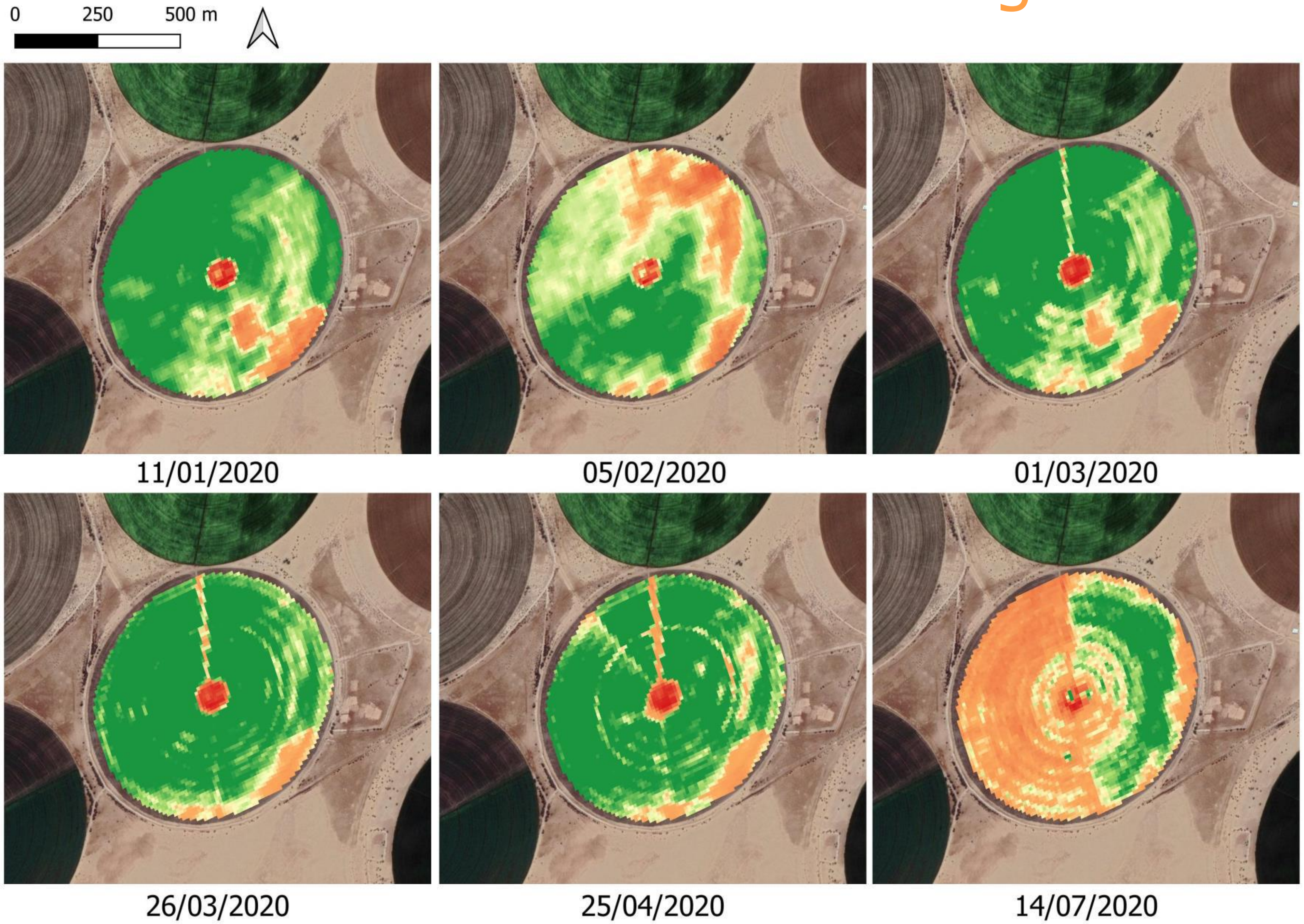

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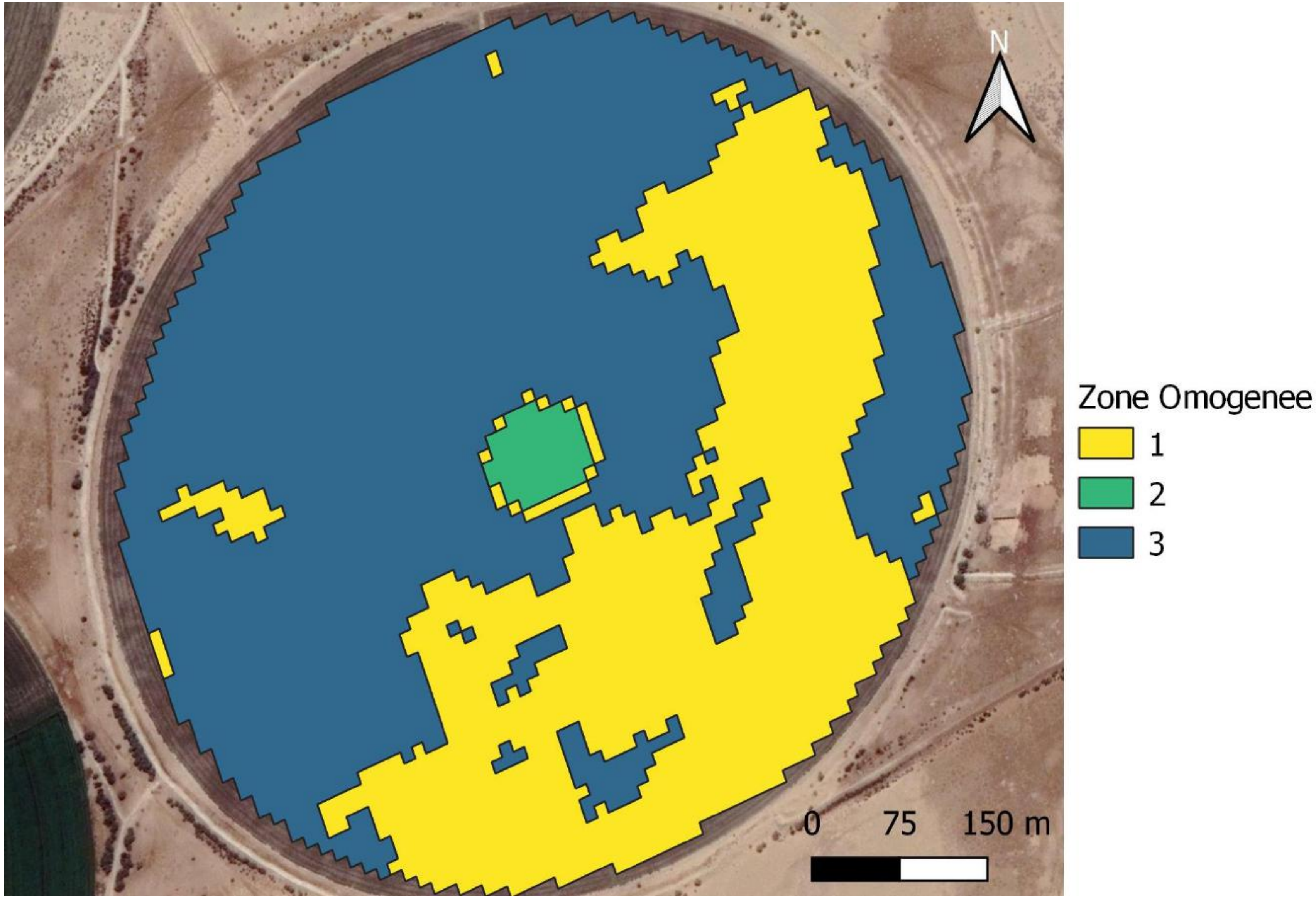
Precision Irrigation – Prescription Maps

Arabia
Saudita
Pivot
Satellite



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Satellite imagery for organic carbon estimation and photovoltaic irrigation efficiency

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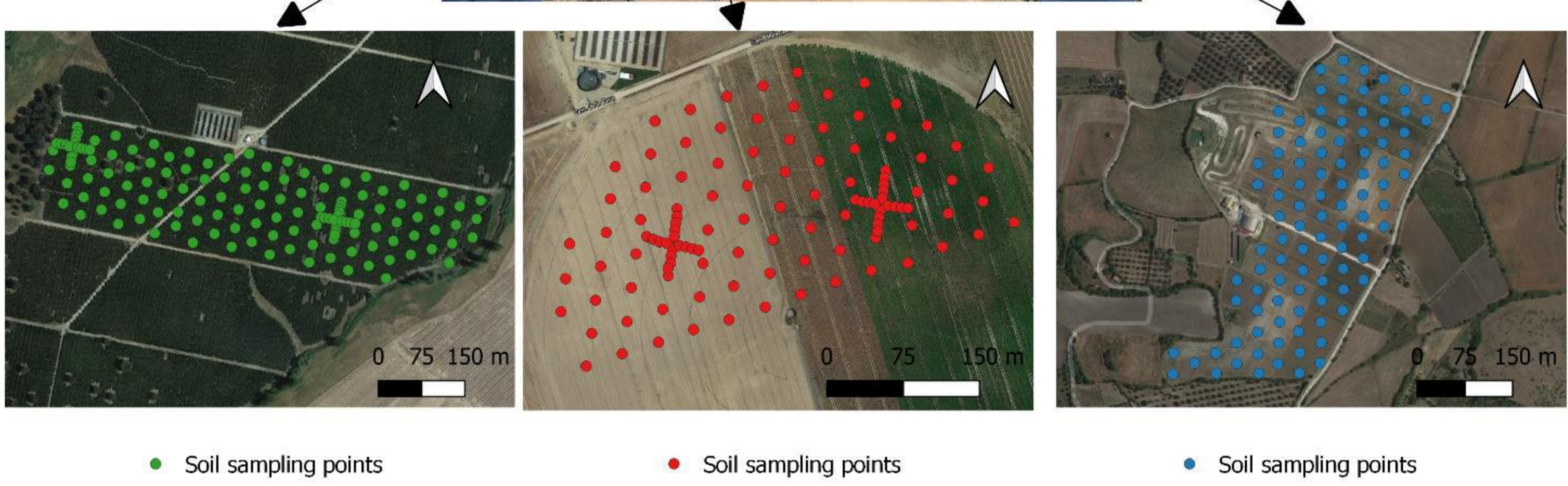
Experimental site

Location	Crop	Irrigation System	Annual water needs	Photovoltaic Generator
Portugal	Olives	Drip system	334.000 m^3	140 kWp
Spain	Rapessed	Pivot	360.000 m^3	160 kWp
Italy	Artichoke	Sprinkling	100.000 m^3	40 kWp



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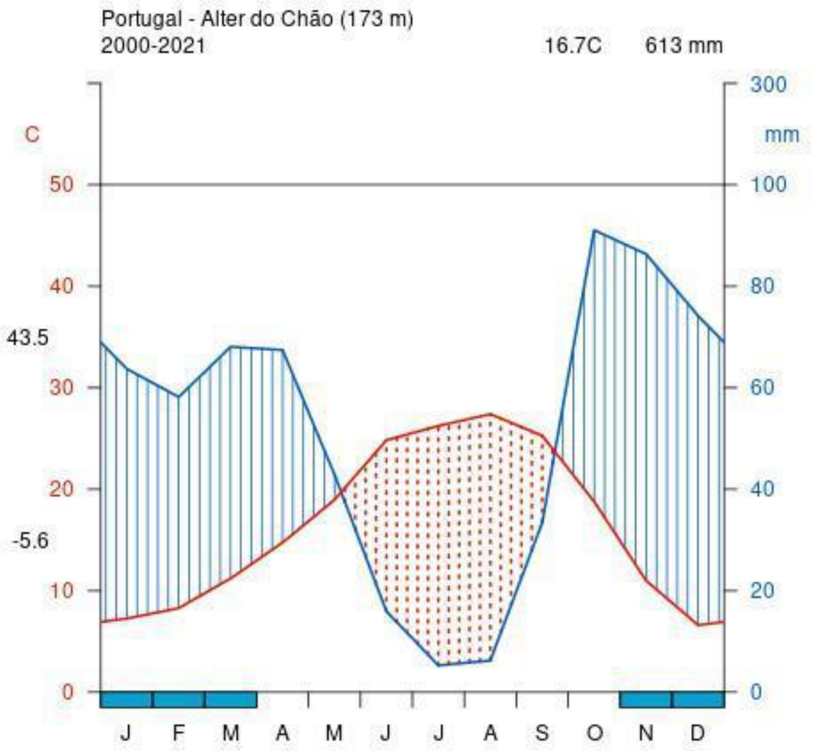
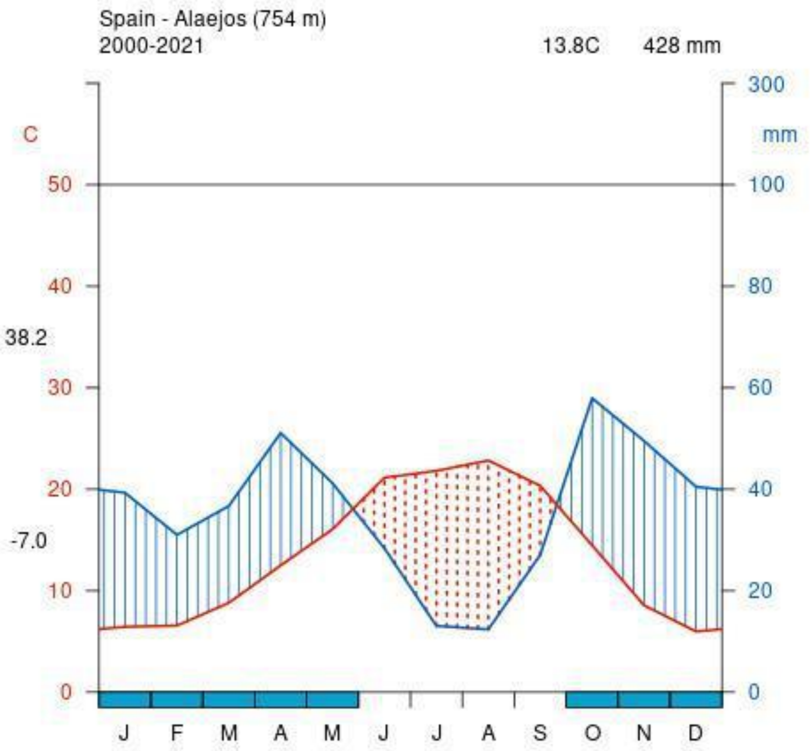
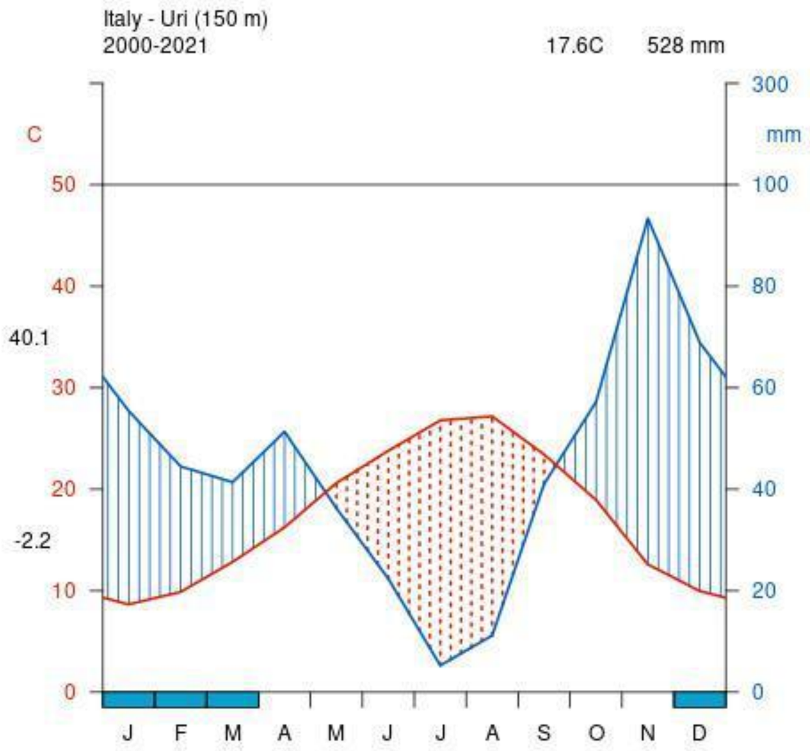
Experimental site - Climate







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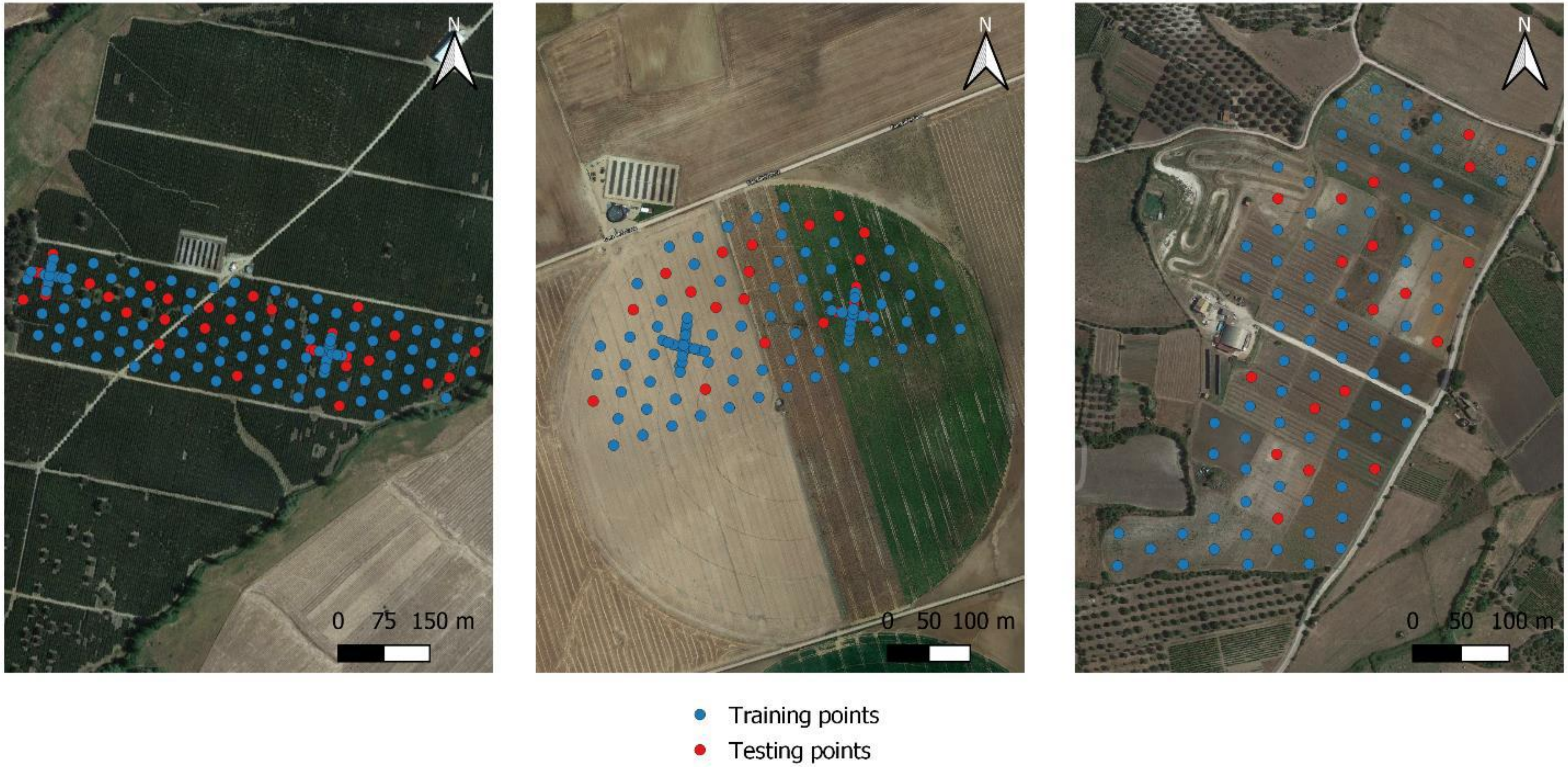
Soil Sample Locations



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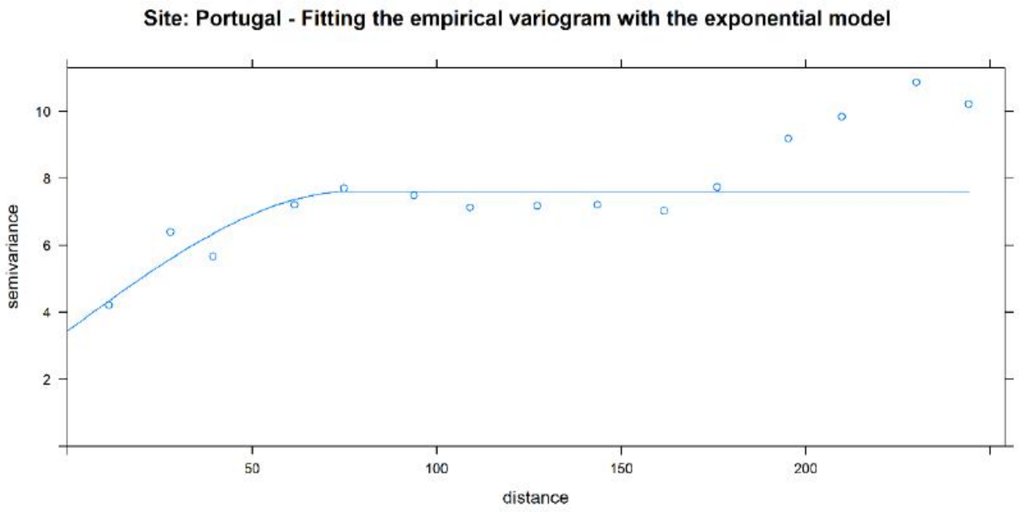
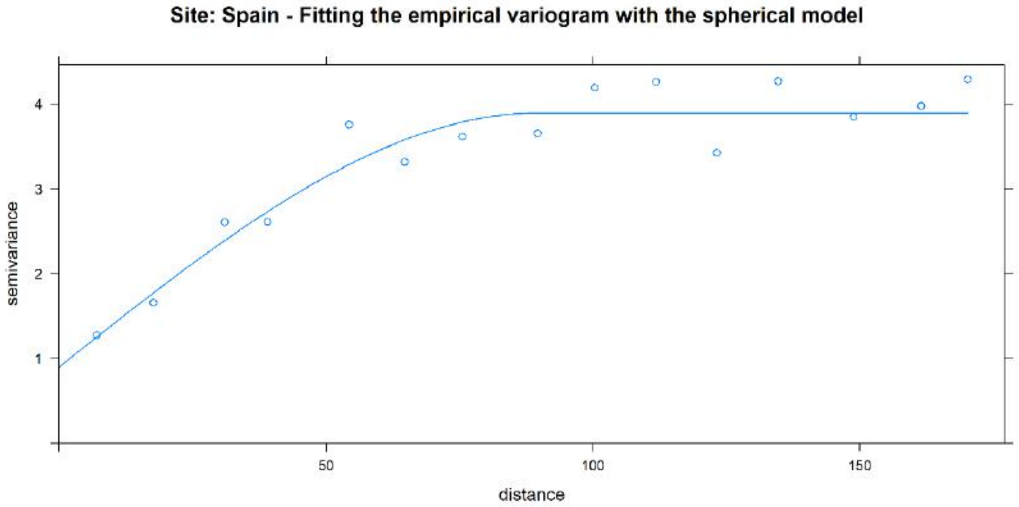
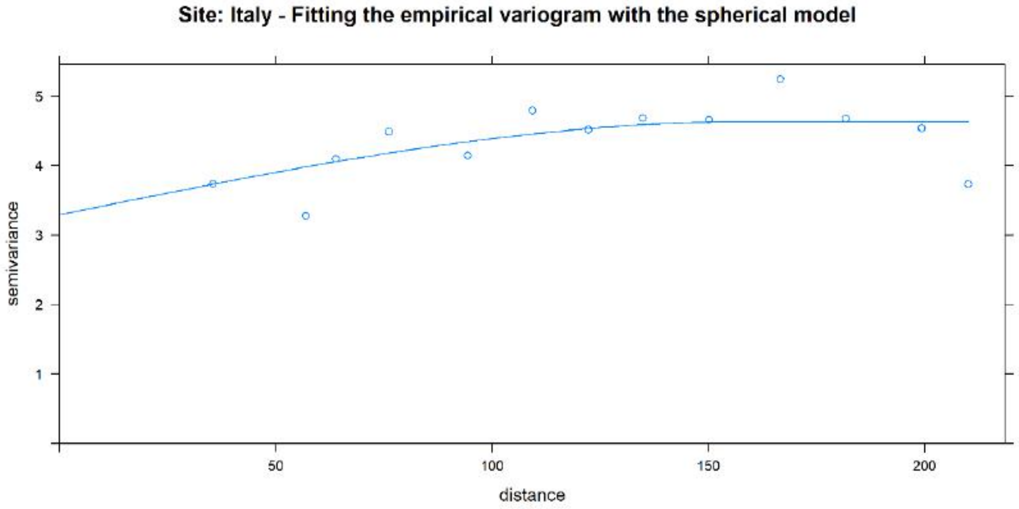
Geostatistics + Cluster Analysis







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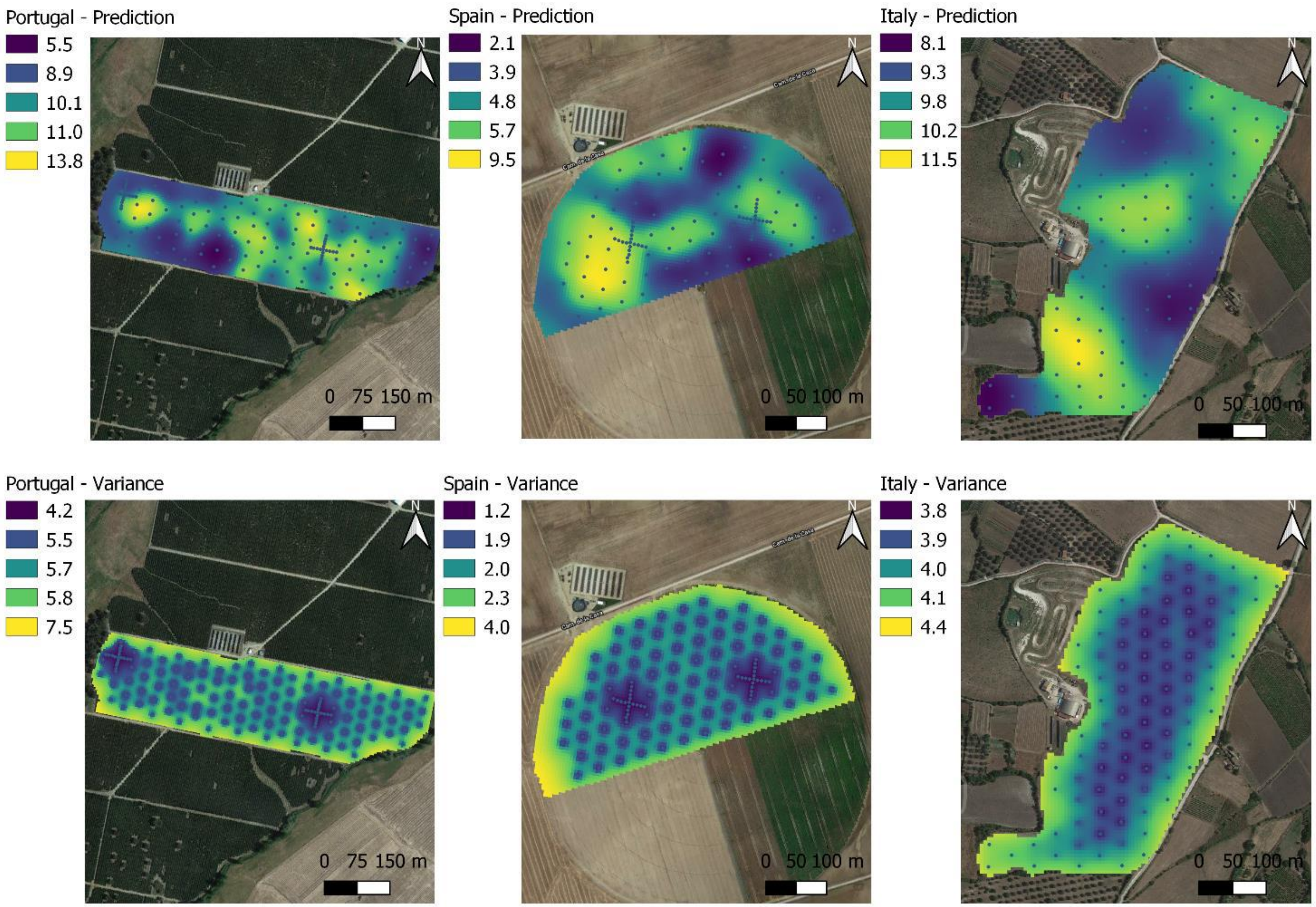
Variablity map of soil organic carbon



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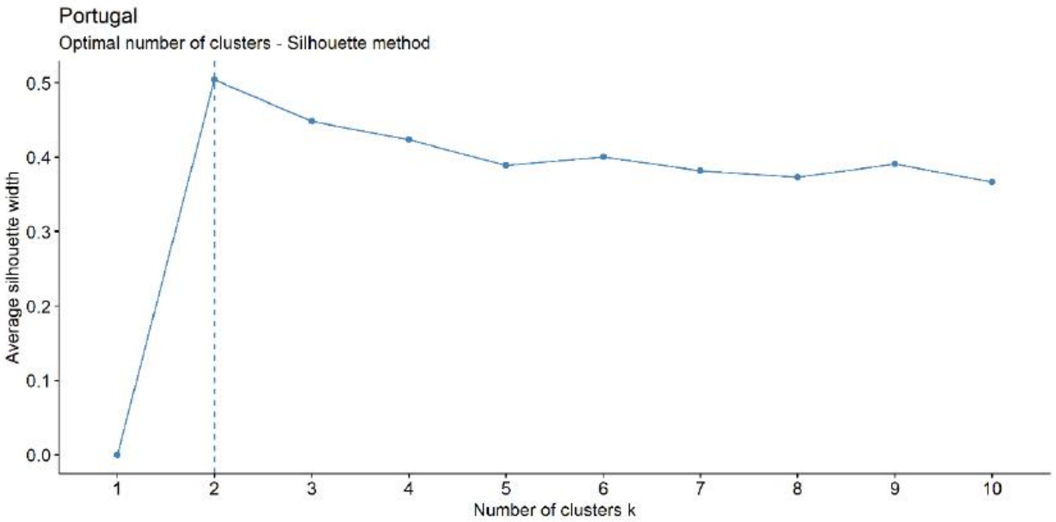
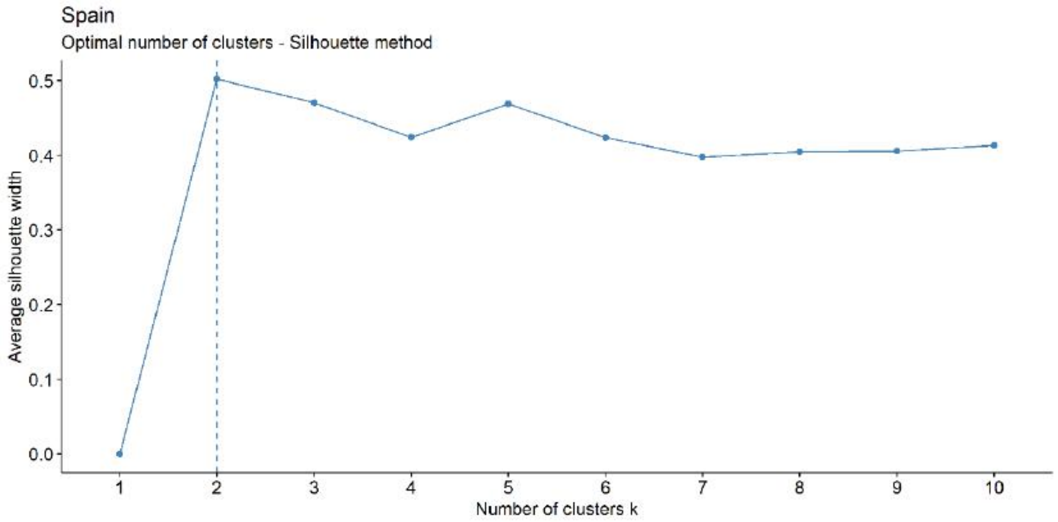
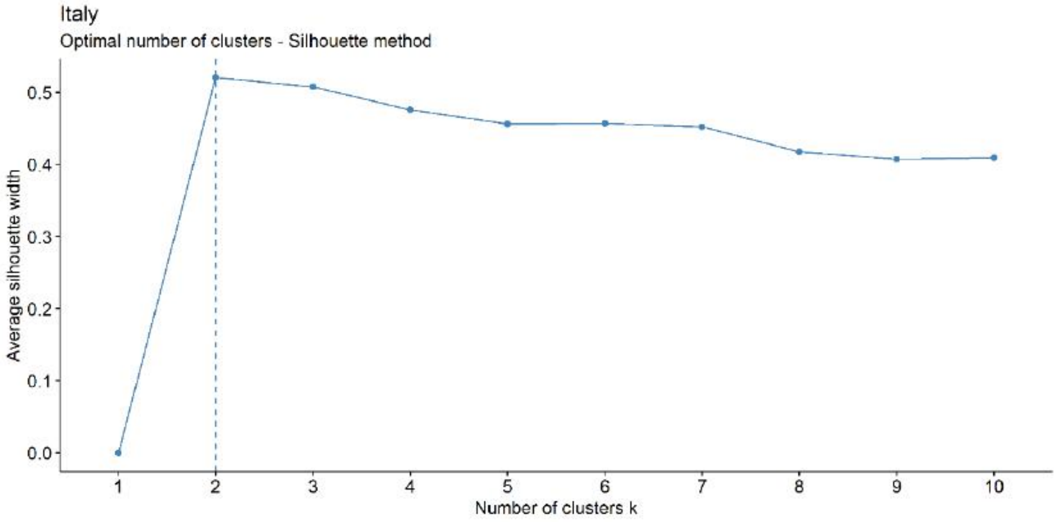
Cluster Analysis







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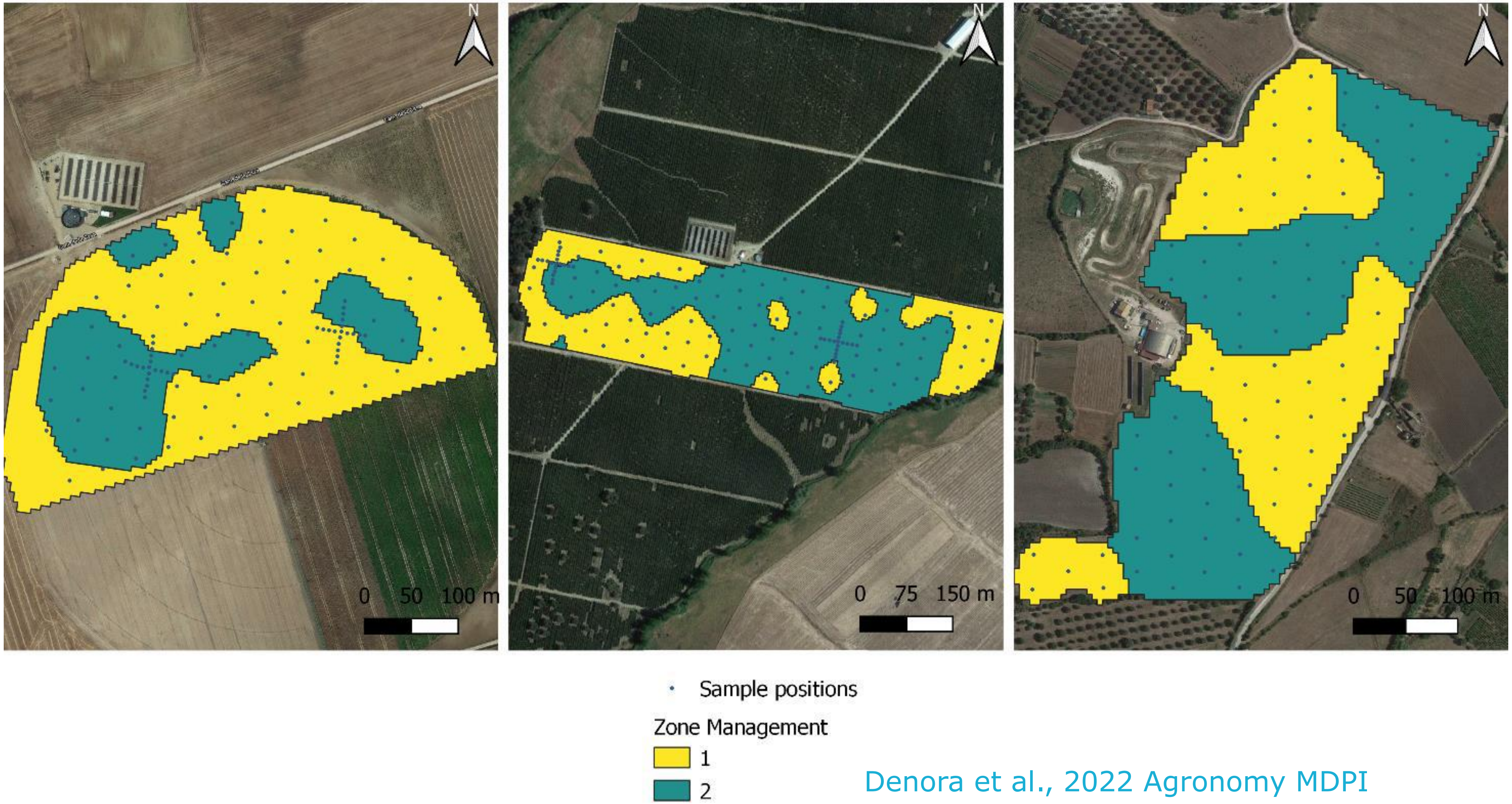
Cluster Analysis



Denora et al., 2022 Agronomy MDPI

https://www.mdpi.com/2073-4395/12/1/183

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Machine learning – Aim of work

Aim of the work

The specific objective is to develop a machine learning framework that enables the estimation of organic carbon content from multi-data-sources.

What is machine learning?

Artificial intelligence is nothing more than applied mathematics and statistics

Artificial intelligence needs the examples (Data)

By providing artificial intelligence with examples, it is able to create models capable of running independently.

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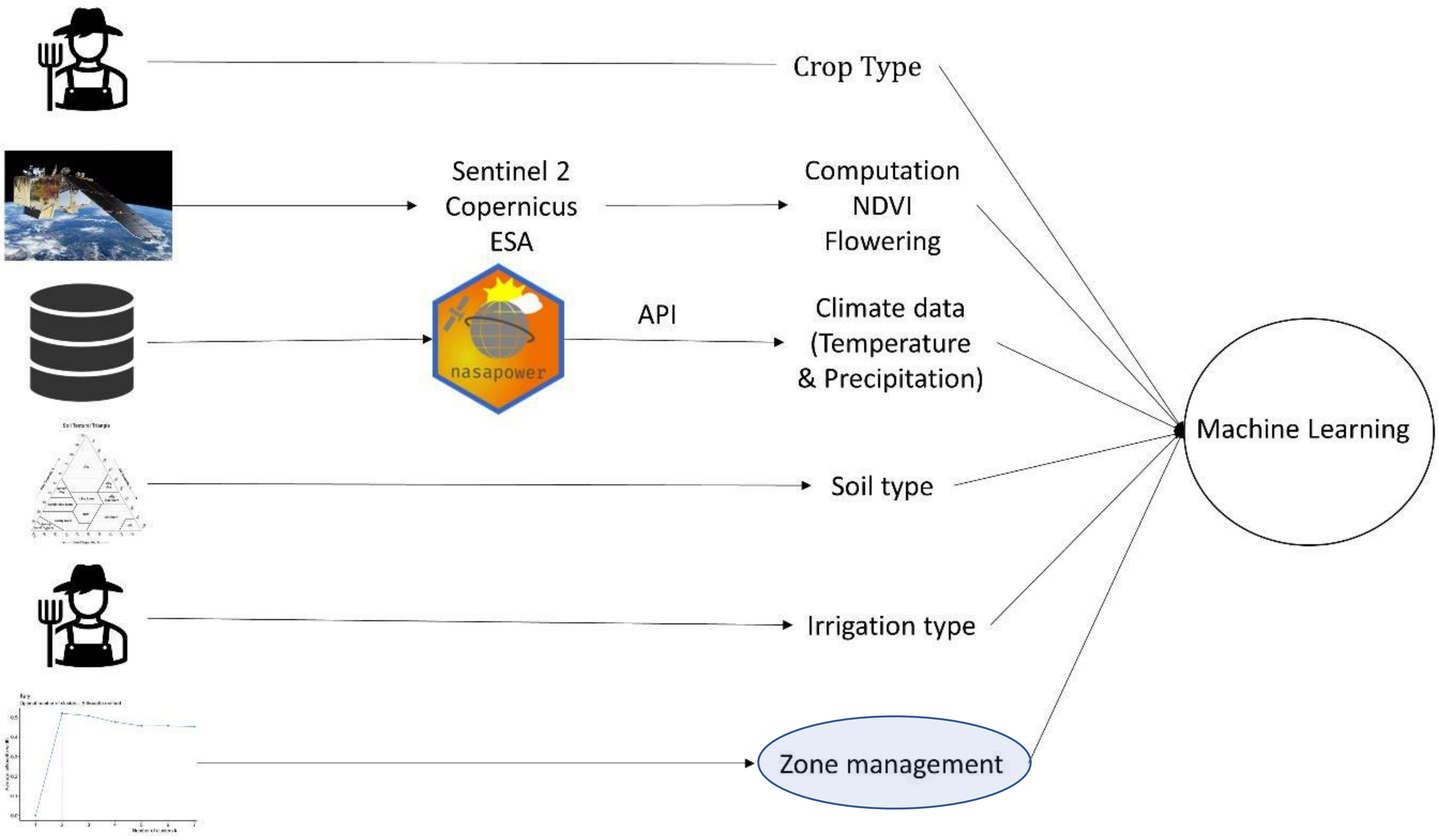
Machine learning approch



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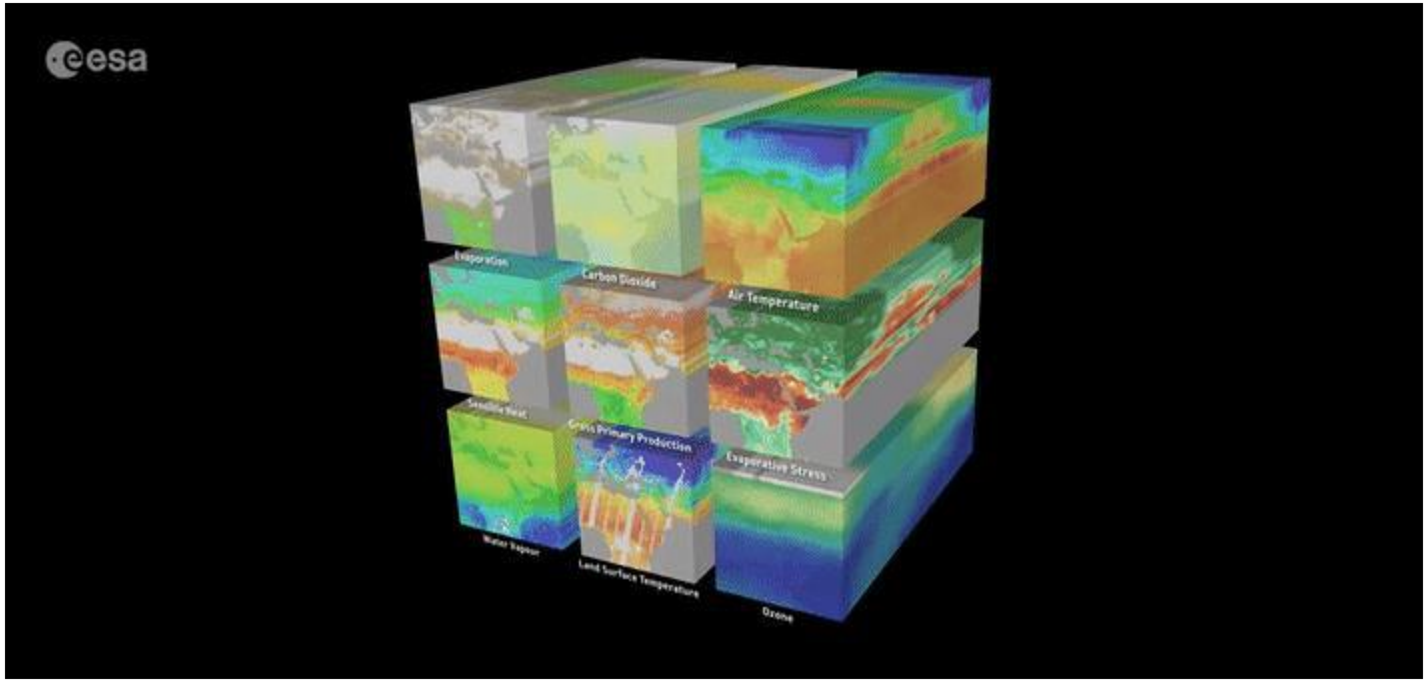
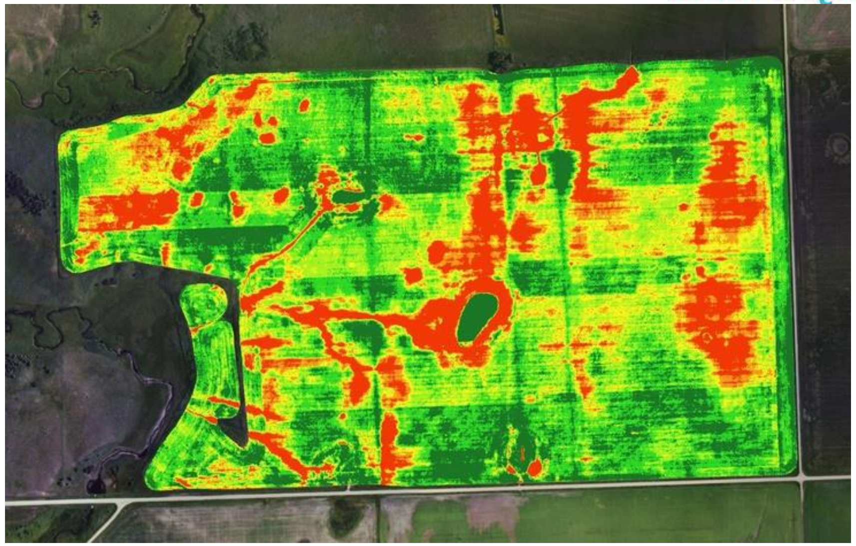
Sentinel 2 Data-Cube





Site	Time window	Cloud cover	Number of images	Crop	Phenological stages
Portugal	2017-04-25 / 2017-07-24	30	5	Olives	Flowering
Spain	2017-02-25 / 2017-06-11	30	5	Rapeseed	Flowering
Italy	2017-10-11 / 2017-11-03	30	5	Artichoke	Flowering

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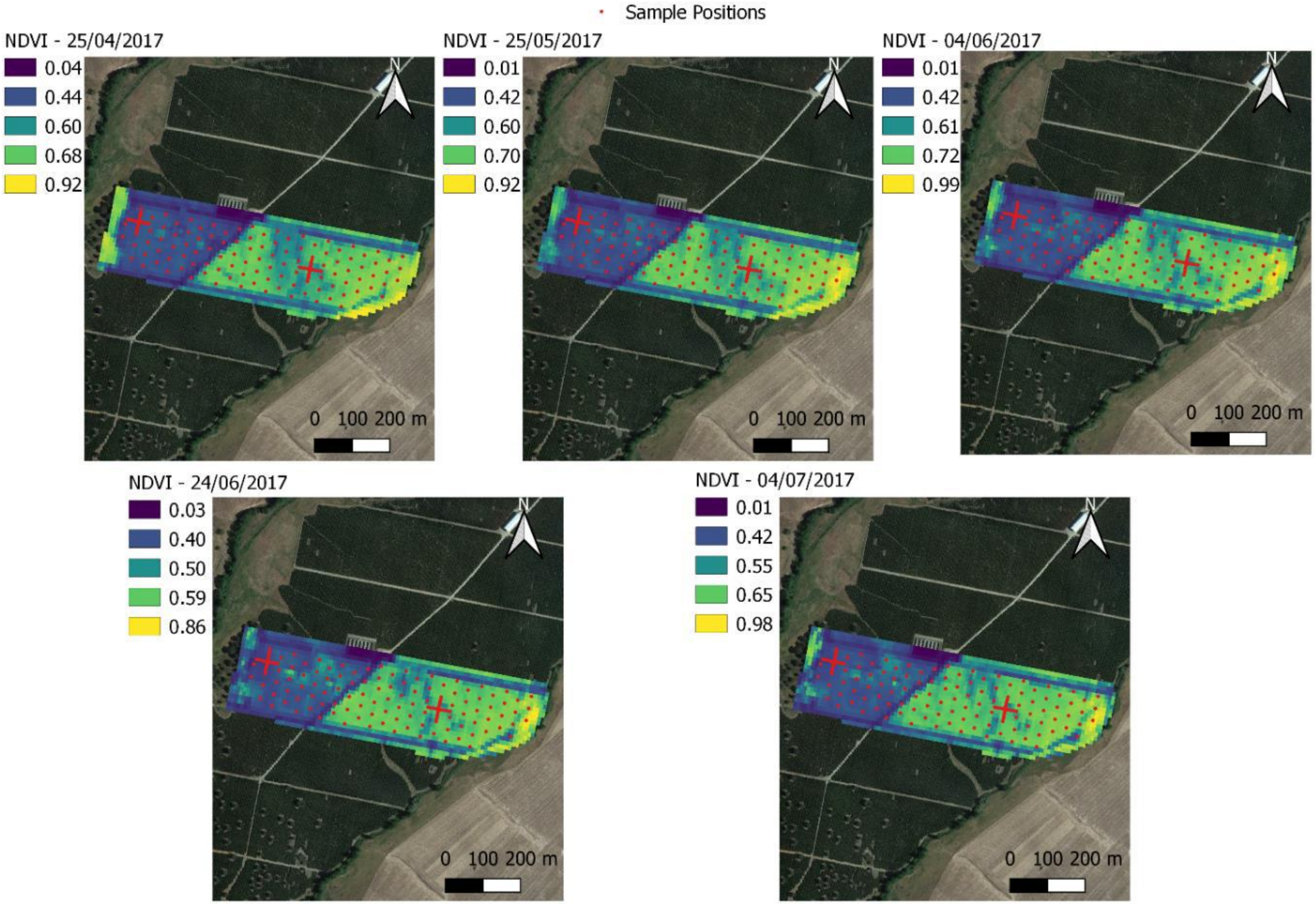
NDVI Sentinel 2



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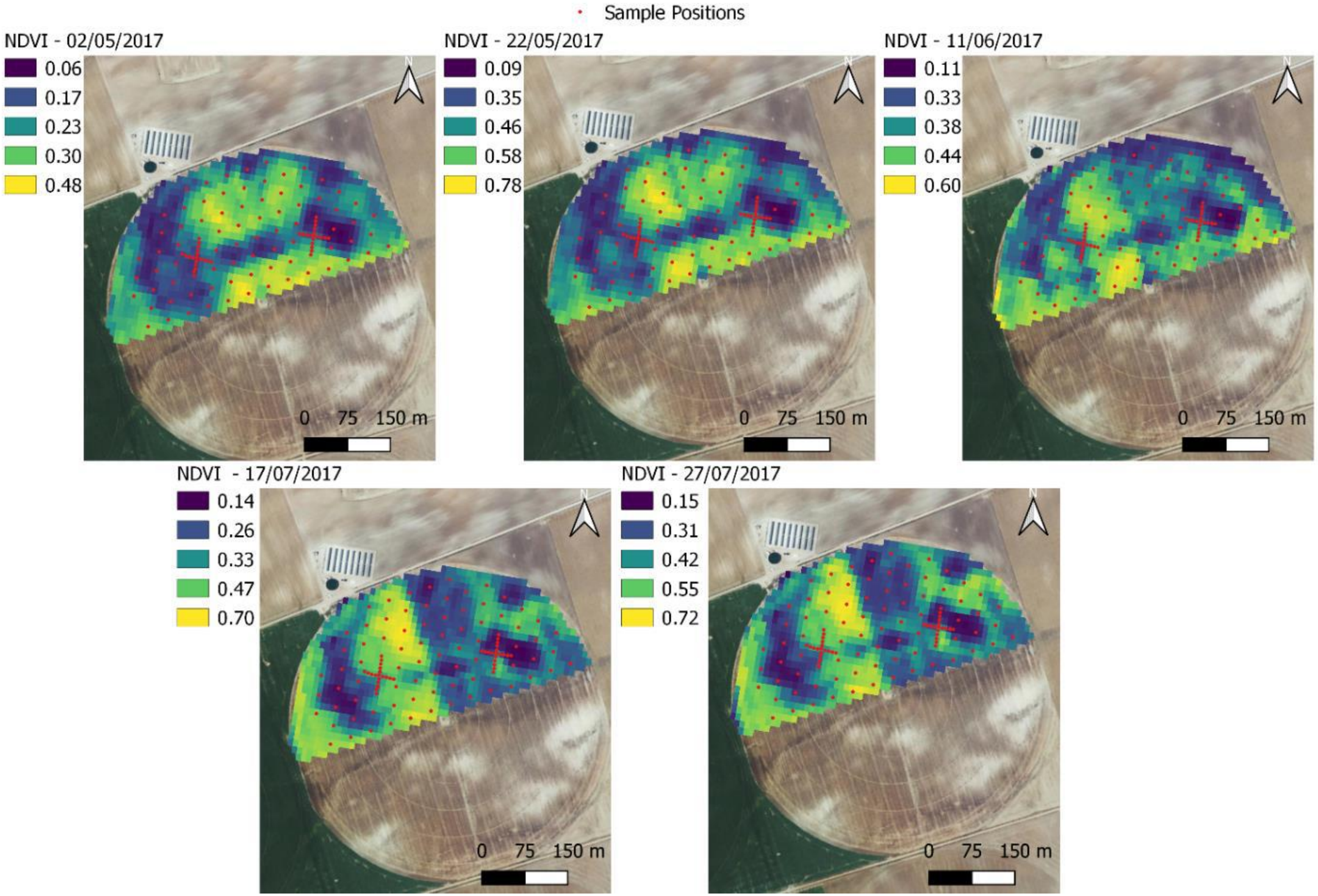
NDVI Sentinel 2



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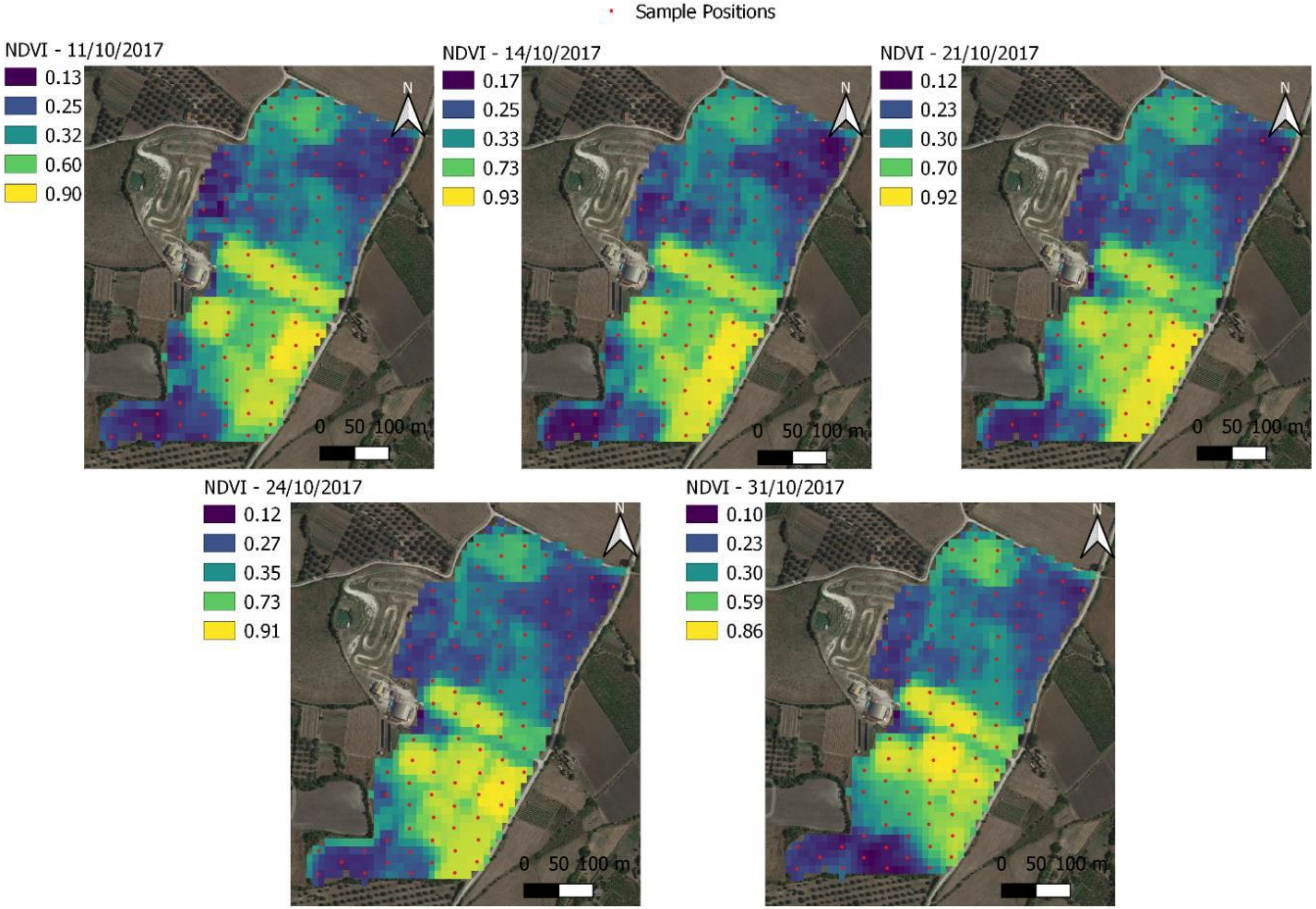
NDVI Sentinel 2



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Machine Learning Approach - Results

SolaQua

	With Zone Management				Without Zone Management			
Model	Training		Test		Training		Test	
	RMSE	R^2	RMSE	R^2	RMSE	R^2	RMSE	R^2
Linear model	1.61	0.77	1.76	0.75	2.18	0.60	2.34	0.48
Random Forest	1.38	0.87	1.66	0.87	2.15	0.77	2.25	0.52
Xgboost	1.39	0.90	1.56	0.89	2.06	0.76	2.32	0.49

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Conclusions

1. Grid sampling + Geostatistics + Cluster analysis allows differentiation of the field to be irrigated into homogeneous zones so that precision irrigation can be performed
2. Satellite imagery has an excellent ability to map soil organic carbon content
3. The combination of different types of data and the use of Machine Learning algorithms allows estimates of soil organic carbon content to be made with high accuracy
4. The inclusion of homogeneous zones within the Machine Learning procedure allows an improvement in the accuracy of the model in estimating the organic carbon content (g/kg) in soil.

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Thanks for your attention!

www.sol-aqua.eu

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