

# Monitoring the impact of *Xylella* on Apulia's olive orchards using Sentinel-2 satellite data and aerial photographs

Rebecca Scholten, Laura Martinez Sanchez, Alberto Hornero,  
Juan A Navas-Cortes, Pablo J. Zarco-Tejada, Pieter S. A. Beck

Second European conference on *Xylella fastidiosa*  
30 October 2019

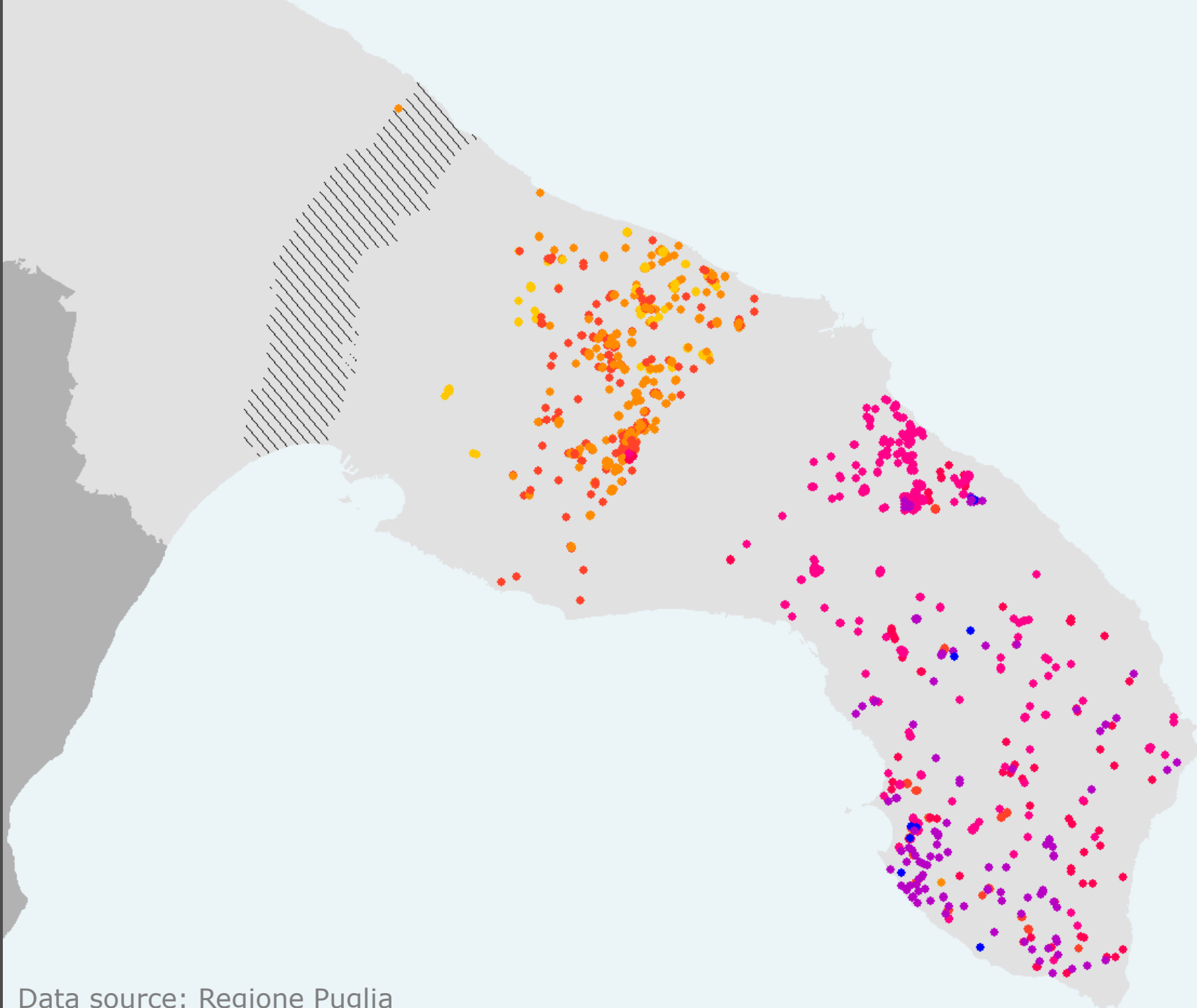


# Monitoring the impact of *Xylella* on Apulia's olive orchards using **MODIS** satellite data supported by weather data

Rebecca Scholten, Laura Martinez Sanchez, Alberto Hornero,  
Juan A Navas-Cortes, Pablo J. Zarco-Tejada, Pieter S. A. Beck

Second European conference on *Xylella fastidiosa*  
30 October 2019





Data source: Regione Puglia



- GALLIPOLI 8
- Mancaversa 6
- MATINO 8
- LECCE 45
- LIDO PIZZO  
Marina di Gallipoli
- Grotto della Seta  
Marina di Gallipoli





... same place in 2015

GALLIPOLI 8

Mancaversa 6

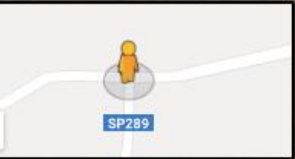
MATINO 8

LECCE 45

LIDO PIZZO  
Marina di Gallipoli

lido Punta della Suina  
Gallipoli

AGENZIA TURISTICA  
VENATORIA  
"DIANA"





Can we monitor severe damage  
to olive orchards across Apulia?

# What do we mean here with 'severe damage'?

symptom severity: 0



1



2



3



4



# What do we mean here with 'severe damage'?

symptom severity: 0



1



2



3



4

**Severe damage mapping**  
With satellite sensors



# What do we **NOT** mean with 'severe damage'?

symptom severity: 0



1



2



3



4

**Early Detection**  
with sensors on aircraft















An aerial photograph of a landscape, likely a rural or agricultural area, showing fields, trees, and a road. A large, semi-transparent blue rectangle is overlaid on the center of the image, representing a single pixel in MODIS satellite data. The text "1 pixel in MODIS satellite data" is written in white, bold font at the top of the blue area. The text "observed twice a day" is written in white, bold font at the bottom of the blue area.

**1 pixel in MODIS satellite data**

**observed twice a day**



Olive orchard



Severely damaged olive orchard





Olive orchard



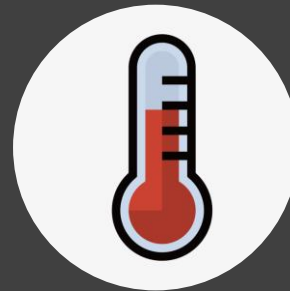
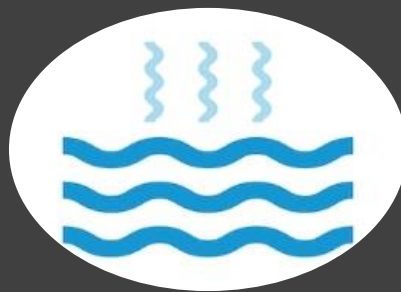
Evergreen crowns & deep roots

Severely damaged olive orchard



No crowns, highly seasonal & shallow roots





SPEI &  
temperature  
from ERA5



We predict a shift in the way  
vegetation productivity responds to  
seasonal weather conditions



# We work at the level of orchards, not trees

Infected area + buffer zone<sup>i</sup>

27 188 olive orchards<sup>ii</sup>  
covering 2 261 km<sup>2</sup>

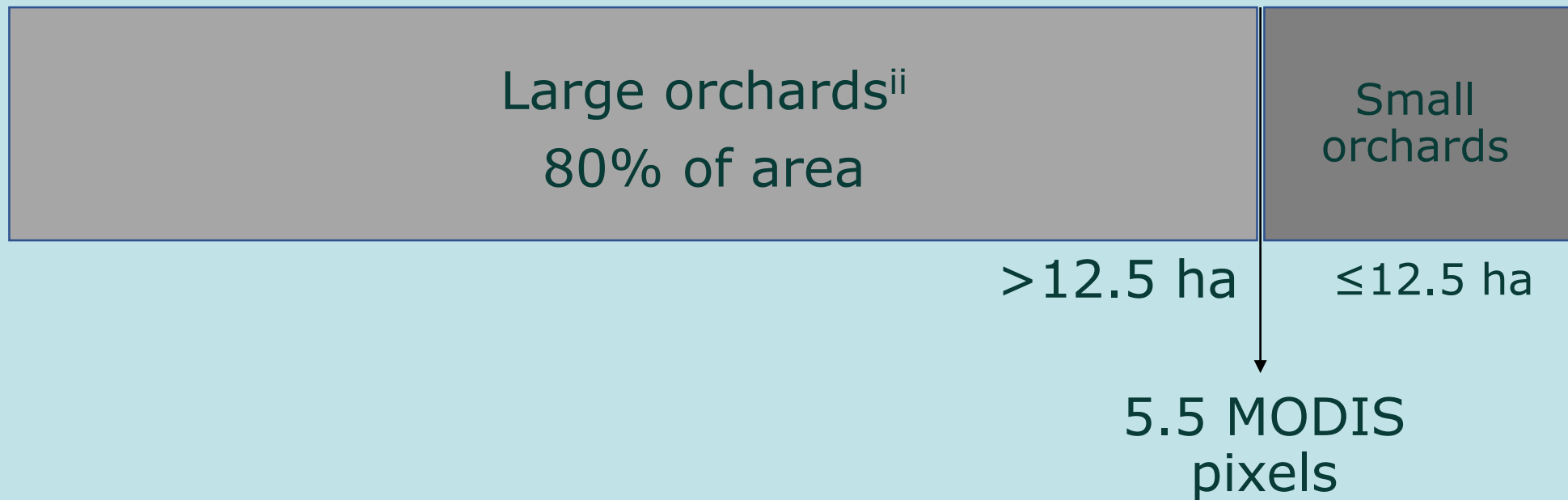
<sup>i</sup> as of August 2018

<sup>ii</sup> based on Regione Puglia land cover map 2011



# We focus on large orchards

Infected area + buffer zone<sup>i</sup>



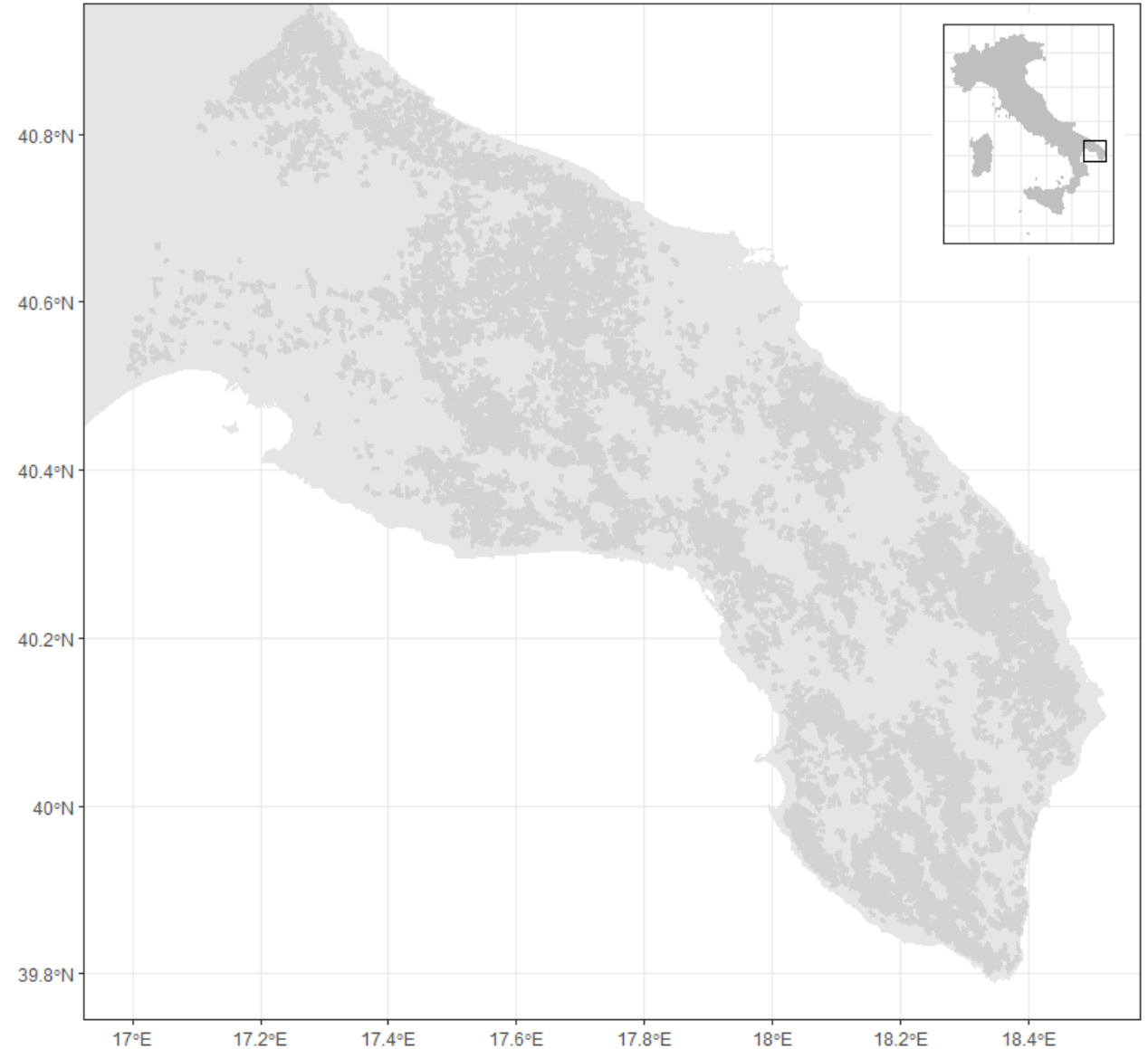
<sup>i</sup> as of August 2018

<sup>ii</sup> based on Regione Puglia land cover map 2011



# Large orchards

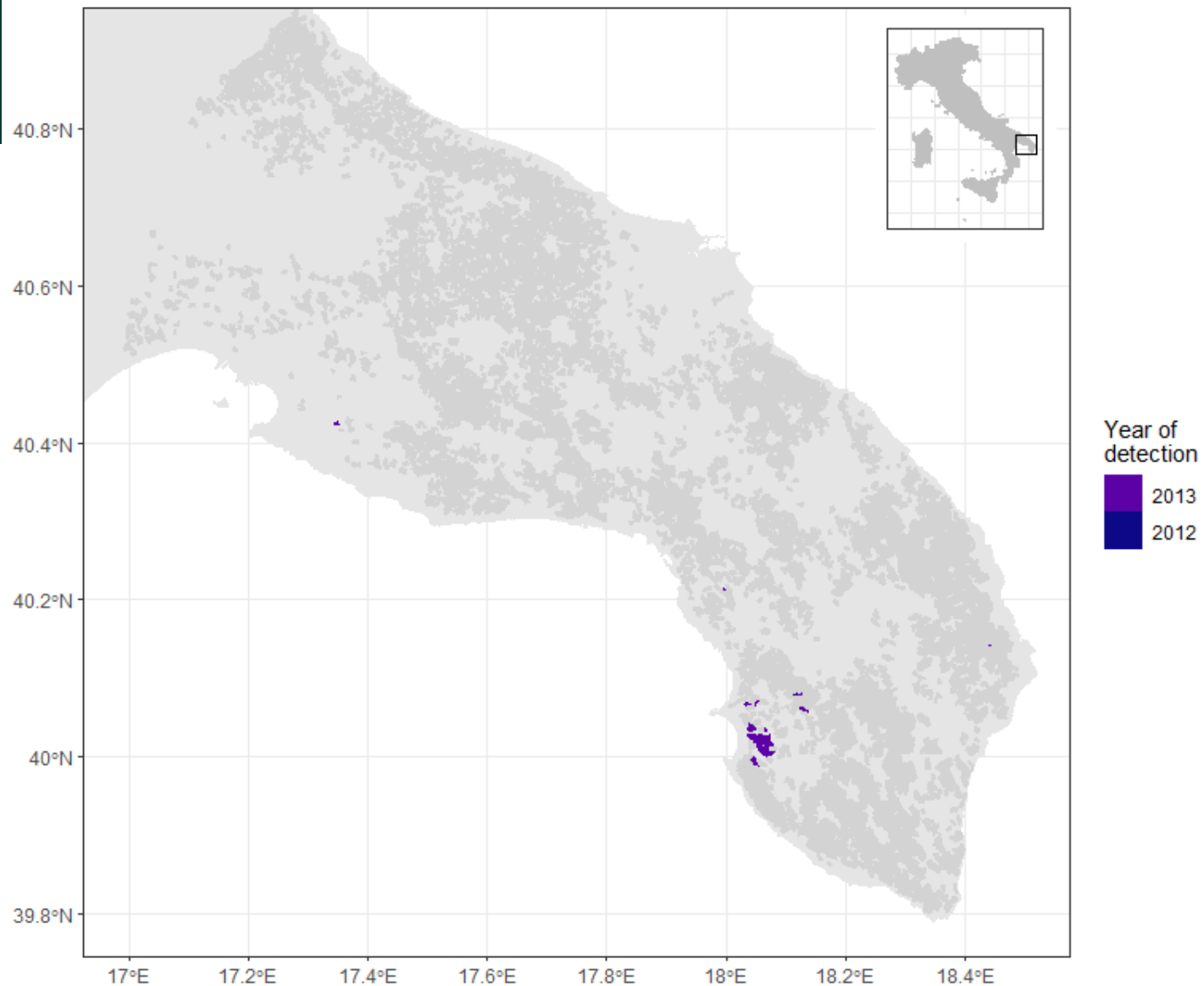
3135 large olive orchards in  
the infected + buffer zone





# The first damage detections

near Galipolli in 2012-2013





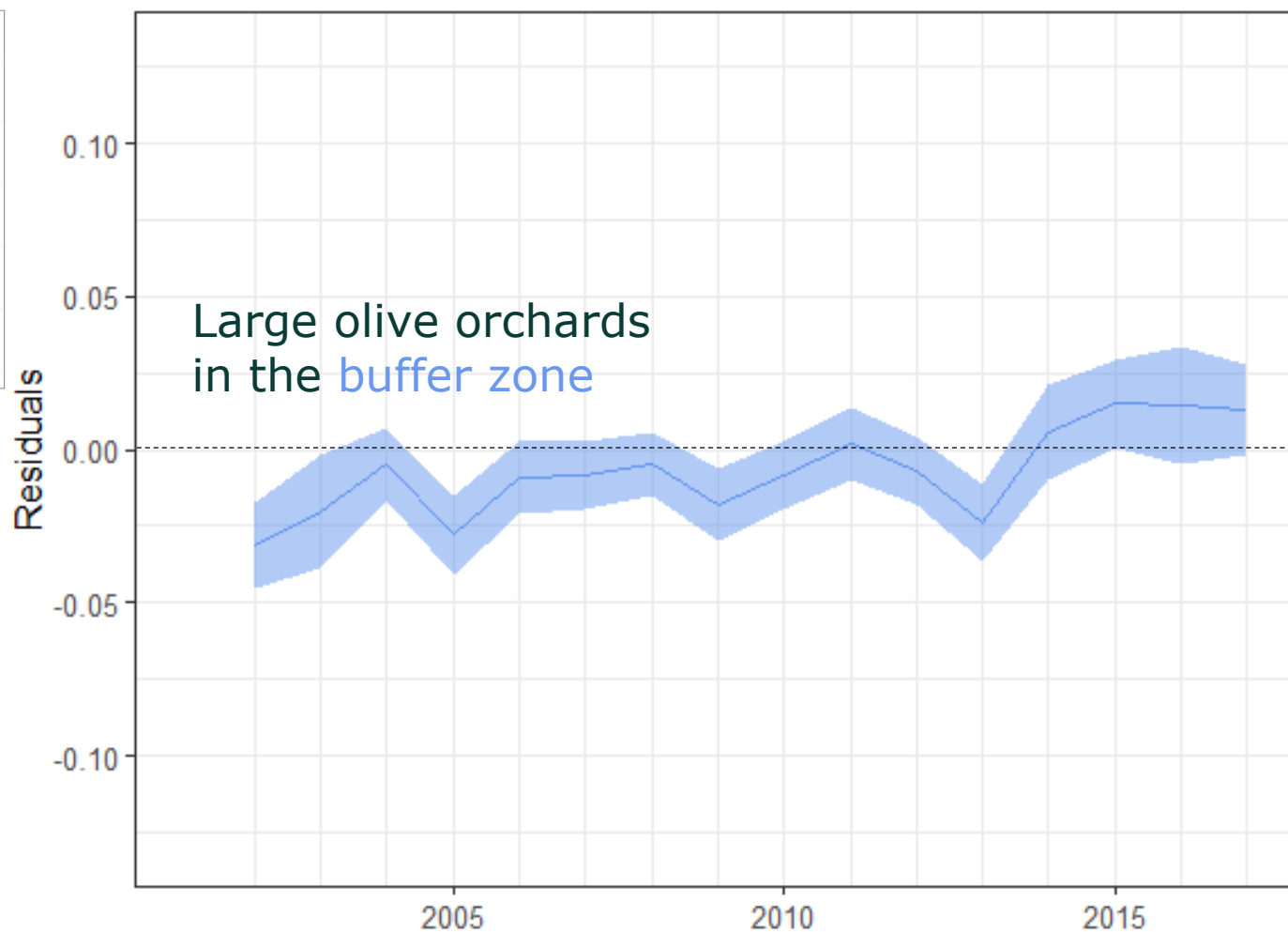
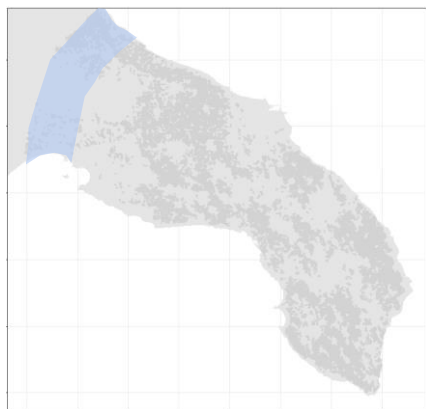
# Does our method work?

Two independent sources of validation data

1. Official monitoring data: surveys & demarcated areas
2. Field observations of nine *Xylella*-infected plots where all trees were assessed for symptoms (i.e. damage) in 2016 and 2017



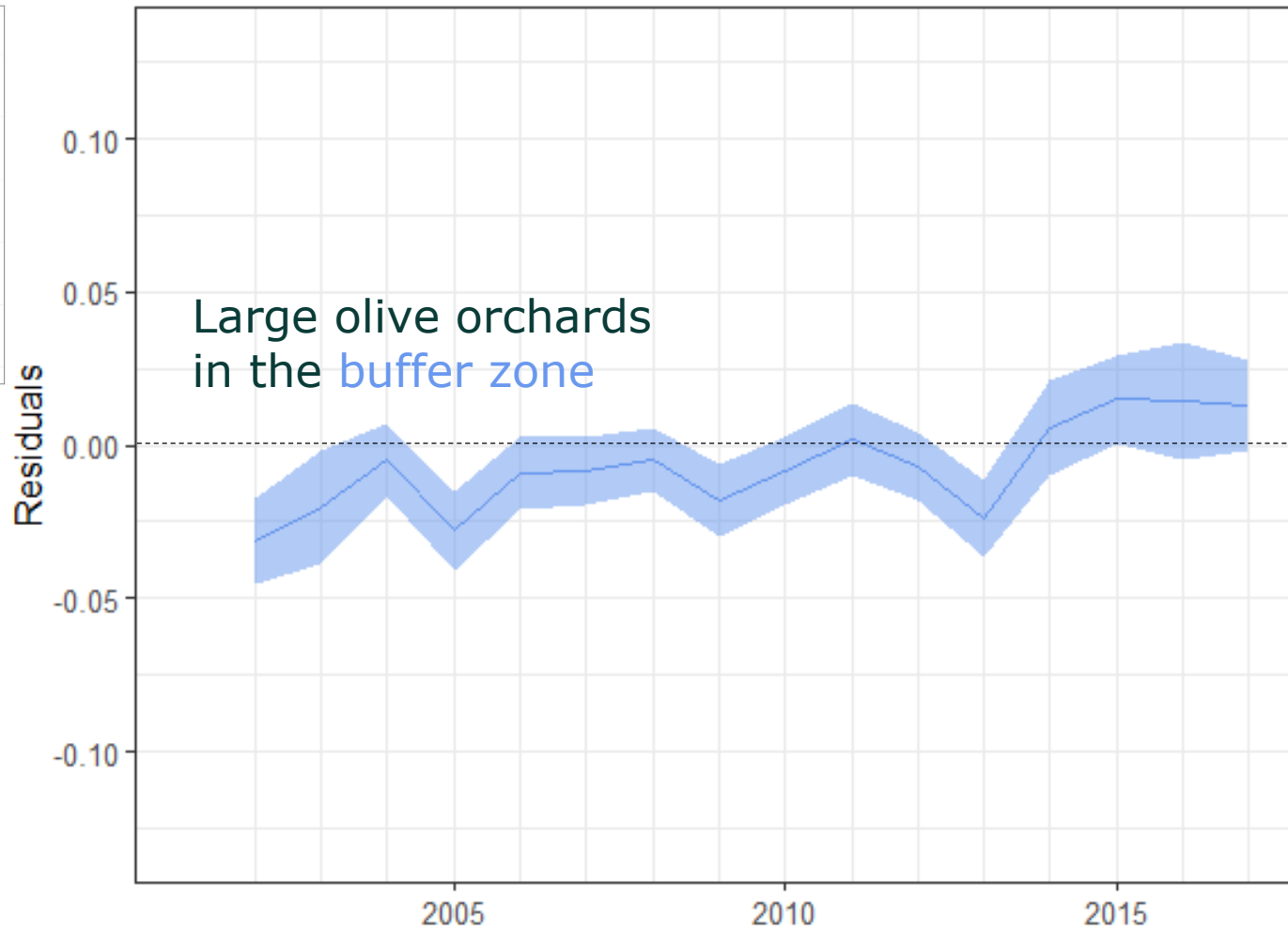
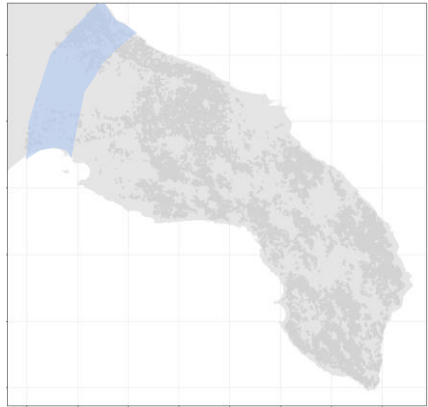
# Validation 1: using official monitoring data



Expected value  
of a healthy  
olive orchard



# Validation 1: using official monitoring data



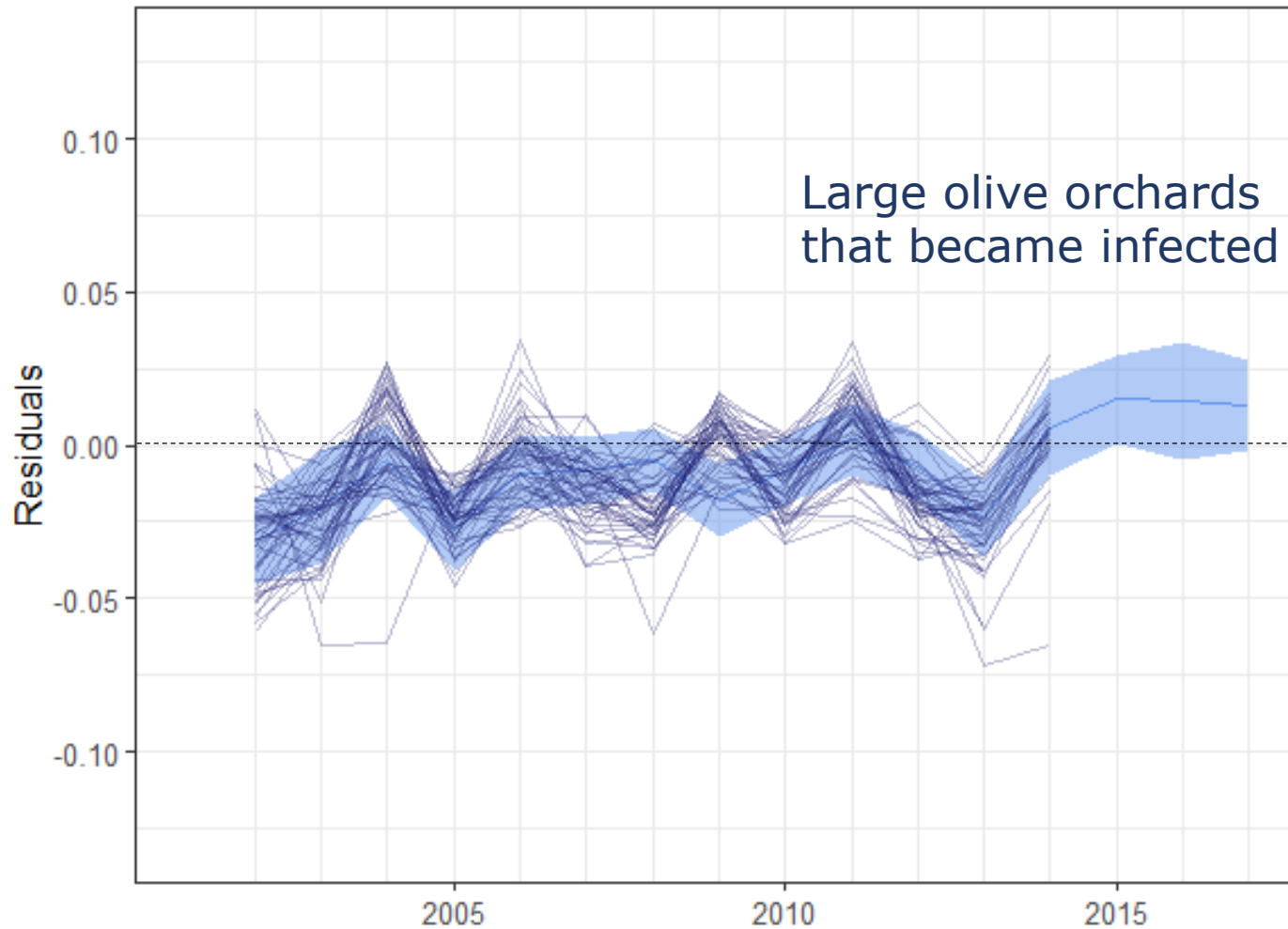
More productive than expected

Expected value of a healthy olive orchard

Less productive than expected



# Validation 1: using official monitoring data

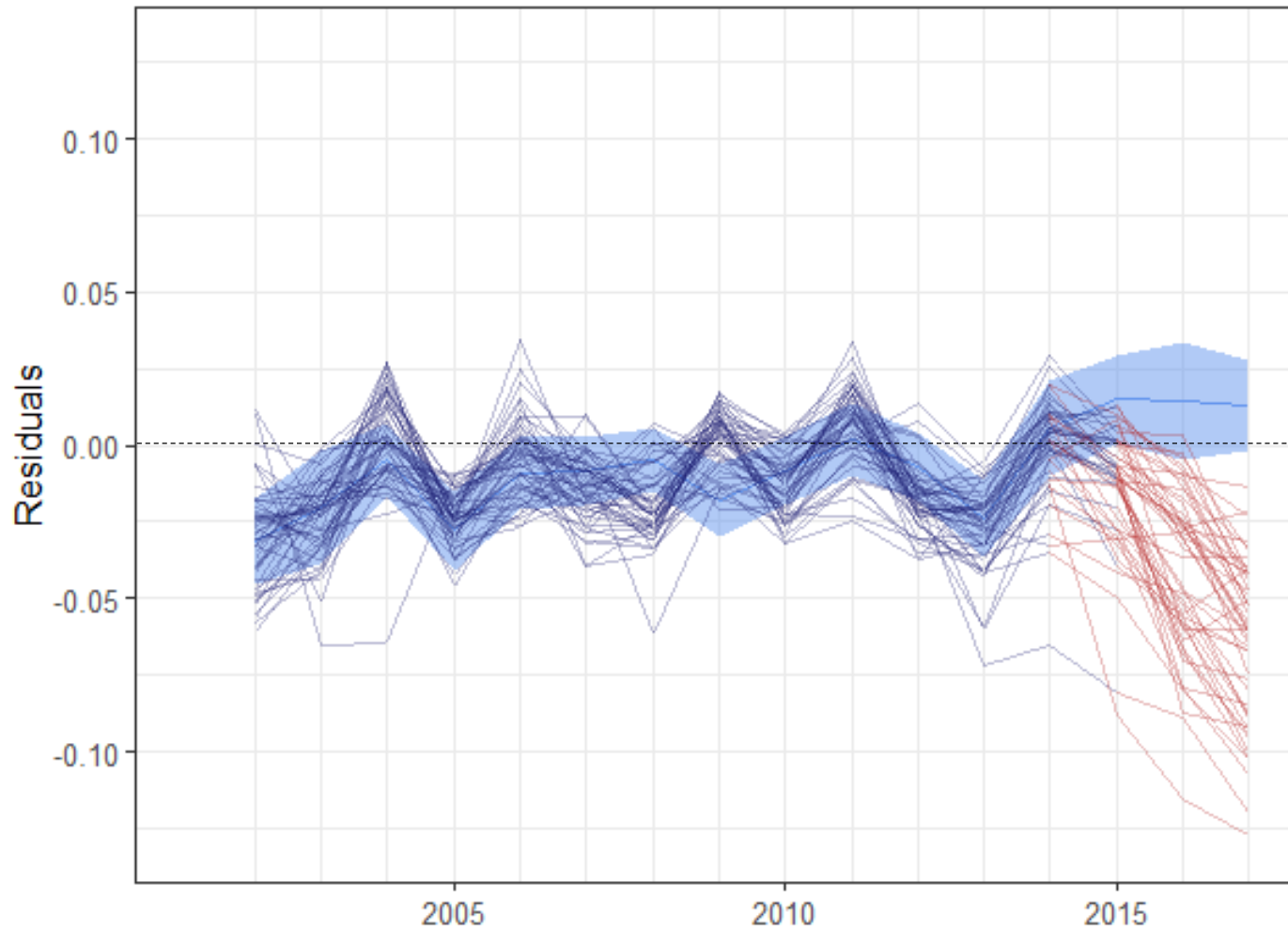


Large olive orchards  
that became infected

More productive  
than expected

Less productive  
than expected

# Validation 1: using official monitoring data



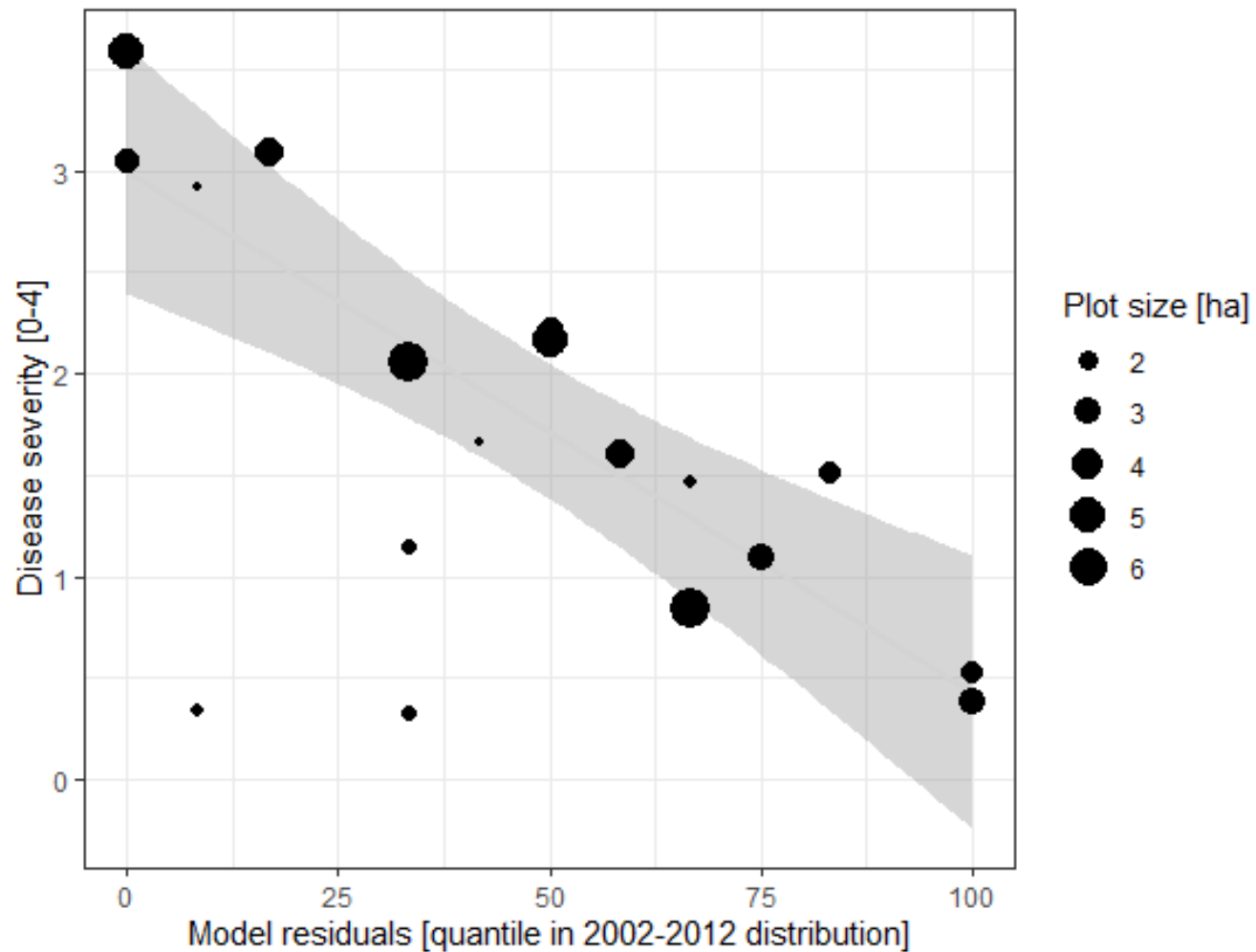
More productive  
than expected

**Infected** olive orchards

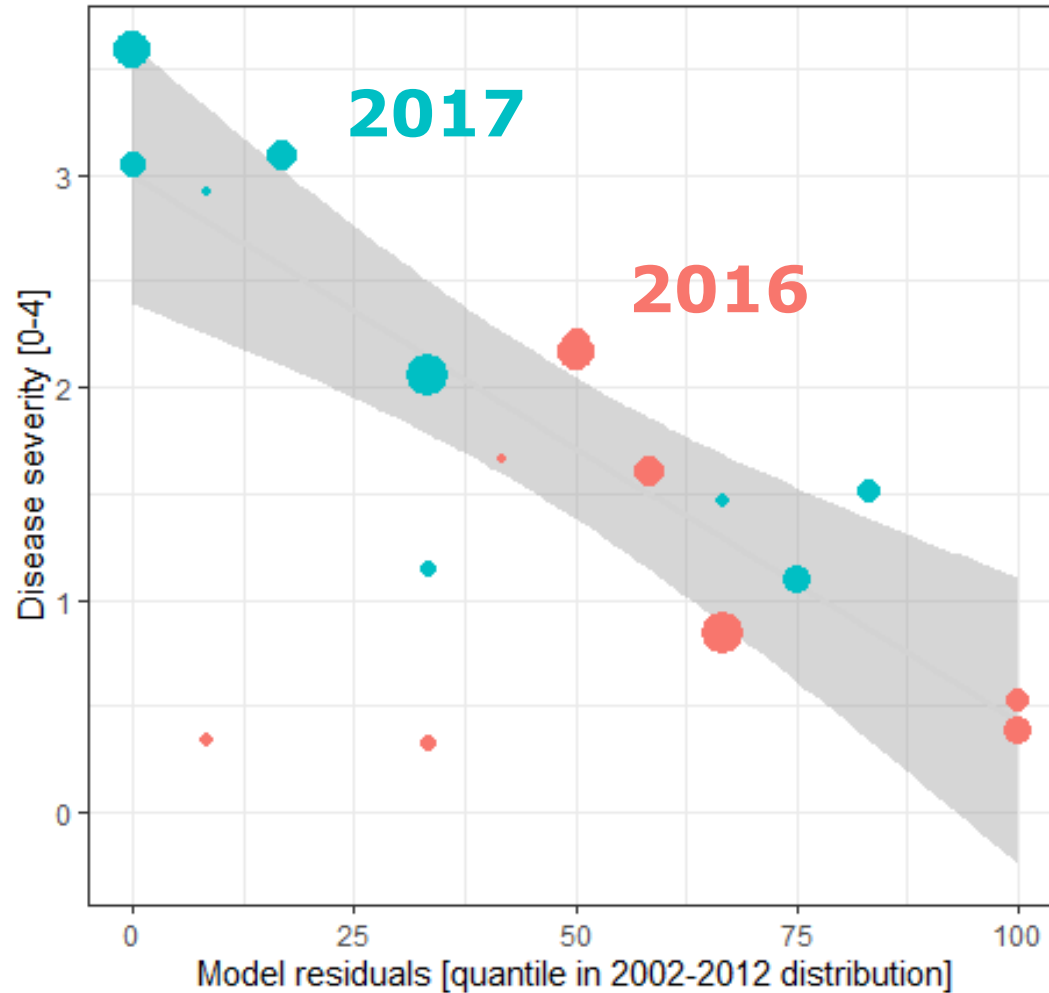
Less productive  
than expected



# Validation 2: using field observations

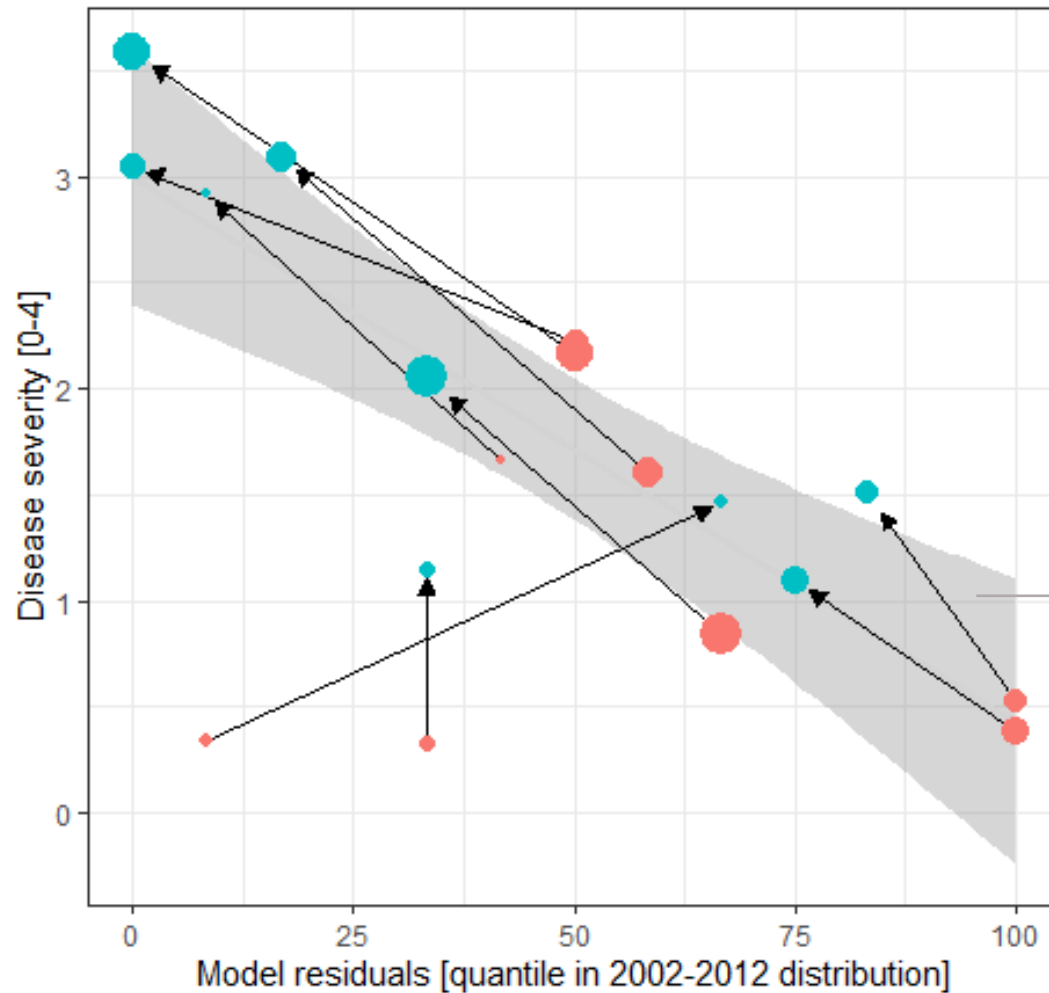


# Validation 2: using field observations



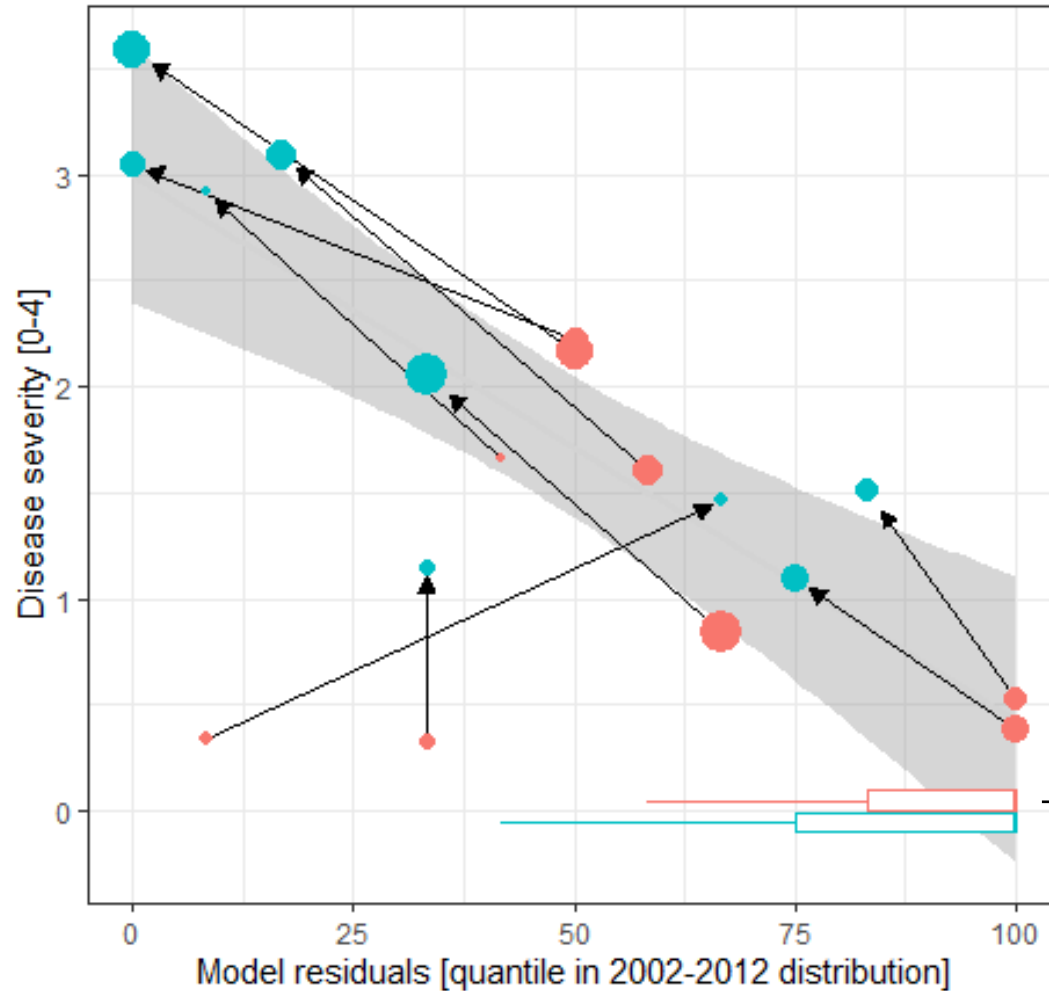


# Validation 2: using field observations



Arrows connect the same plots in different years

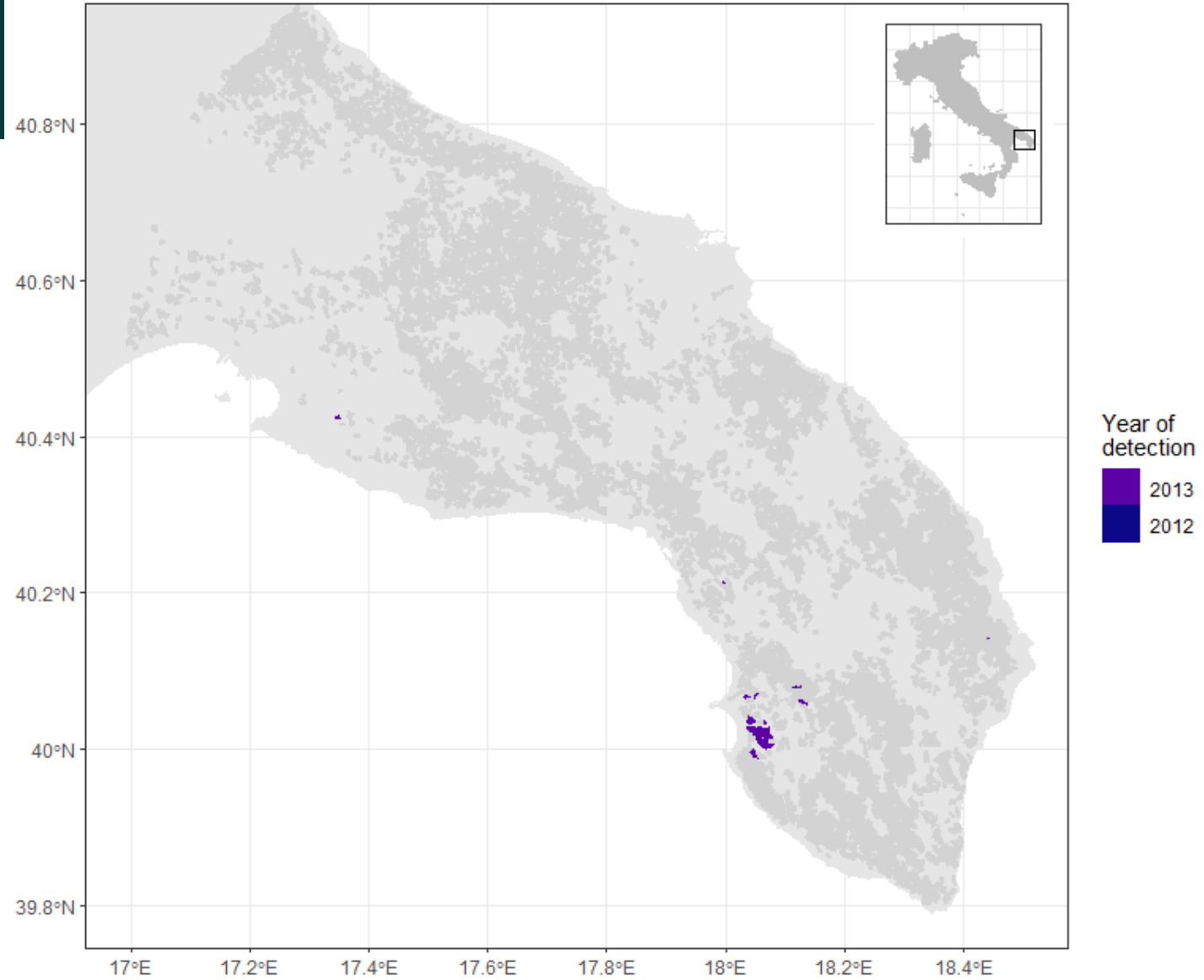
# Validation 2: using field observations



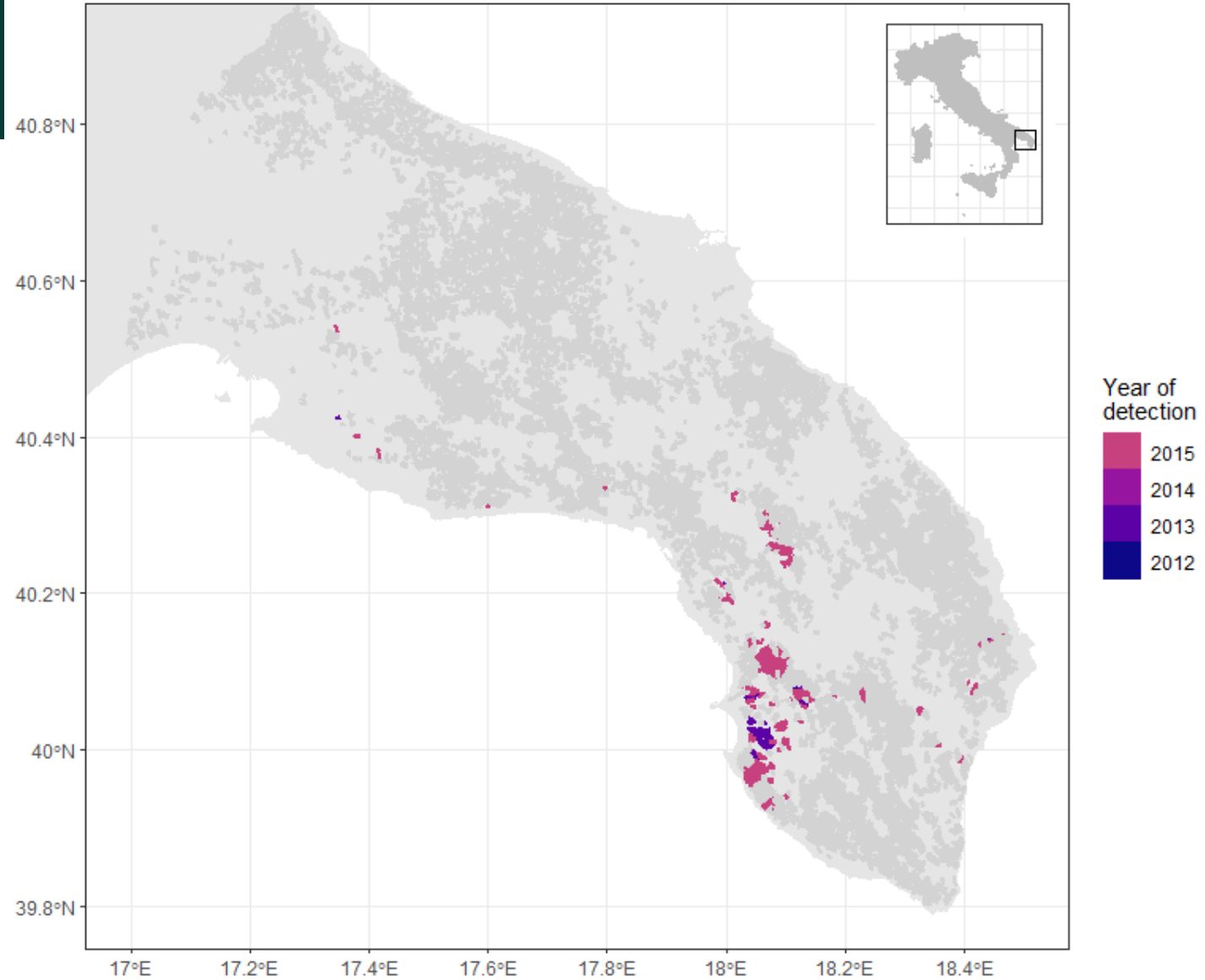
Uninfected orchards  
(buffer zone)



# Severely damaged large olive orchards

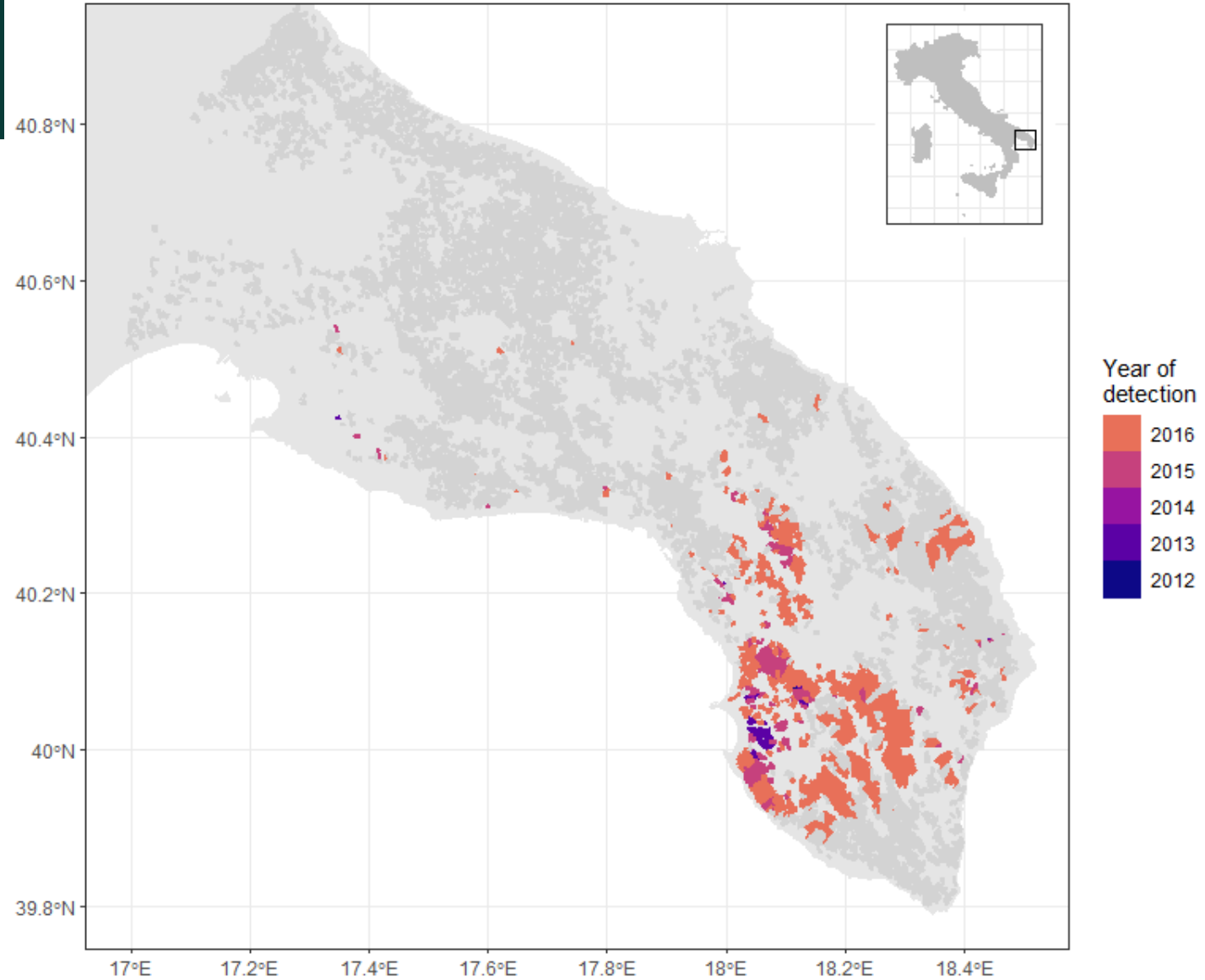


# Severely damaged large olive orchards

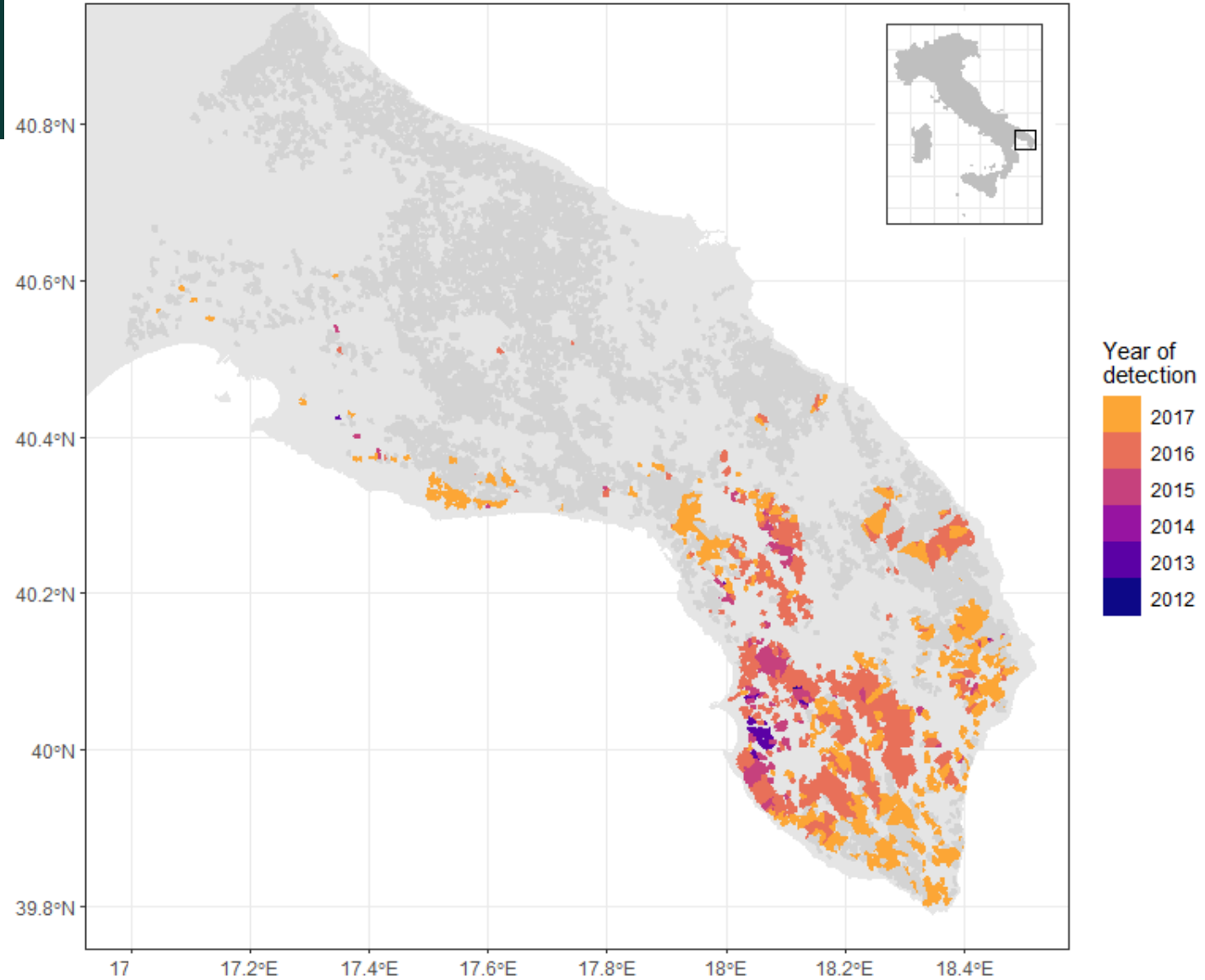




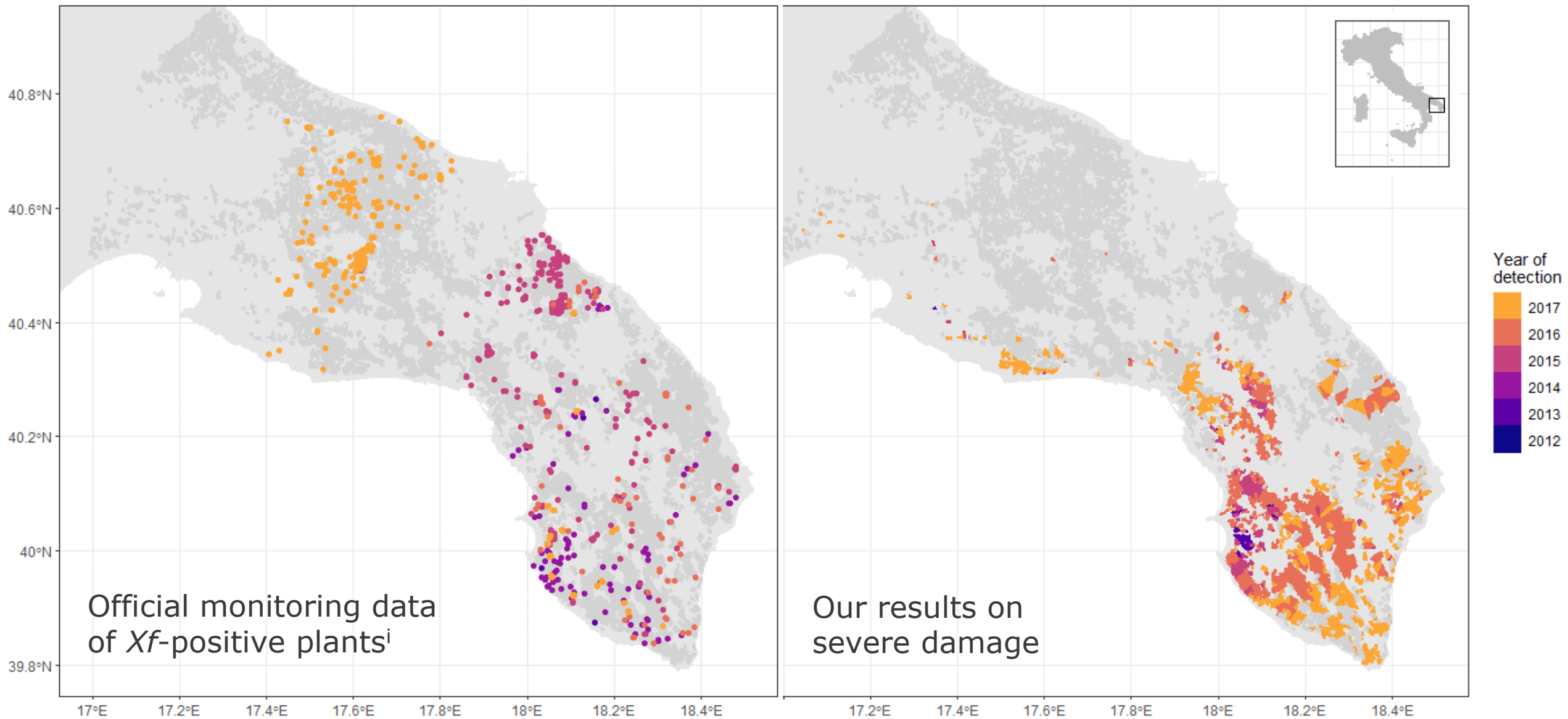
# Severely damaged large olive orchards



# Severely damaged large olive orchards



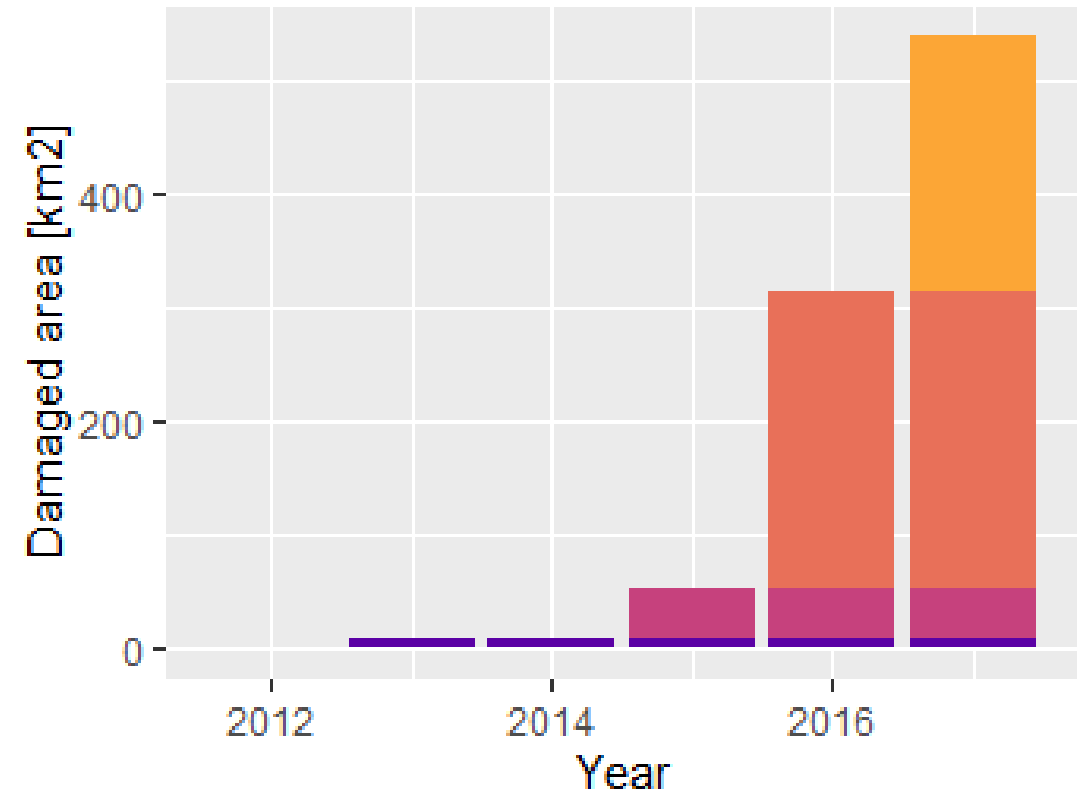




<sup>i</sup> Data source: Regione Puglia

# How big is the detected damaged area?

- By 2017, we detected severe damage in large olive orchards covering 538 km<sup>2</sup>
- Large orchards account for ca 80% of the total orchard area, so the total severely damage area might be closer to 650 km<sup>2</sup>
- ... equivalent to ca 6.5 million olive trees (assuming a planting density of 100 trees/ha)
- The area with severe damage continues to grow





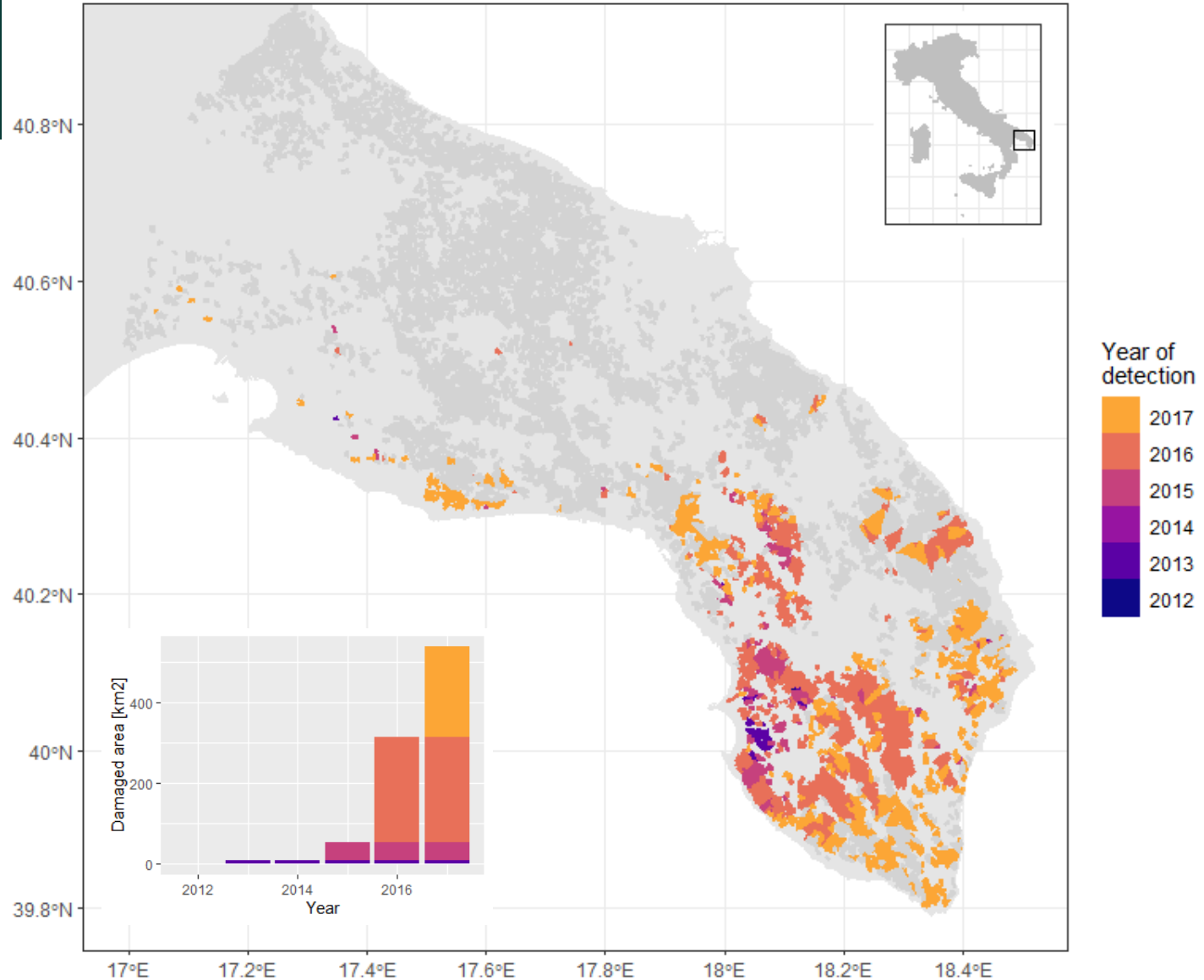
# Conclusions & outlook

- **Severe damage in large olive orchards can be mapped** on near-annual basis using satellite and weather data
- Independent **field observations confirm the results**
- We cannot attribute the damage we see exclusively to *Xylella*, but the **satellite-detected damage pattern is consistent with the official surveillance**; e.g. ground zero near Gallipoli, damage trails infection
- **By 2017, large orchards covering 538 km<sup>2</sup>** were damaged
- Update to 2019 possible by the end of this year

# Thank you

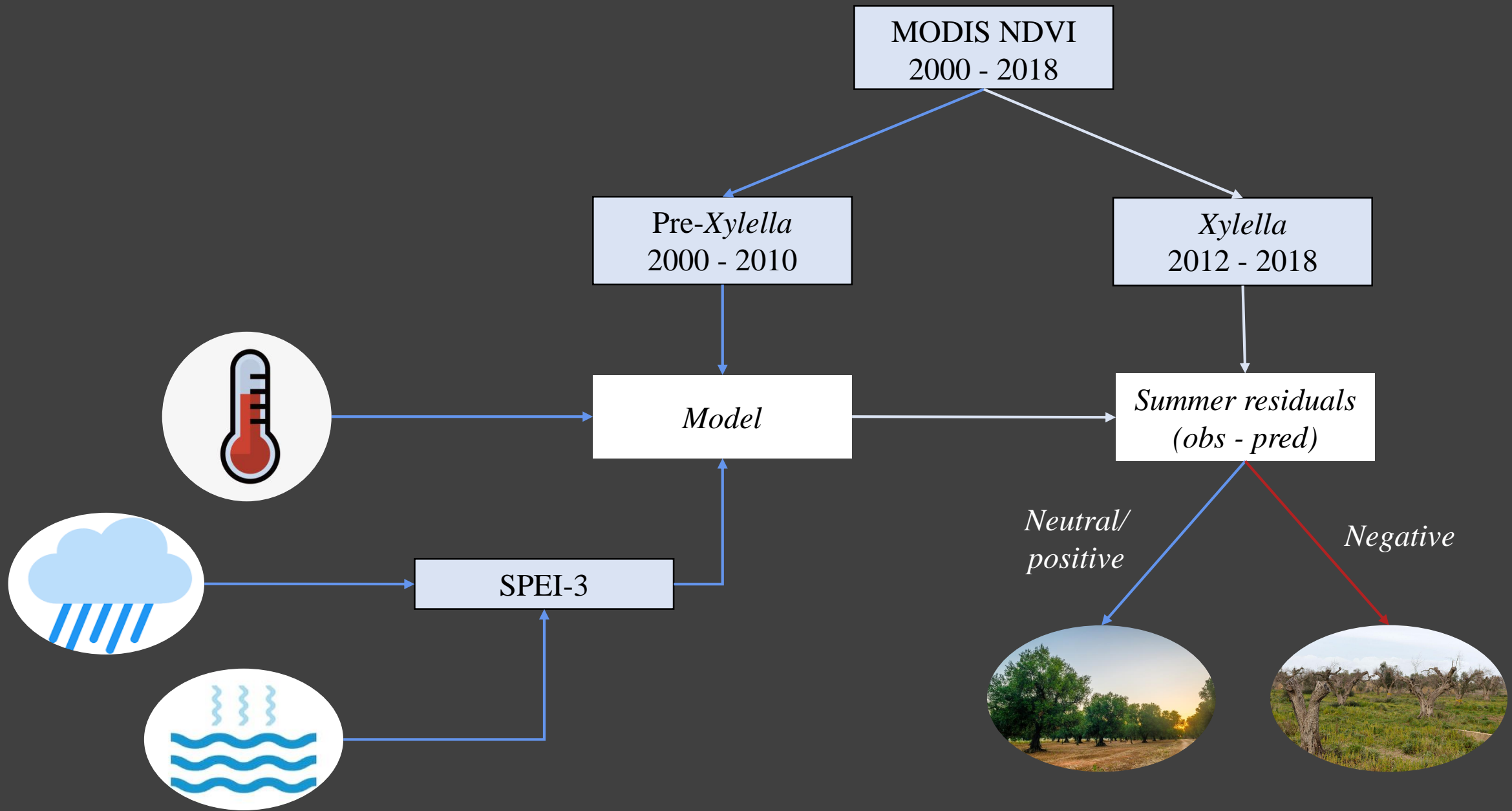
## Any questions?

You can find me at  
[pieter.beck@ec.europa.eu](mailto:pieter.beck@ec.europa.eu)









# Original MODIS NDVI time series

