Big Problems, Big Solutions: Holistic Approach and Integrated Pest Management for *Phytophthora cinnamomi* in the Fagesos Project

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EUROCASTANEA European Chestnut Network

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01/09/22 - 30/09/27

Phytophthora-induced decline of fagaceae ecosystems in Southern Europe exacerbated by climate change: preserving ecosystem services through improved IPM

- The project has among its objectives the development of IPM protocols for the mitigation of damage caused by *P. cinnamomi* in *Quercus ilex* , *Q. suber* , and *C. sativa* as well as its large-scale application.

- By the end of the project, we expect to treat up to 1,070 ha (7 demonstrative sites) and to protect up to 18,119 ha of vulnerable areas in total.

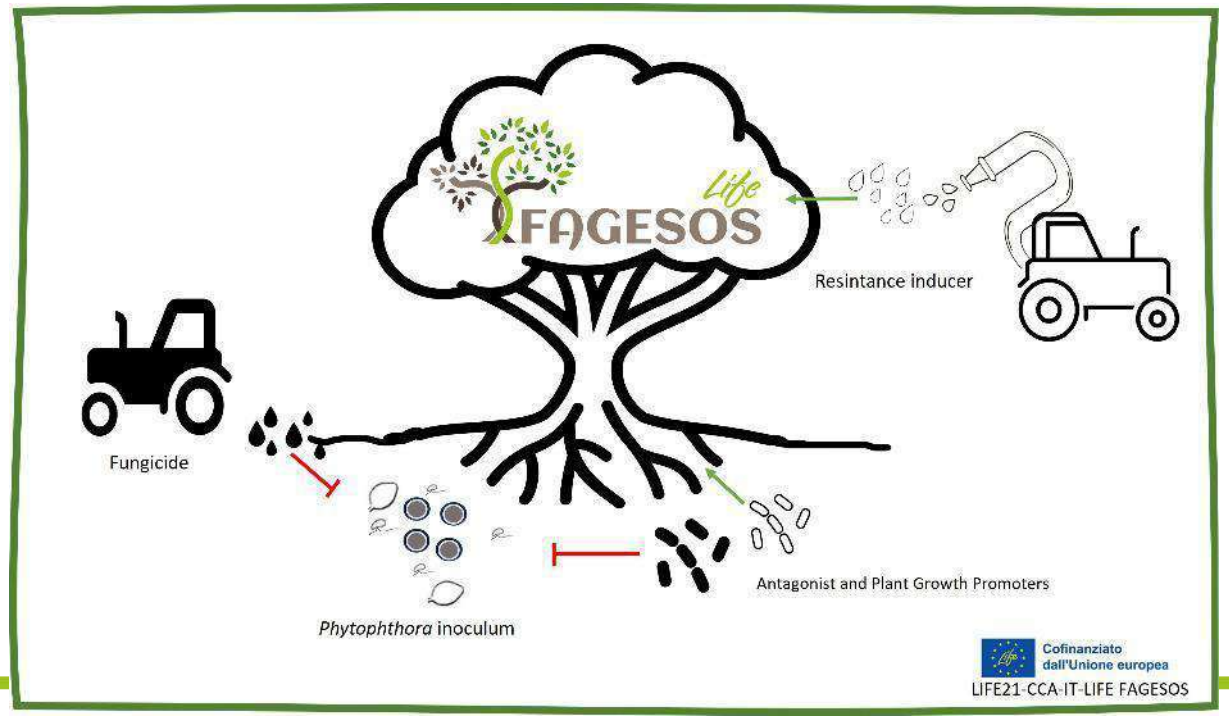
Holostic Pest Management (HPM) as alternative a IPM

- Holism is the theory that systems, and each part of a system, should be viewed as a whole and not as isolated parts.
- “Holistic,” then, is an approach that looks at the big picture and considers all parts.
- Holistic pest management is an integrated and preventative approach that considers the overall health of the plant and the environment to prevent problems and manage them wisely if they arise.

Three-phase treatments:

- Fungicide that reduces the pathogen in the soil (BIOFENCE)
- Application of fungi with antagonistic action that inhibit the growth of the pathogen and bacteria that stimulate the growth of the tree roots (TRICOTEN and BACTRIUM)
- Application of the resistance inducer (KALEX EVO/ CENTURY/KALEX UMIC)

Hygiene measures



Castanea sativa

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII

Biofence FL
Bactrium+Tricosan
Centrury Pro/Kalex evo

I) Footwear cleaning stations:

These stations include a brushing module to remove soil. In addition, they are either equipped with a spraying module to disinfect shoes or with a recipient for water and disinfectant integrated with the brushing module

(Blu, gruppo chimico Arco)

II) Vehicle cleaning stations

- Disinfectant mats (Fosse Ltd) have been placed at the entrance and exit of roads crossing or bordering infected areas, to contrast the passive movement of the inoculum.
- The mats are filled with disinfectant solution with no runoff except when vehicles pass over.

III) Mobile cleaning kits:

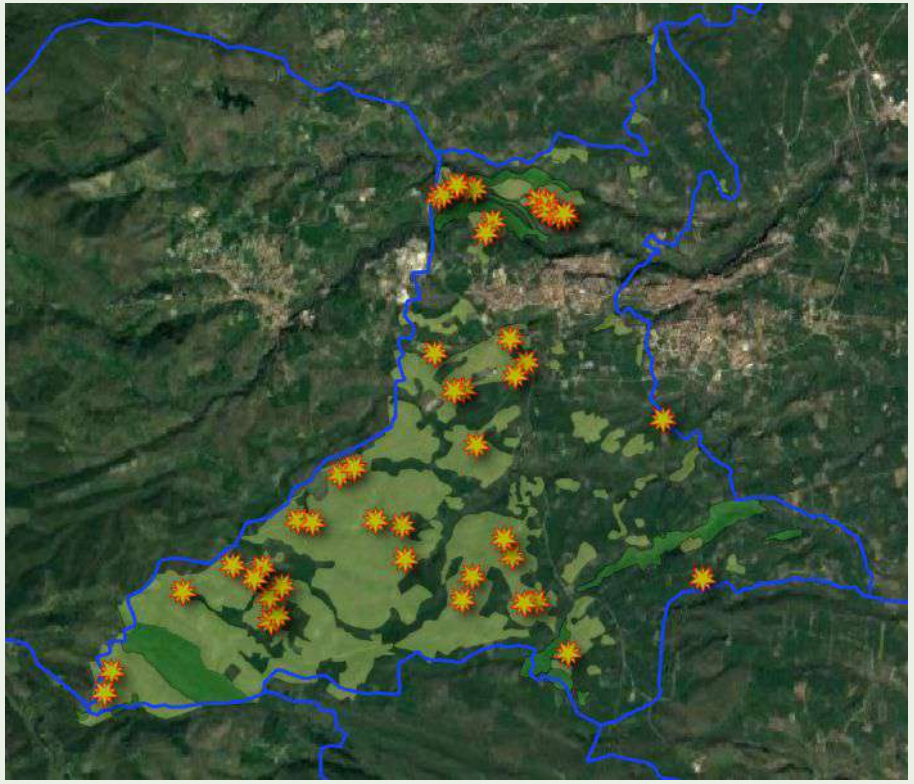
Disinfectant spray and brush to sanitize boots and other tools for those people (trekkers, workers, growers, forest technicians) who may be frequently or necessarily interacting with infected areas.

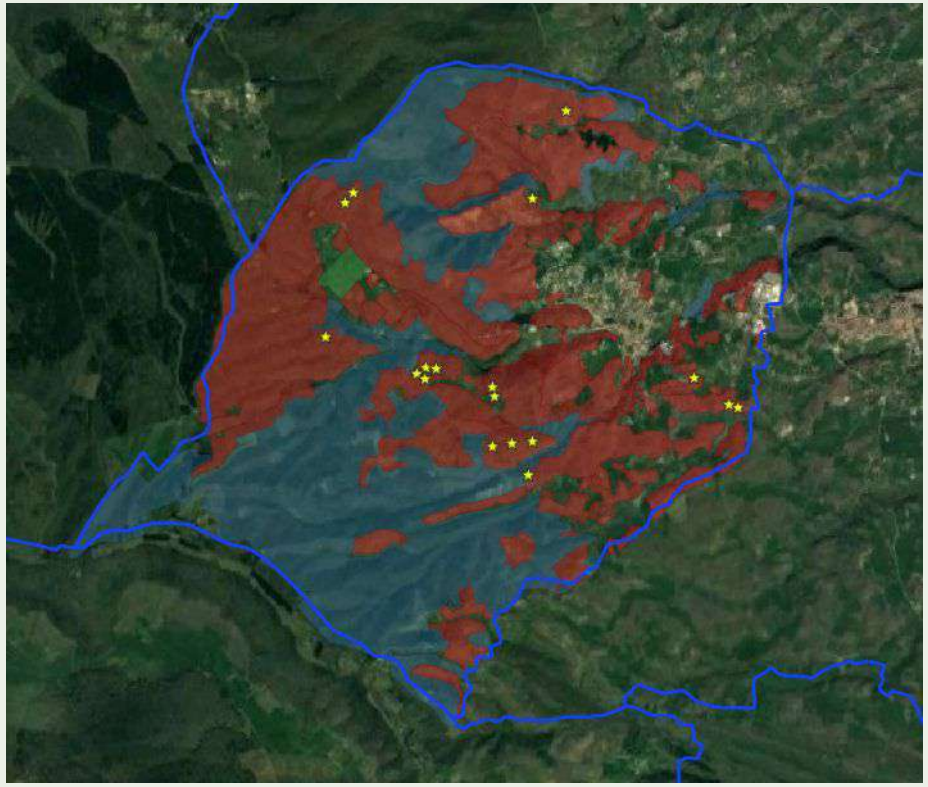
Individually, we are a drop. Together, we are an ocean

•47 owners in Italy and 60 in Portugal joined the activity and in a coordinated manner implemented the proposed IPM

2024-2025

WP4 Large-scale implementation of the new customized protocols



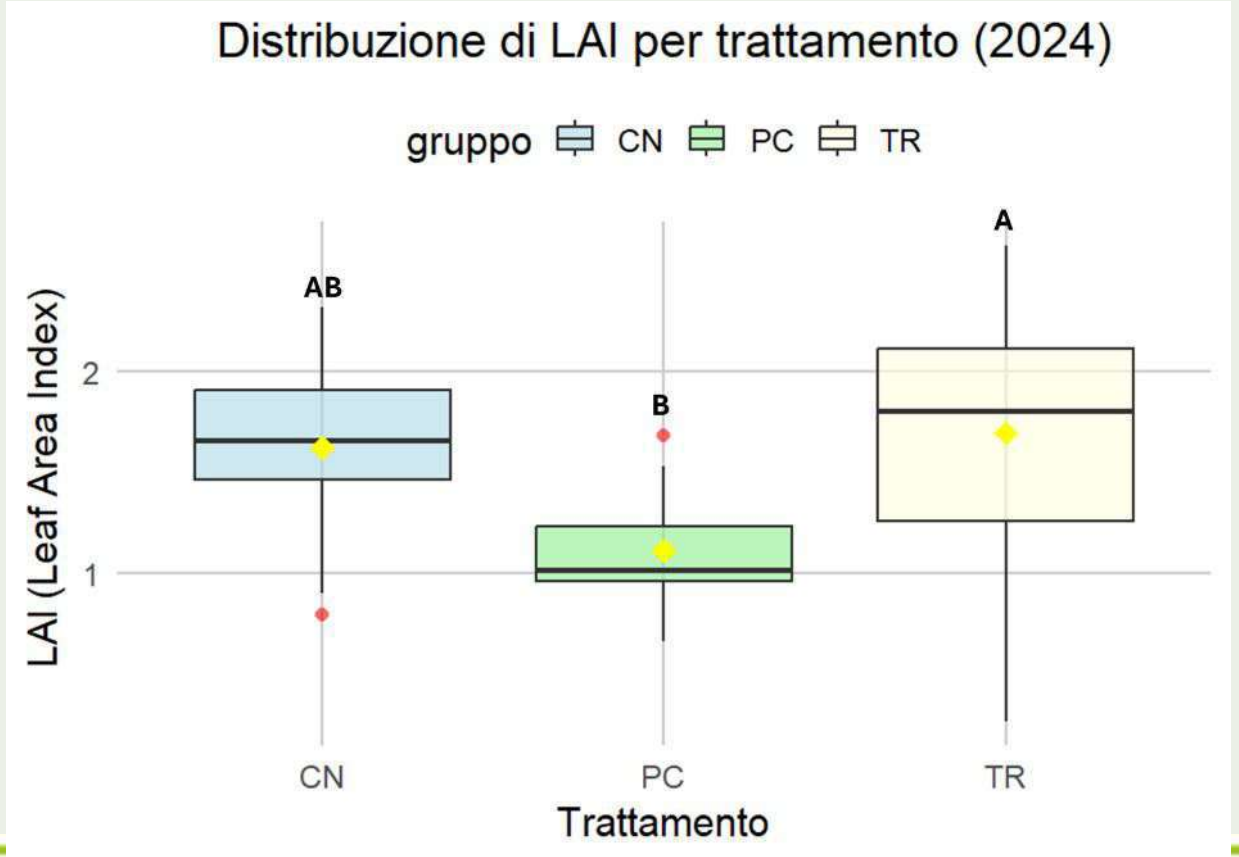


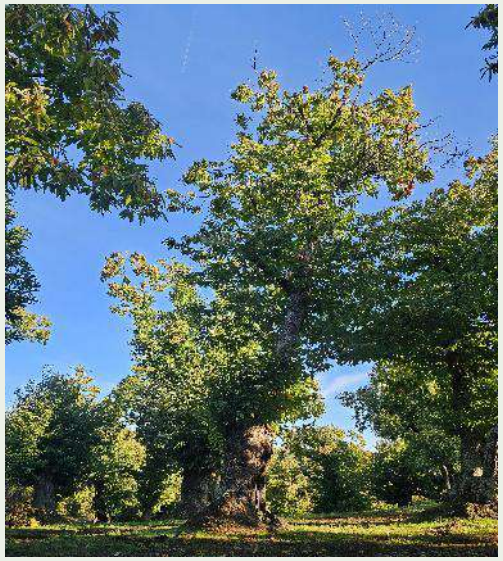
60 foci, 47 owners, 367 hectares (Italy)

Leaf Area Index (LAI) is a dimensionless parameter that quantifies the total leaf surface area (one-sided) per unit of ground area (m^2/m^2). It is commonly used in plant pathology and forest health studies to assess canopy density and plant vigor. In the context of *Phytophthora* infections, a reduction in LAI can indicate foliar damage, defoliation, or canopy thinning caused by the pathogen, making LAI a useful indirect indicator of disease impact on host plants.

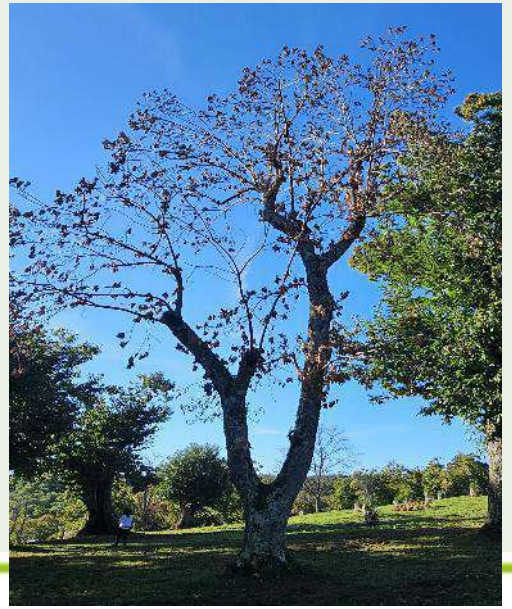
LAI-2000 *Plant Canopy Analyzer*

The device analyzes the difference between radiation above and below the canopy at different angles. This allows it to estimate the LAI, vegetation density, and light transmittance.





Pc



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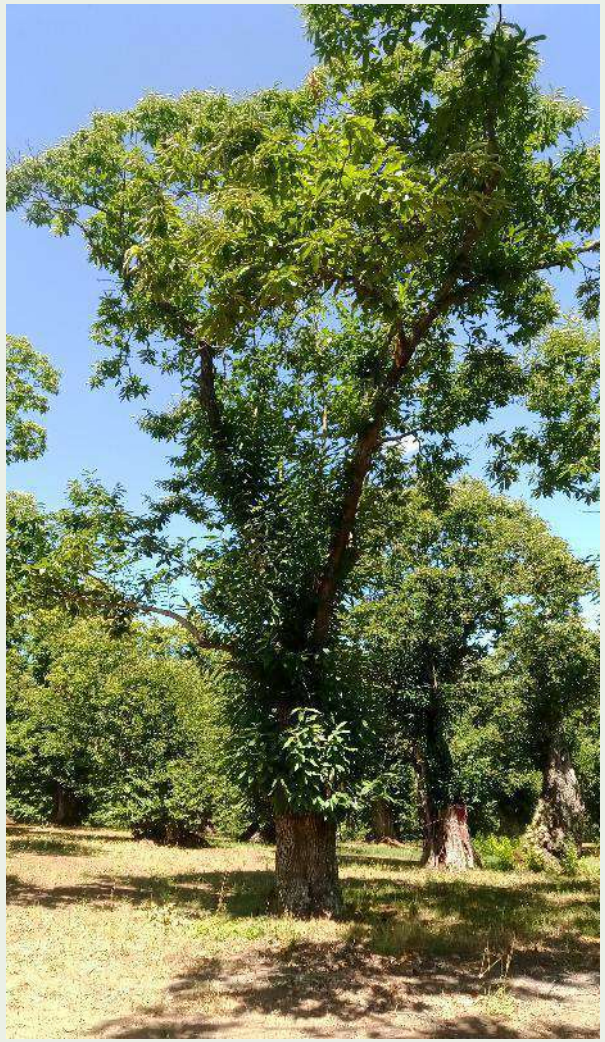
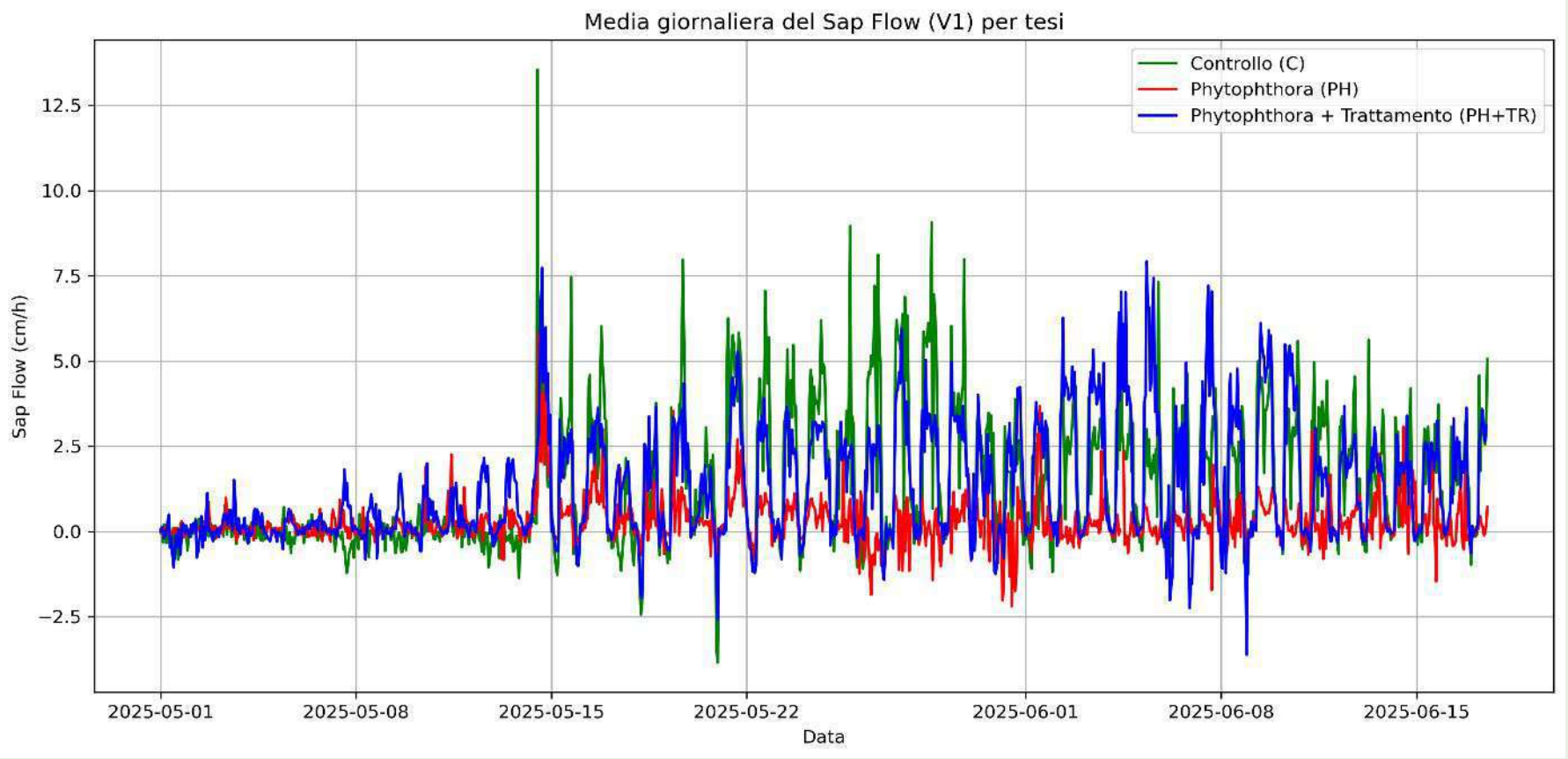


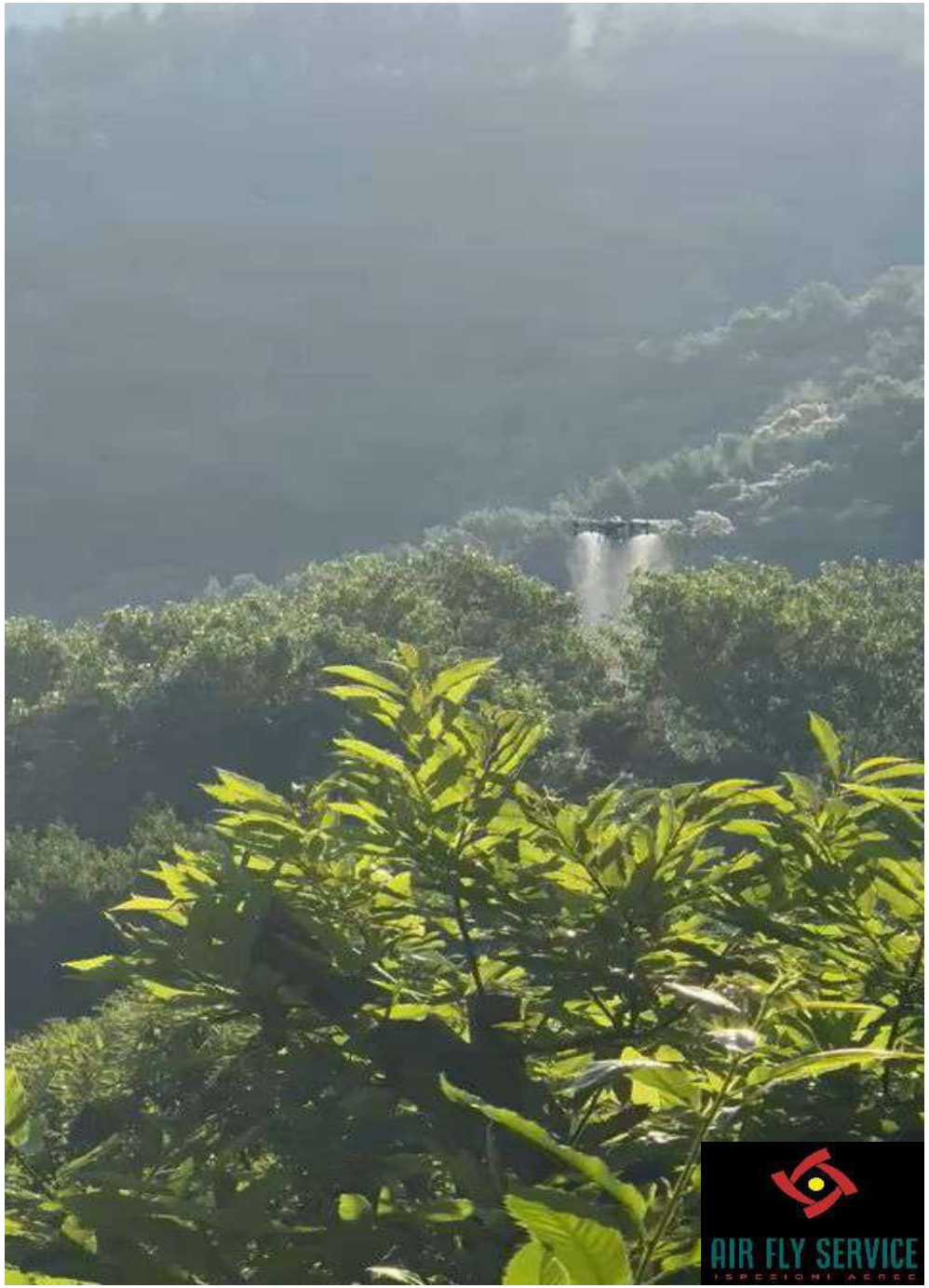


Multiple Comparison of Means - Tukey HSD FWER= 0.05						
group1	group2	meandiff	p-adj	lower	upper	reject
C	PH	-0.2703	0.0	-0.3249	-0.2158	True
C	PH+TR	0.0151	0.7628	-0.0353	0.0655	False
PH	PH+TR	0.2854	0.0	0.2313	0.3395	True

Treatments in chestnut copices

- Develop of protocols for drone treatments
- Foliar application will be carried out using a drone.

Advantages of Using Drones	Precision
	Accessibility
	Efficiency.
	Reduced Labor.
	Minimized Soil Compaction and soil movement
Disadvantages	Regulatory Restrictions
	Cost
	Weather Dependence



- This project will carry out the largest IPM at European level for the mitigation of *P. cinnamomi* in forest and agroforestry environments.
- It is the first time that this type of "holistic" treatment has been adopted.
- The treatments will serve for the registration and placing on the market of Tricotem and Bactrium by ATENS
- New treatment protocols are being developed, both for soil application and, where not feasible, for aerial methods adapted to local constraints.
- This coming September, a thorough assessment will be conducted in the treated areas after two years of intervention. So far, the results are promising and indicate potential for effective long-term management.

Monitoring *P. cinnamomi* ink disease in chestnuts through ensemble models

Francisco J. Ruiz-Gómez [1]; Ariza, A.[1]; Cidre, A. [1]; González, P.[1] ; Molina, A.[1]

[1] Department of Forest Engineering, University of Córdoba

FAGESOS aims to propose and apply new integrated pest management (IPM) protocols, that can be tailored to specific traits of the target ecosystem and that will be implemented by an extensive multi-actor network

A **remote sensing-based monitoring system** able to quantify and identify the existing and new disease foci

The implementation of a **risk model** to identify the areas at risk of introduction of the disease

The use of **hygiene measures** for preventing the introduction and spread of ***P. cinnamomi*** and others AIFPs

The implementation of a **training network** able to reach all categories of **stakeholders**

The evaluation and use of **new products**, in alternative of the **K-phosphonate**

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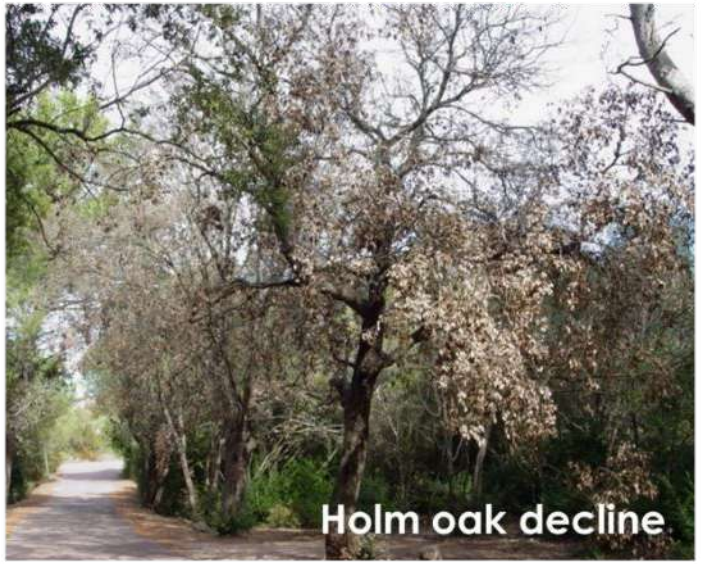

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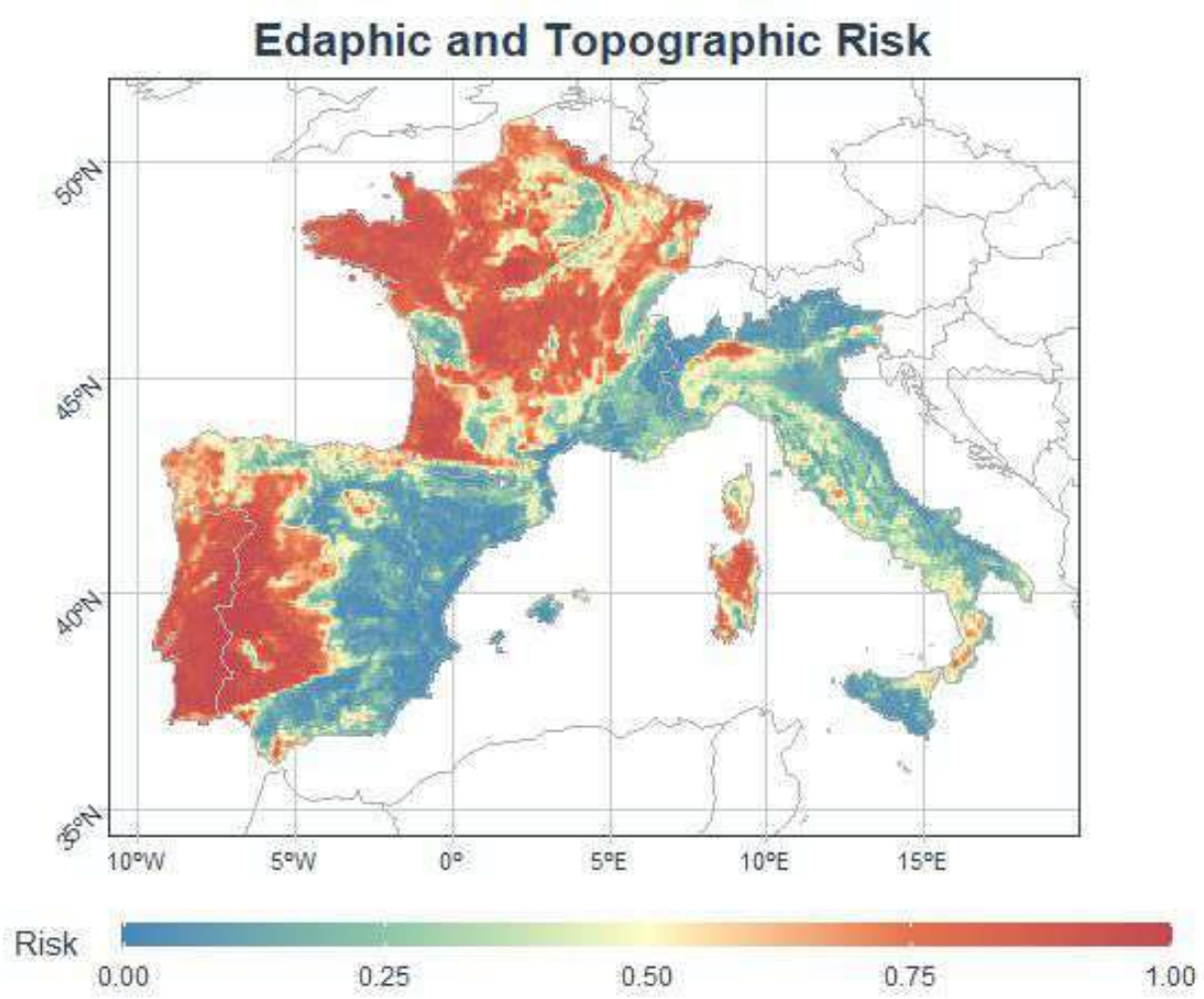
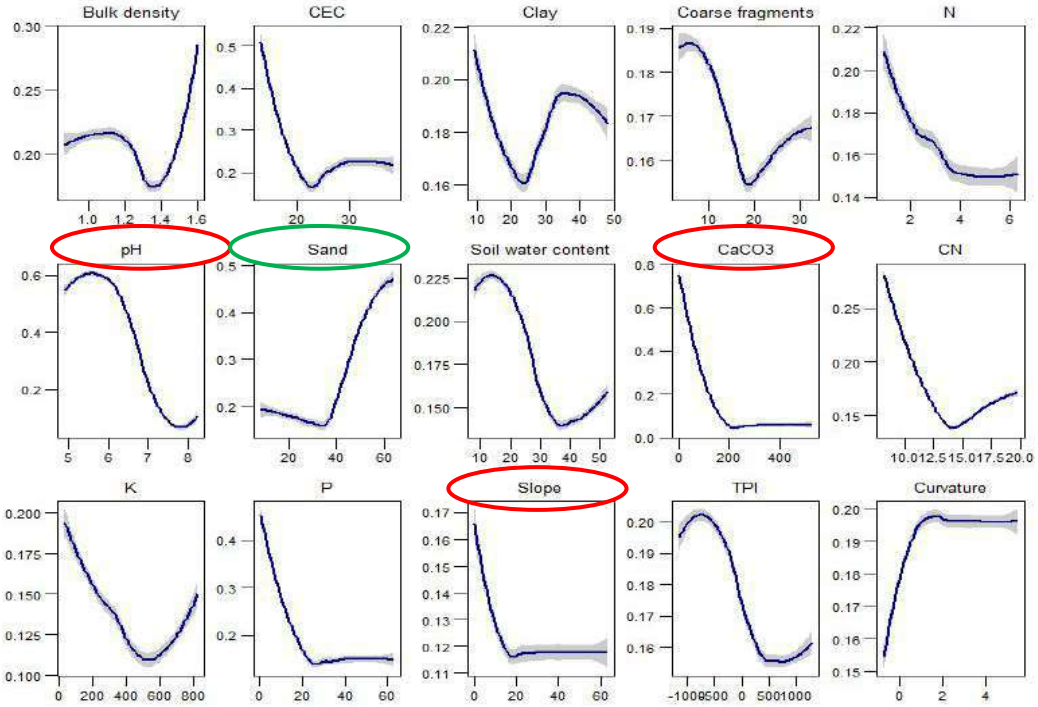
▪ Risk and impact of *P. cinnamomi* in Mediterranean European countries



Risk model

Cidre González et al., 2000.

https://doi.org/10.1016/j.ecolmodel.2025.111115



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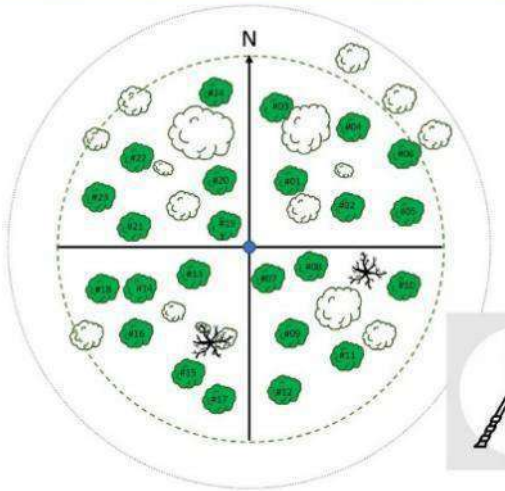
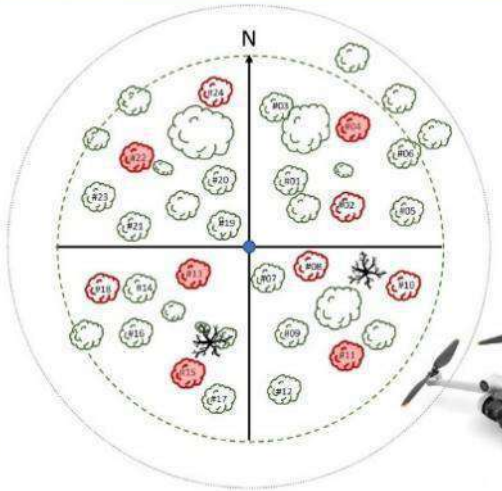
▪ Monitoring of IPM effectiveness



MP establishment (and once a year)

24 tres characterized for:

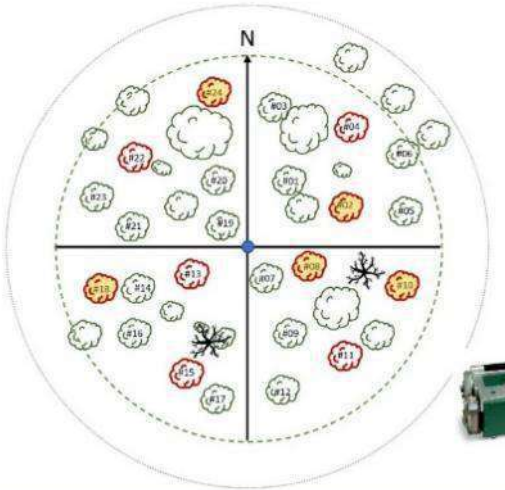
- Crown condition
- DBH
- Highness
- Crown diameter



Drone flight day

5-6 of the 10 selected tres for intensive monitoring characterized for:

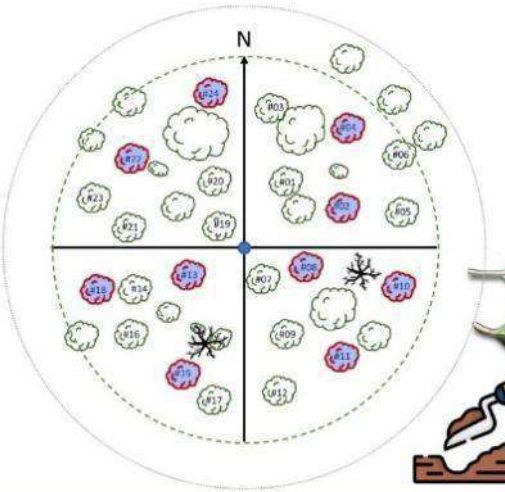
- Leaf gas exchange
- Chlorophyll fluorescence
- Leaf pigment content



The day before or after the drone flight day

The remaininng of the 10 selected tres for intensive monitoring characterized for:

- Leaf gas exchange
- Chlorophyll fluorescence
- Leaf pigment content



During the monitoring week

All the 10 selected tres for intensive monitoring characterized for:

- Crown structure (LAI)
- Pathogen abundance
- Metabolomics
- Microbiome
- Root system

Remote sensing-based monitoring system

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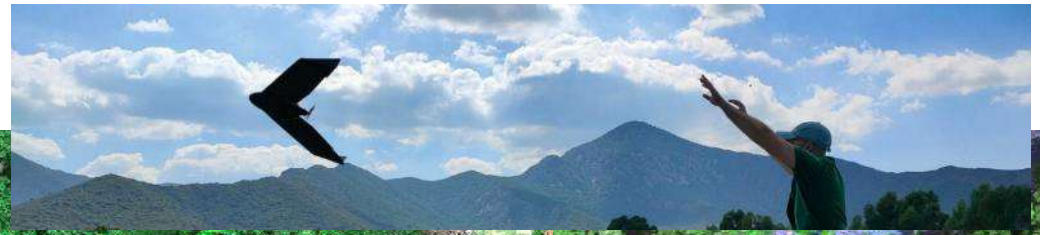
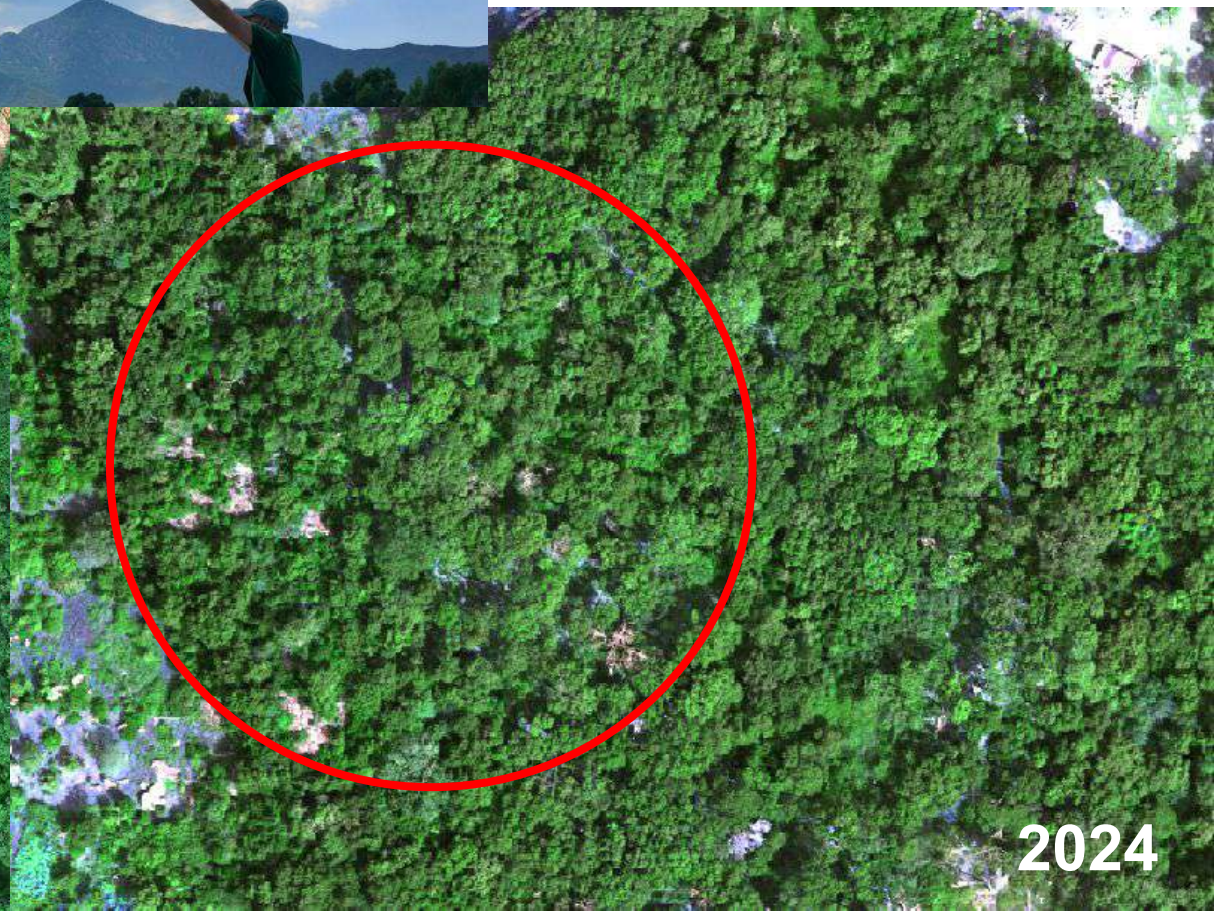
- Modelling canopy response for RS monitoring





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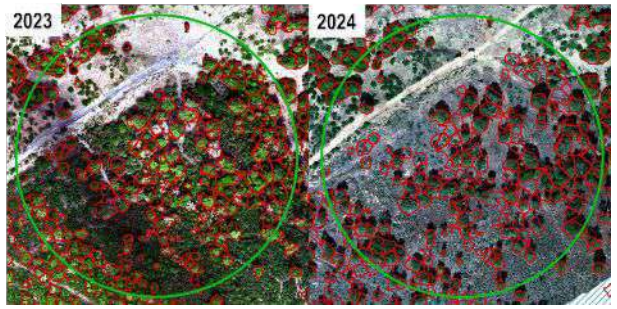
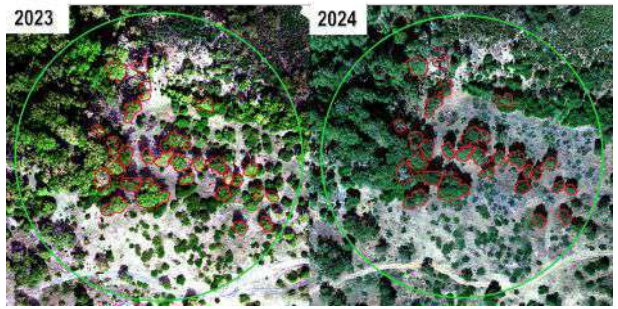


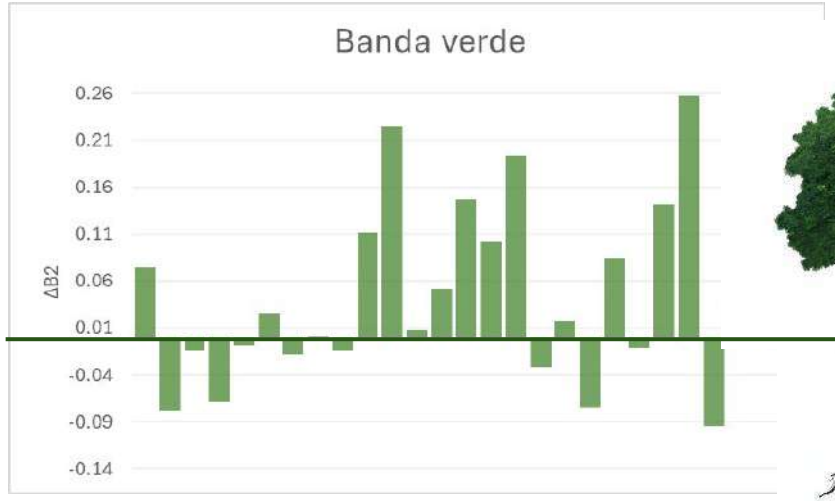
IPM

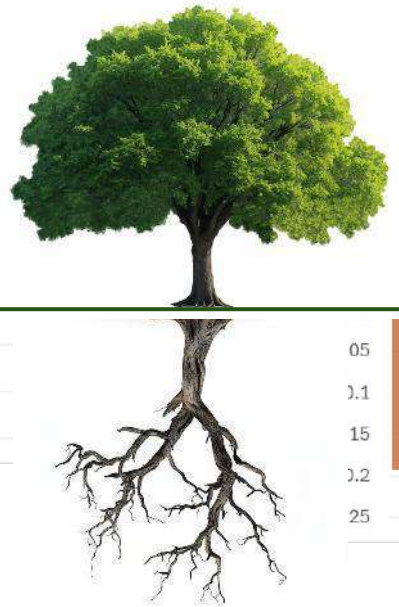
CONTROL

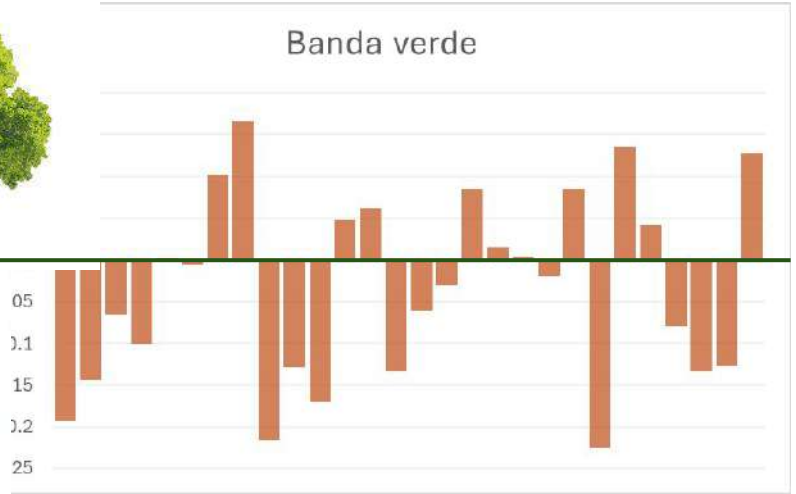


13 trees (48%) improve their reflectance values

14 trees (52%) are getting worse







Δ ~ +5,7%

Δ ~ -3.4%

▪ Forecasting dispersal at landscape level: Ensemble models

Mode and dispersal mechanisms of *Phytophthora cinnamomi* in the field

<u>Mechanism I</u>

Within soil:

a. Inoculum movement

b. Root to root contact

<u>Mechanism II</u>

Inoculum dispersal in surface water (runoff)

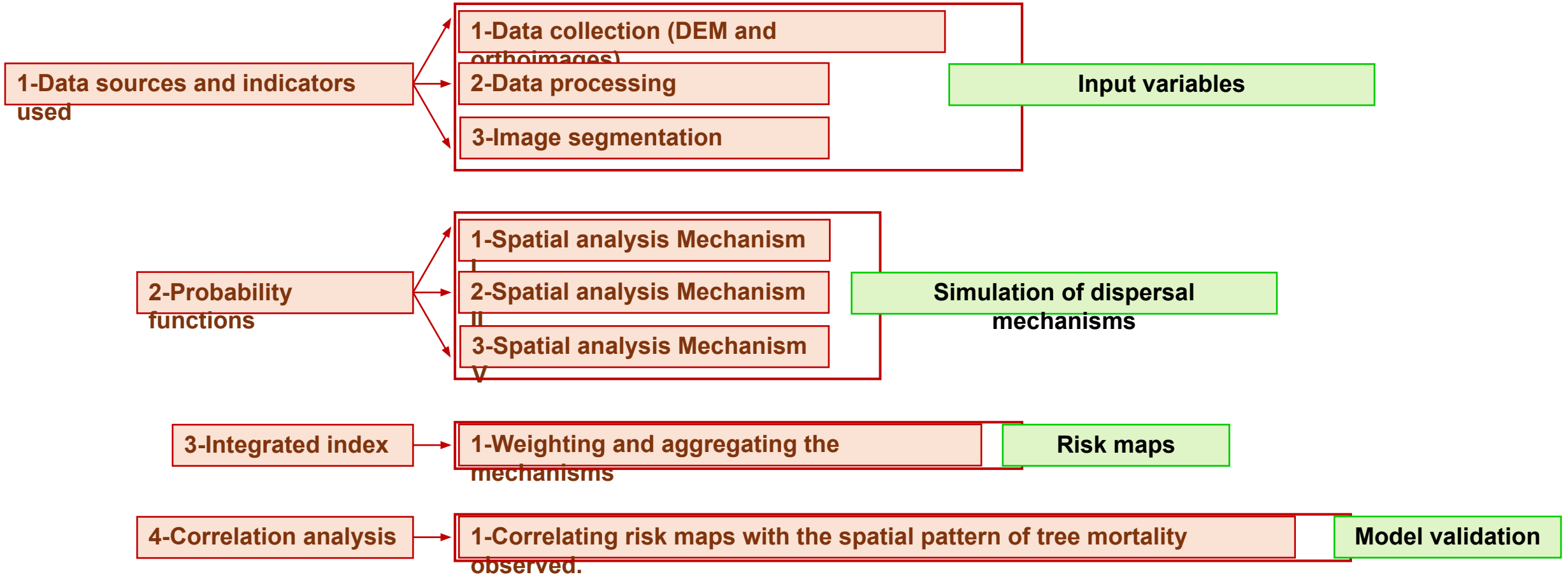
<u>Mechanism III</u>

Dispersal by human or animals activity

Source: Ristaino & Gumpertz (2000).

- Forecasting dispersal at landscape level: Ensemble models

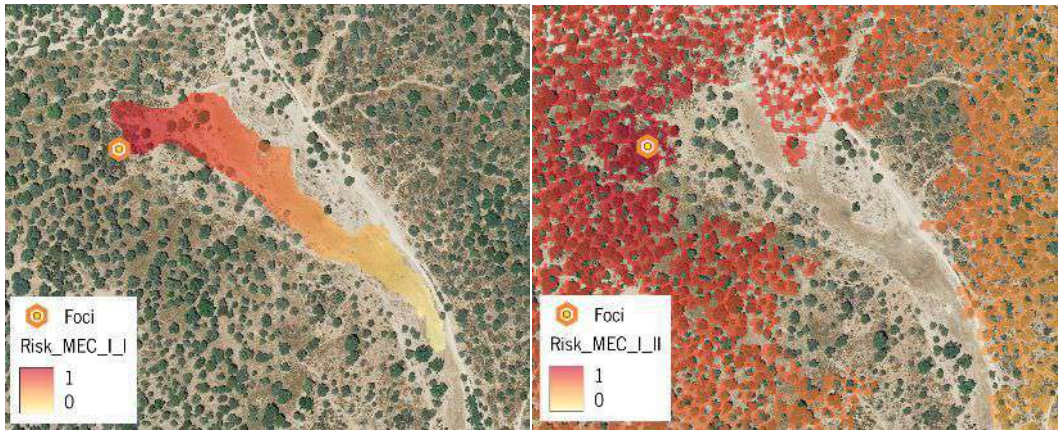
Materials and Methods



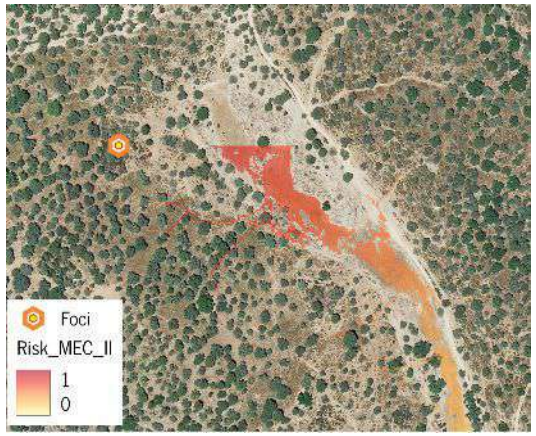
- Forecasting dispersal at landscape level: Ensemble models

Results

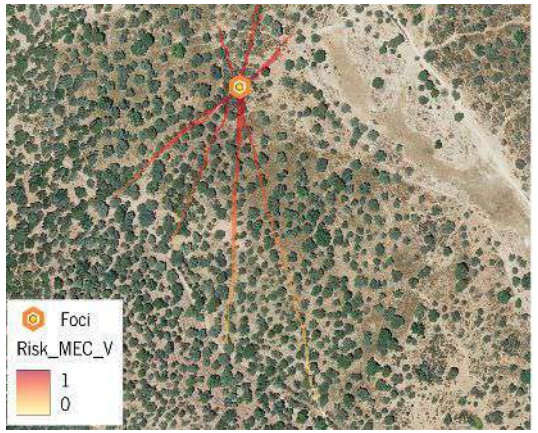
Simulation of Dispersal Mechanisms



Dispersal of Inoculum in Soil



Inoculum Dispersal in Irrigation and Surface Water



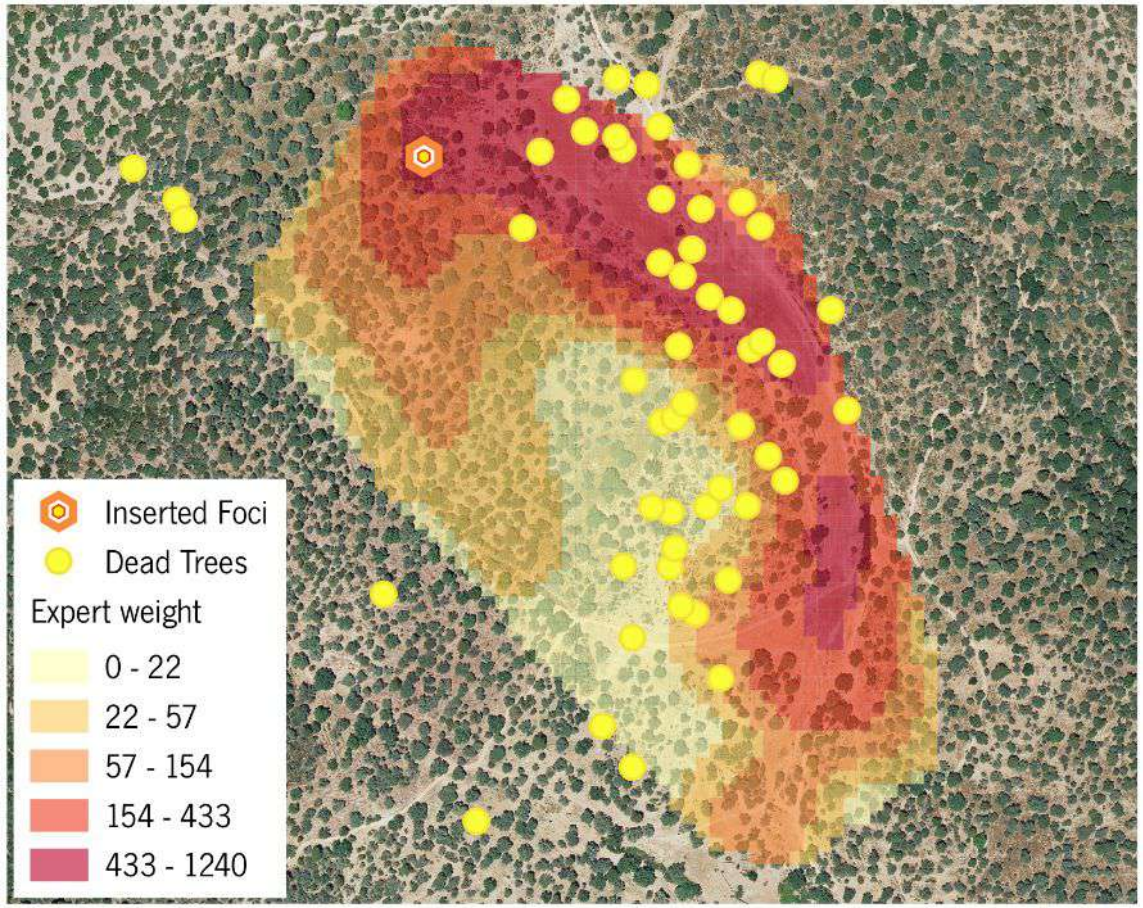
Dispersal by Animals Activity

- Forecasting dispersal at landscape level: Ensemble models

Identification of High-Risk Areas

Expert Weight

Mechanism Ia: 60%
Mechanism Ib: 10%
Mechanism II: 25%
Mechanism III: 5%



≈ 70% Accuracy

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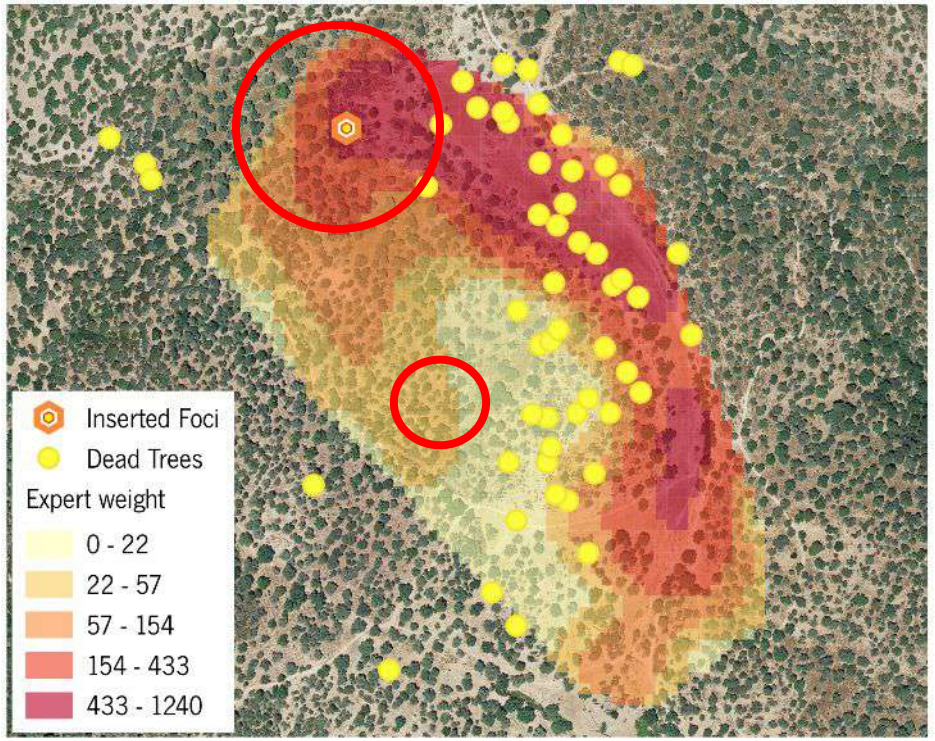
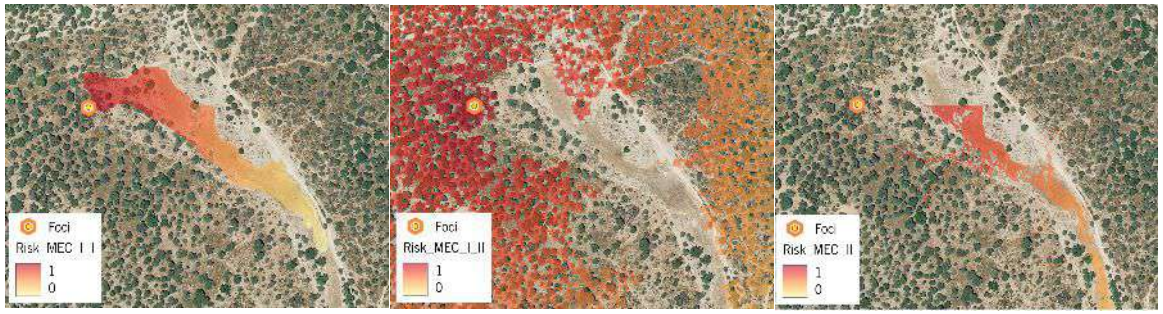
Forecasting dispersal at landscape level: Ensemble models

From the effects to the origin



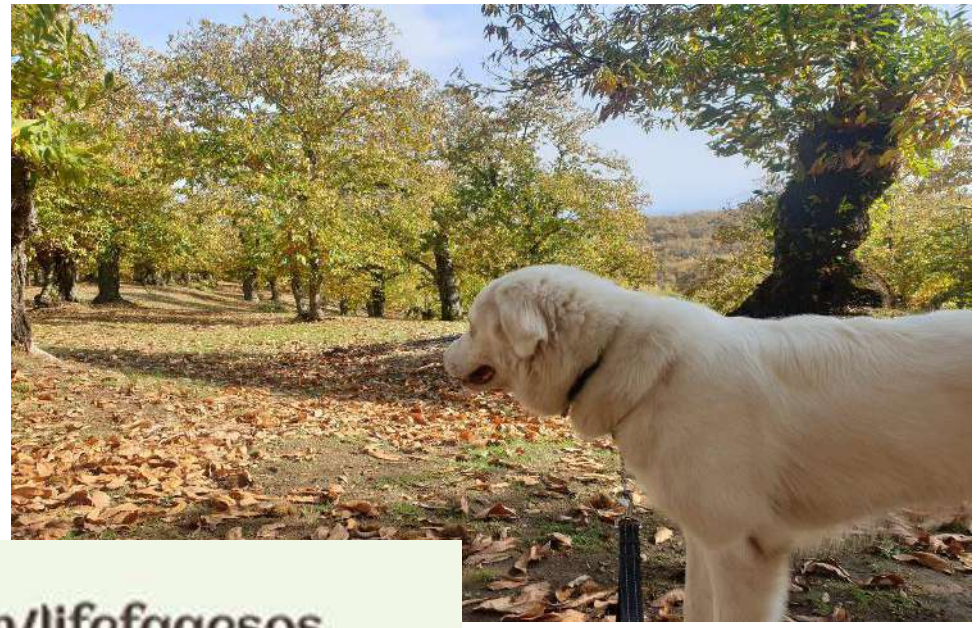


To detect disease origin and secondary foci

Improvement of treatment strategies

Deliverables D3 and D4 are available
(IT, ESP, PT and EN)

https://www.lifefagesos.it/en/



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