# The application of remote sensing in the official monitoring of *Citrus tristeza virus* and *Xylella fastidiosa*

**Anna Maria D'ONGHIA, Franco SANTORO, Stefania GUALANO**

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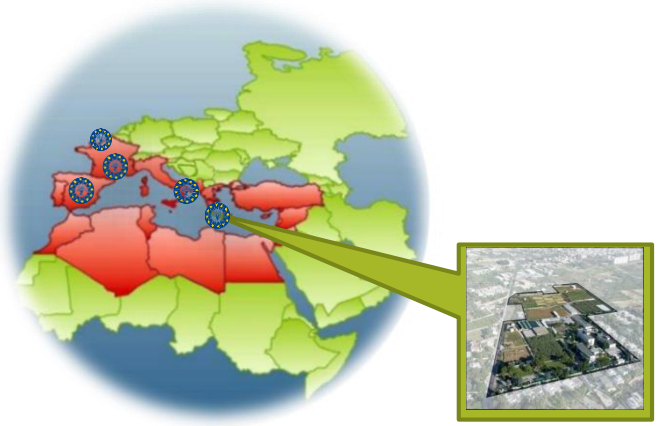
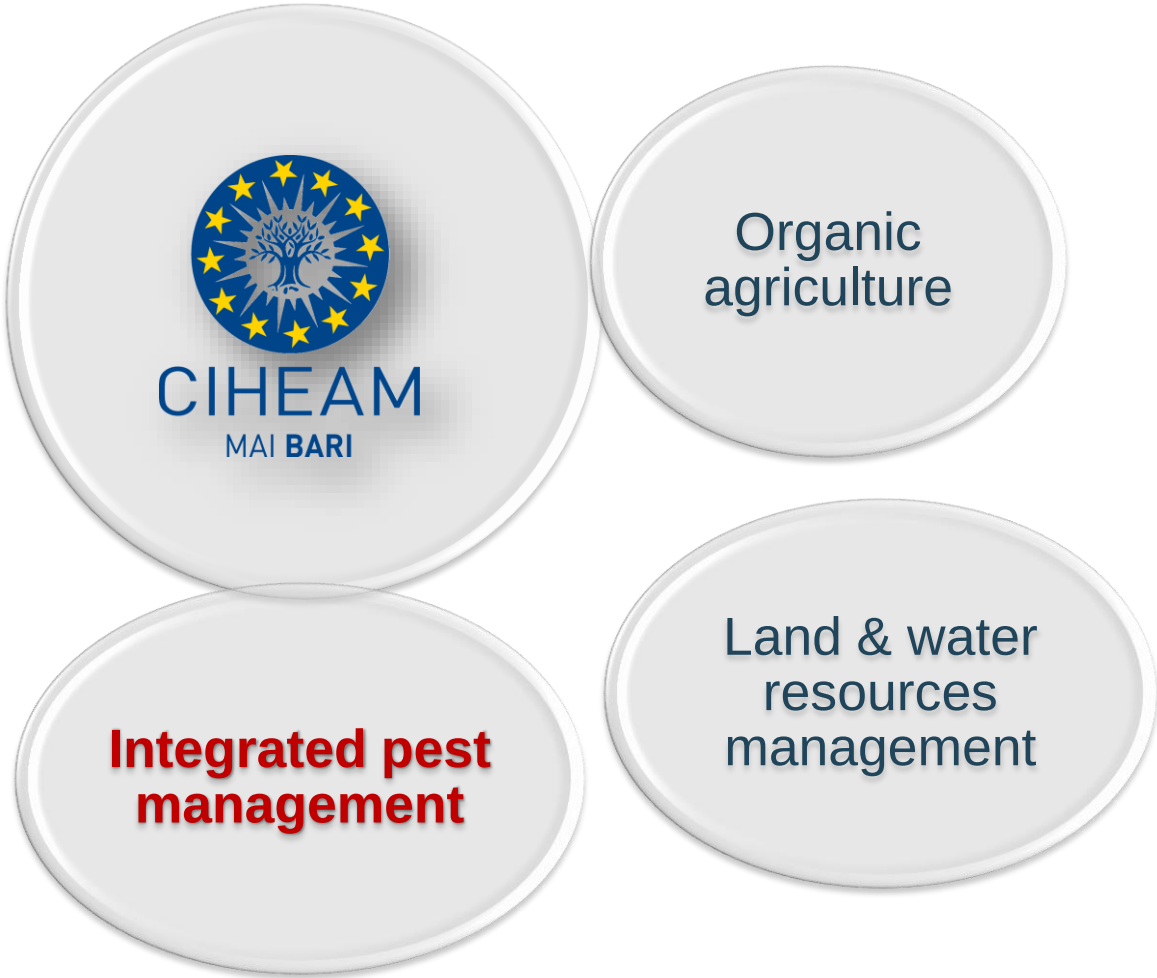
**CIHEAM of Bari, Italy**



Perspectives on the Use of Remote Sensing in Plant Health
Scientific Colloquium organised by EPPO & EUPHRESCO
*UNESCO, Paris, France 27th of September 2018*

# Food security in the Mediterranean region

- Education *(Master & MSc)*
- Applied Research
- International Cooperation
- Networking




**Raise awareness on phytosanitary emergencies in the EU-Med region**

Euphresco
Network for phytosanitary research coordination and funding

PHeRS

**Technical support to the Apulian Plant Protection Service**

**Pest monitoring**

CIHEAM
MAI BARI

Certification of plant material

*Citrus tristeza virus*

*Plum pox virus*

*Erwinia amylovora*

*Phytoplasma vitis*

**Xylella fastidiosa**

# Application of Remote Sensing in the official pest monitoring programmes

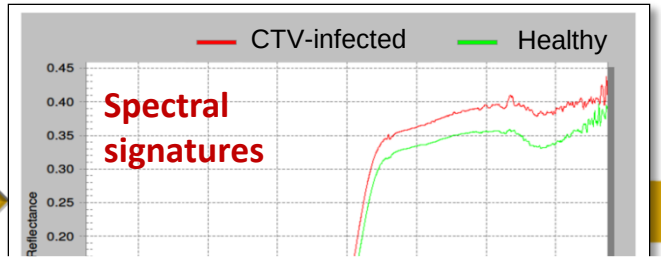
1. RS in the monitoring of *Citrus tristeza virus*
2. A tree counting algorithm for the quantification of citrus trees
3. RS in the monitoring of olive trees showing Olive Quick Decline Symptoms (OQDS) associated to *Xylella fastidiosa* infections

# Application of RS in the official monitoring of *CTV* in Apulia region, Italy

In response to the need of the Phytosanitary Service of Apulia Region:

- to early detect the infection in CTV-free areas
- to eradicate/contain virus spread
- to analyze the spatial and temporal distribution of the infection

# Application of RS for the official monitoring of *CTV* in Apulia region, Italy

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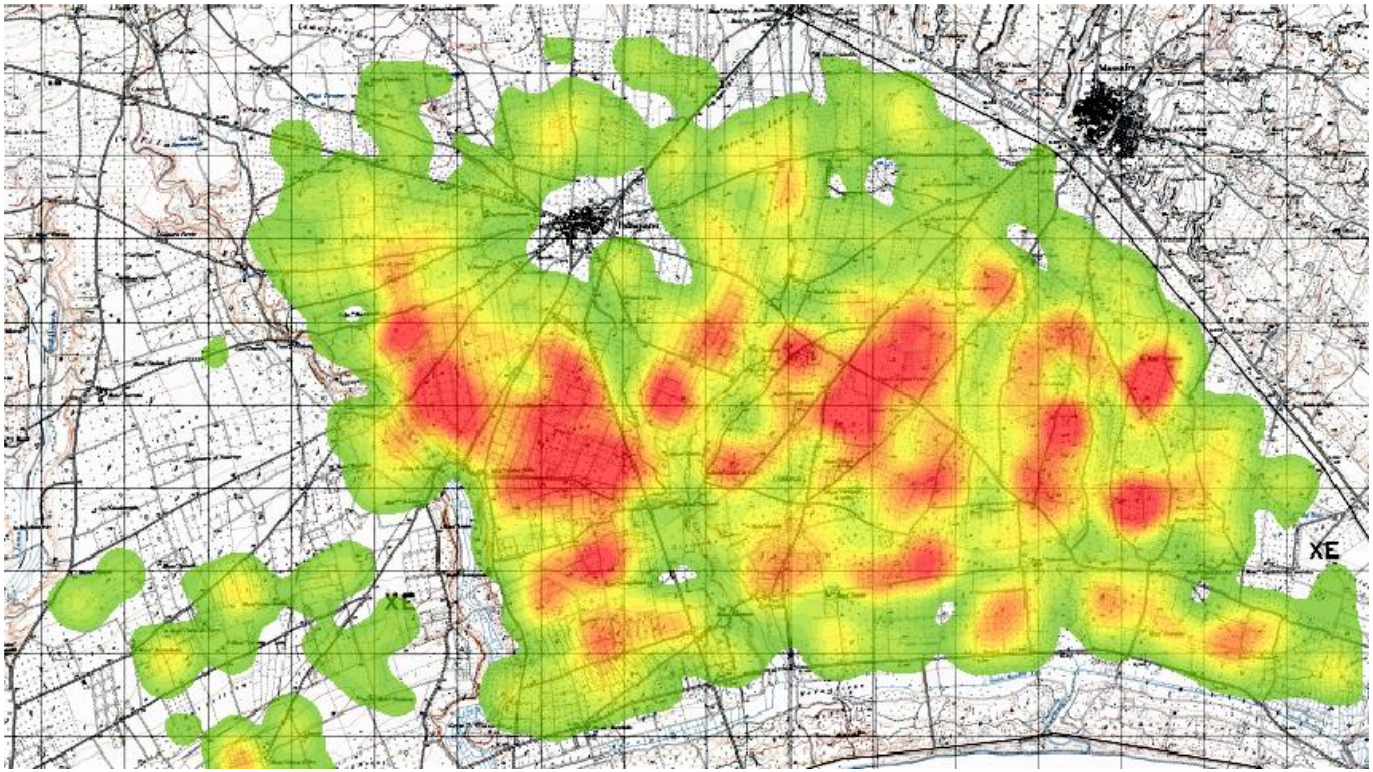
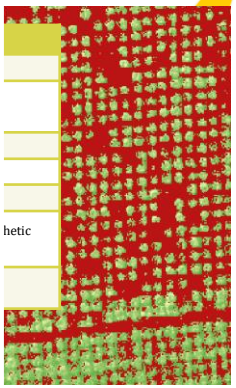
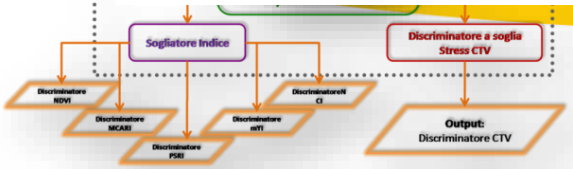
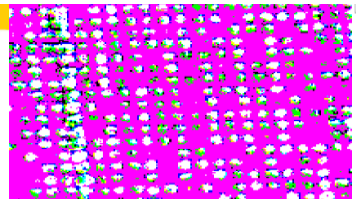


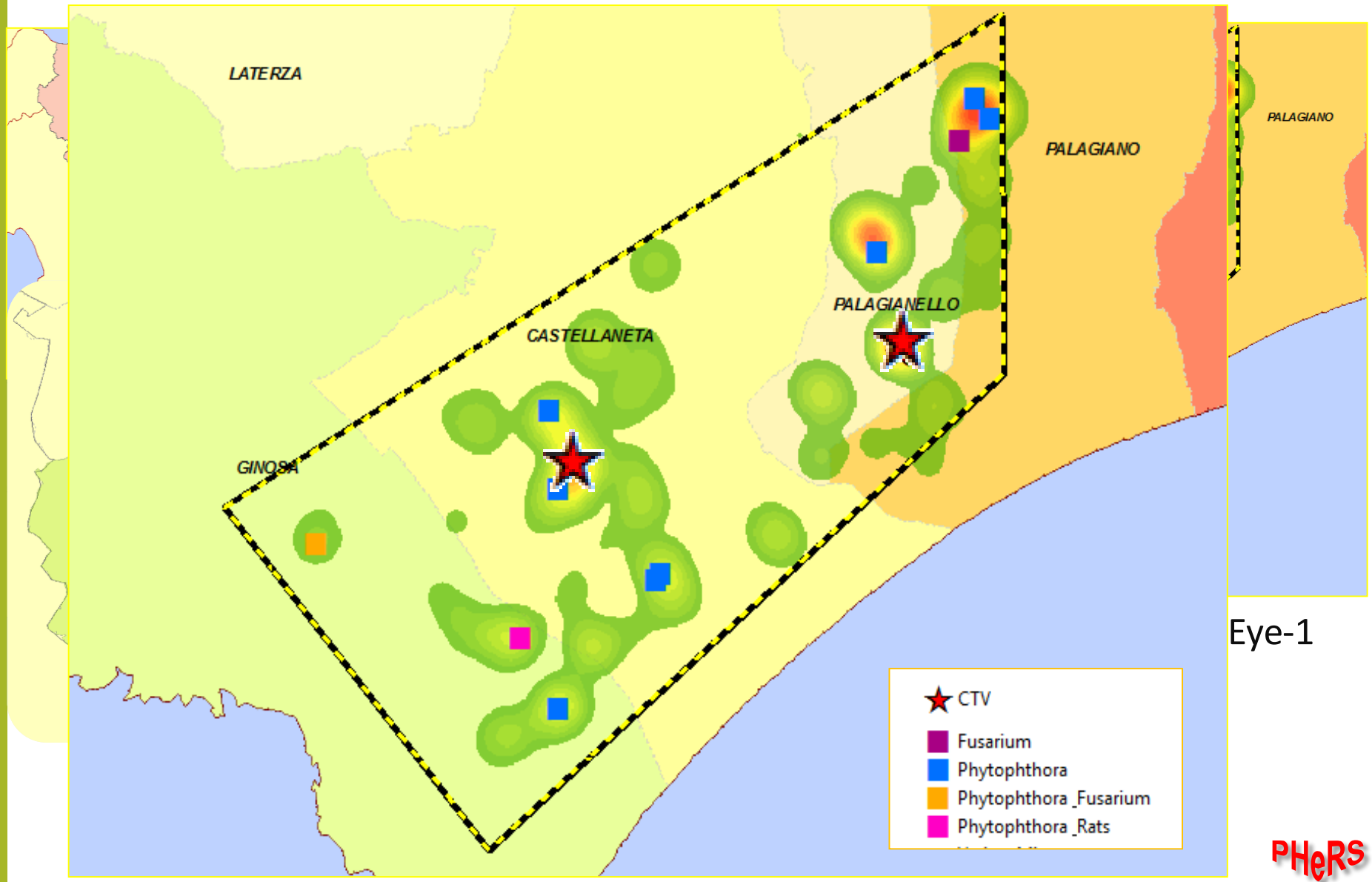




# Application of RS for the official monitoring of *CTV* in Apulia region, Italy

Gualano *et al*., 2012




Eye-1

PHeRS

# Application of Remote Sensing in the official monitoring of *Citrus tristeza virus* (CTV) in Apulia region, Italy

1. RS in the monitoring of *Citrus tristeza virus*
2. Automatic counting algorithm for Citrus trees
3. RS in the monitoring of olive trees showing Olive Quick Decline Symptoms (OQDS) associated to *Xylella fastidiosa* infections

**A tree counting algorithm for precision agriculture tasks**

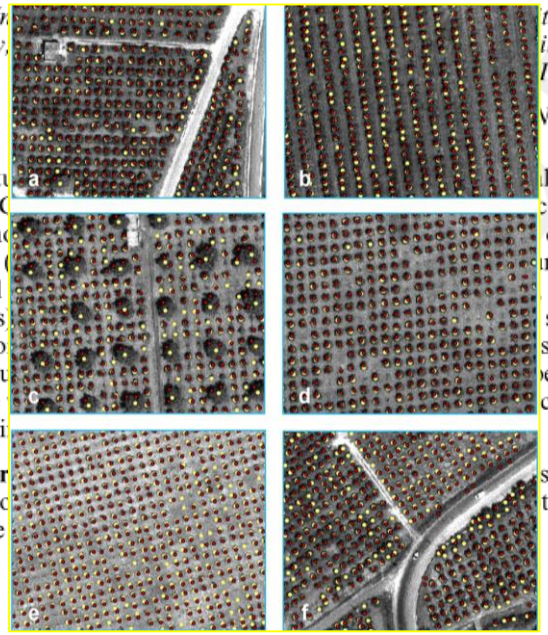
Franco Santoro[a], Eufemia Tarantino[b]*, Benedetto Figorito[c], Stefania Gualano[a] and Anna Maria D'Onghia[a]

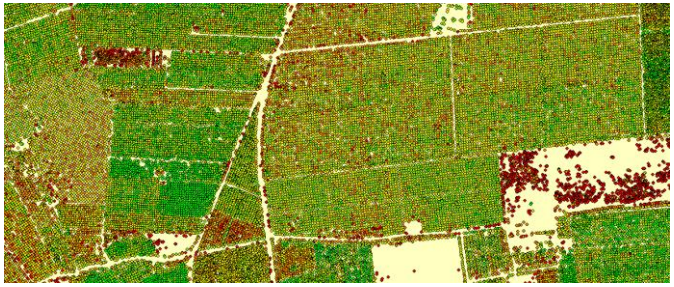
[a]*Centre In… terranéennes (CIHEAM), Bari, Italy,* … *itute of Intelligent Systems* … *Italy*

… *November 2011*)

This stu… l fruit tree identification using … pruning practices, the morpho… one or more brightness peaks … inting and to minimize typical … weeds, and man-made objects … spati… functio… smoo… minimu… erato… mance … consi… capturi…

**Keywor**… ssing; precisio… te ser… culture …



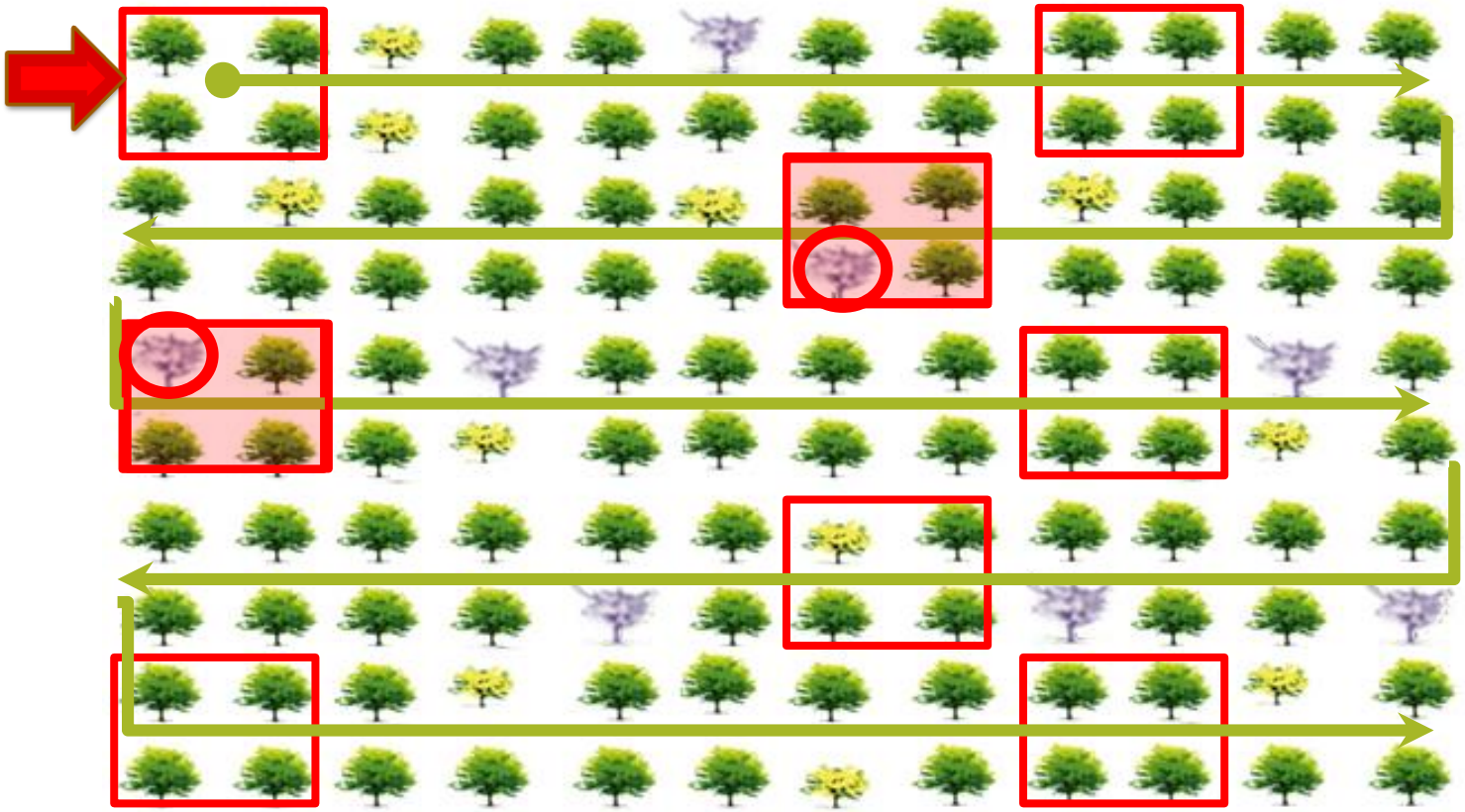
# An automatic procedure for individual fruit tree identification using

## GeoEye-1 sensor data

# Sampling methods

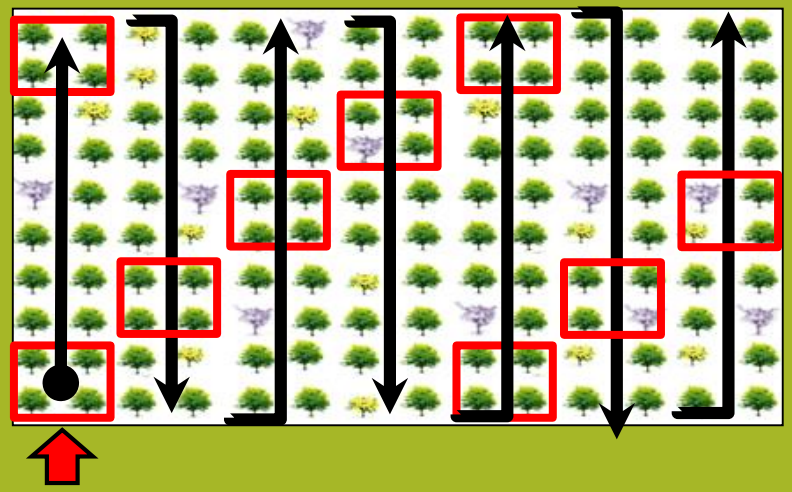
## e.g: Hierarchical Sampling (HS) for Citrus Tristeza Virus)

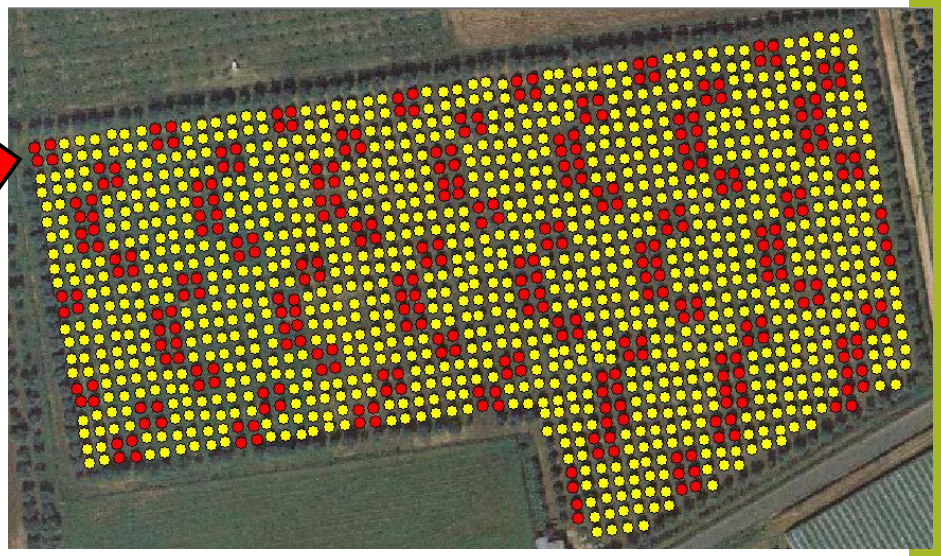
*(Hughes and Gottwald,1998)*

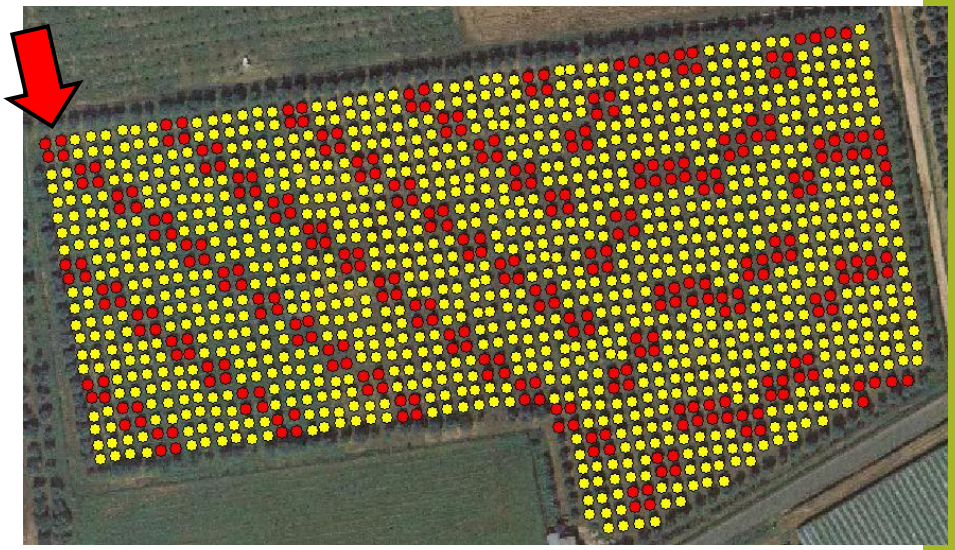


# Evaluation of sampling scheme

**Hierarchical** *(Hughes and Gottwald,1998)*







# Application of Remote Sensing in the official monitoring of *Xylella fastidiosa* in Apulia region, Italy

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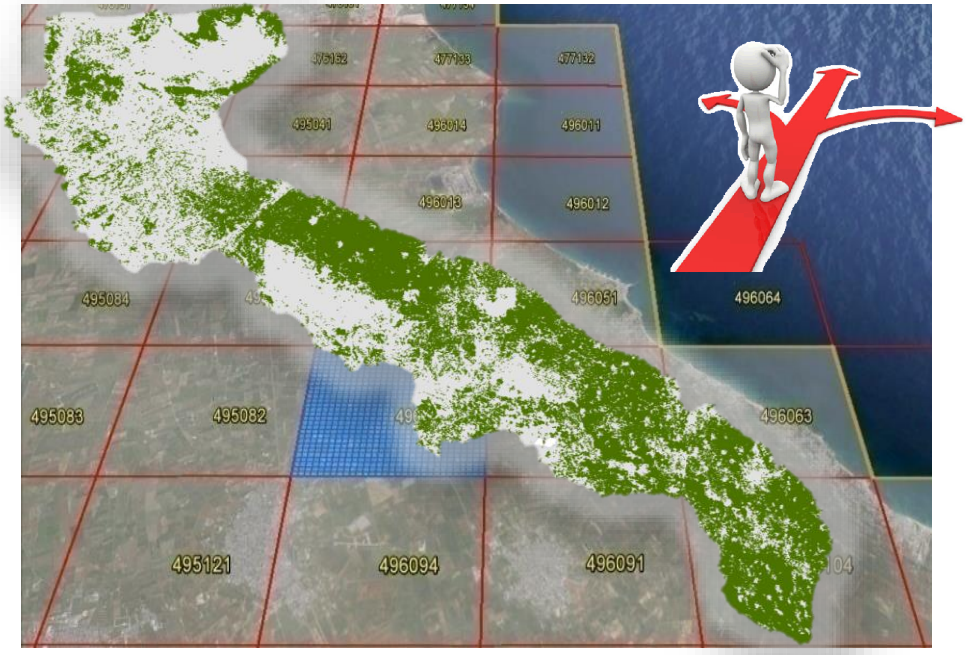
# The surveillance programme of *X. fastidiosa* in Apulia, Italy

## A difficult challenge

- ~ 30 plant host species of CoDiRO strain (> 350 worldwide)
- Symptomless in most of the host plants
- Crops, ornamentals, forestry and wild species can be Xf-hosts
- *Philaenus spumarius* (polyphagous) and other spittlebugs as vector of CoDiRO strain
- All xylem-sap sucking insects are potential Xf-vectors

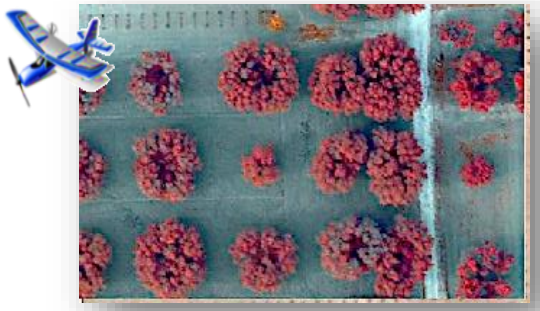
Olive Quick Decline (OQDS)



# The innovative system for early surveillance of Xf

D'Onghia et al., 2014; 2016

## REMOTE SENSING data



## SAMPLING data

Geolocalization

**XylApp**


**Samples**

*Insects*

*Plant*

**XylWeb**



DTBIA

RT - LAMP

## DETECTION data

## Regional Carthographic Service

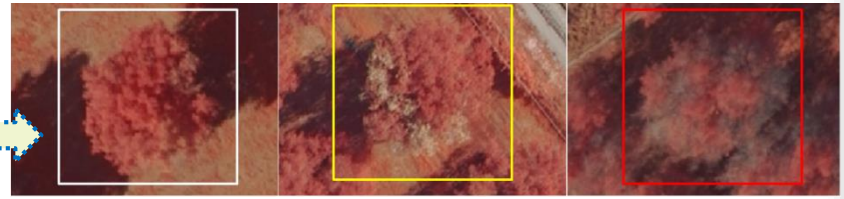
www.emergenzaxylella.it


*Spatial Map of monitoring data*

# Photo-interpretation of high resolution aerial images

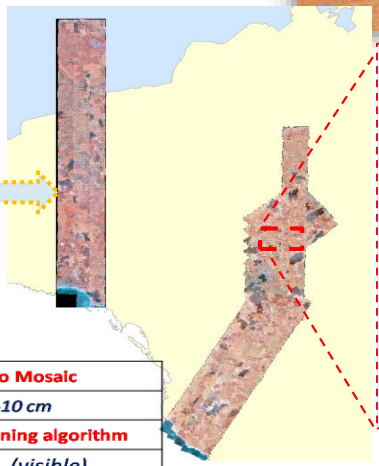
*Gualano et al. 2014*

**Photointerpretation KEYS**
*OQDS symptoms*



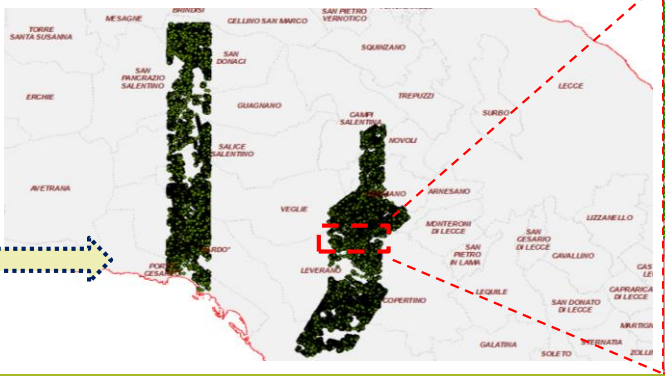

**Photointerpretation**

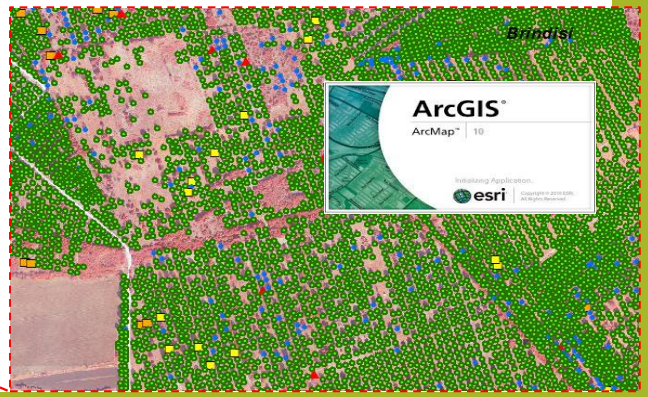
**Ortho aerial images**



| | | |
|---|---|---|
| **Leica DMC** (airborne photogrammetric digital camera) | **Spatial Resolution** | **Ortho Mosaic** |
| | | *7-10 cm* |
| | **Number of bands** | **Pansharpening algorithm** |
| | | *RGB (visible)* |
| | | *Near Infrared (CIR)* |

**Photointerpreted trees 450000 (13000 Ha)**





# Conclusions

- About **64% of OQDS-suspected trees by photointerpretation were OQDS-like** by inspections.
- **The remaining 36% OQDS-suspected** by photointerpretation was associated mainly to poor agricultural practices, biotic stress (e.g. verticillium wilt, olive knot, anthracnose), abiotic stress (e.g. fire, mechanical damage) and to pruned trees **(?).**
- The range of **OQDS-photointerpreted trees found ELISA-positive** was ranging from **0% in the buffer zone to 12% in the containment area** of the demarcated area.
- **No need to use different phototypes for the Photointerpretation** but only presence or absence of OQDS. The procedure can be faster.
- **XylApp** facilitates the finding of the OQDS-suspected trees and data acquisition, thus reducing the costs of inspections & sampling.

# Photointerpretation of OQDS trees by aerial images is sustainable for early detection of Xf in containment & buffer areas

**PHOTOINTERPRETATION of a total of 450.000 olive trees** (about 13.000 Ha)

**INSPECTION of 22.500 OQDS-like** out of 450.000 photointerpreted trees (~5%)

**SAMPLING of 14.600 OQDS** out of 22.500 OQDS-like trees (~65%)

| Activity | Resources | Costs |
|---|---|---|
| **Photointerpretation** | 1 technician x 2 months | 20% |
| | RGB + NIR Orthoimages | **40%*** |
| **Inspection & Sampling** | 2 technicians x 2 months | 40% |
| | | **25.000€** |

**ABOUT 2-3 €/Ha**

* This cost could be reduced of 40% if RGB images used for other purposes (e.g. civil protection) could be at disposal for pest surveillance

# ONGOING RESEARCH activity

*POnTE & Xf-Actors projects H2020*

Hyperspectral & thermal images are used to early detect *X. fastidiosa* infections in asymptomatic & mild symptomatic olive trees (Zarco-Tejada et al., 2018)

*Xf-Actors project H2020*

Spectral discrimination (greenhouse & field) of Xf-infections and infections by tracheomicotic fungi in olive trees

Identification of the metabolomic profile associated to Xf infection and correlation with spectral wavelenghts in order to find a pest-specific 'package of wavelenghts'

Development of $XylApp_{EU}$ for field acquisition of remote sensing data

An automatic tree counting procedure using RGB orthoimages & satellite images to quantify olive trees (land cover, % infected olive trees etc.)