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

XF ACTORS

POnTE PestOrganisms ThreateningEurope

European Commission

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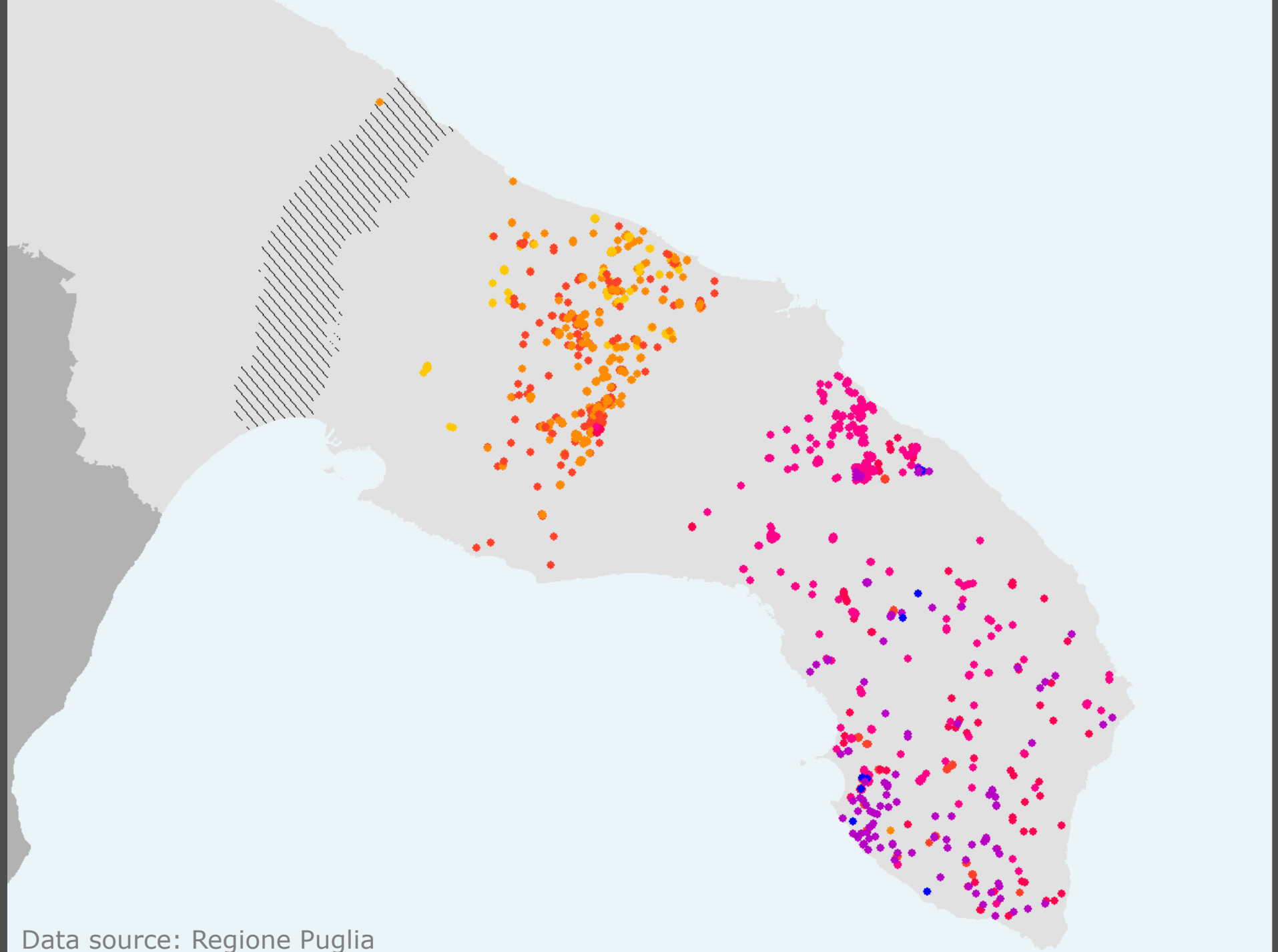

Data source: Regione Puglia

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Google Street view 2011
GALLIPOLI 8
MATINO 8
LECCE 45
LIDO PIZZO


... same place in 2015
Apulia
Google
Street View - Sep 2015
GALLIPOLI 8
Mancaversa 6
MATINO 8
LECCE 45
LIDO PIZZO
Marina di Gallipoli
lido Punta della Suina
Gallipoli
"DIANA"
SP289
Google

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

European Commission

What do we mean here with ‘severe damage’?

symptom severity: 0

1 2 3 4

Severe damage mapping

With satellite sensors

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What do we NOT mean with ‘severe damage’?

symptom severity: 0

1

2

3

4

Early Detection
with sensors on aircraft

Zarco Tejada *et al.* Nature Plants 2018

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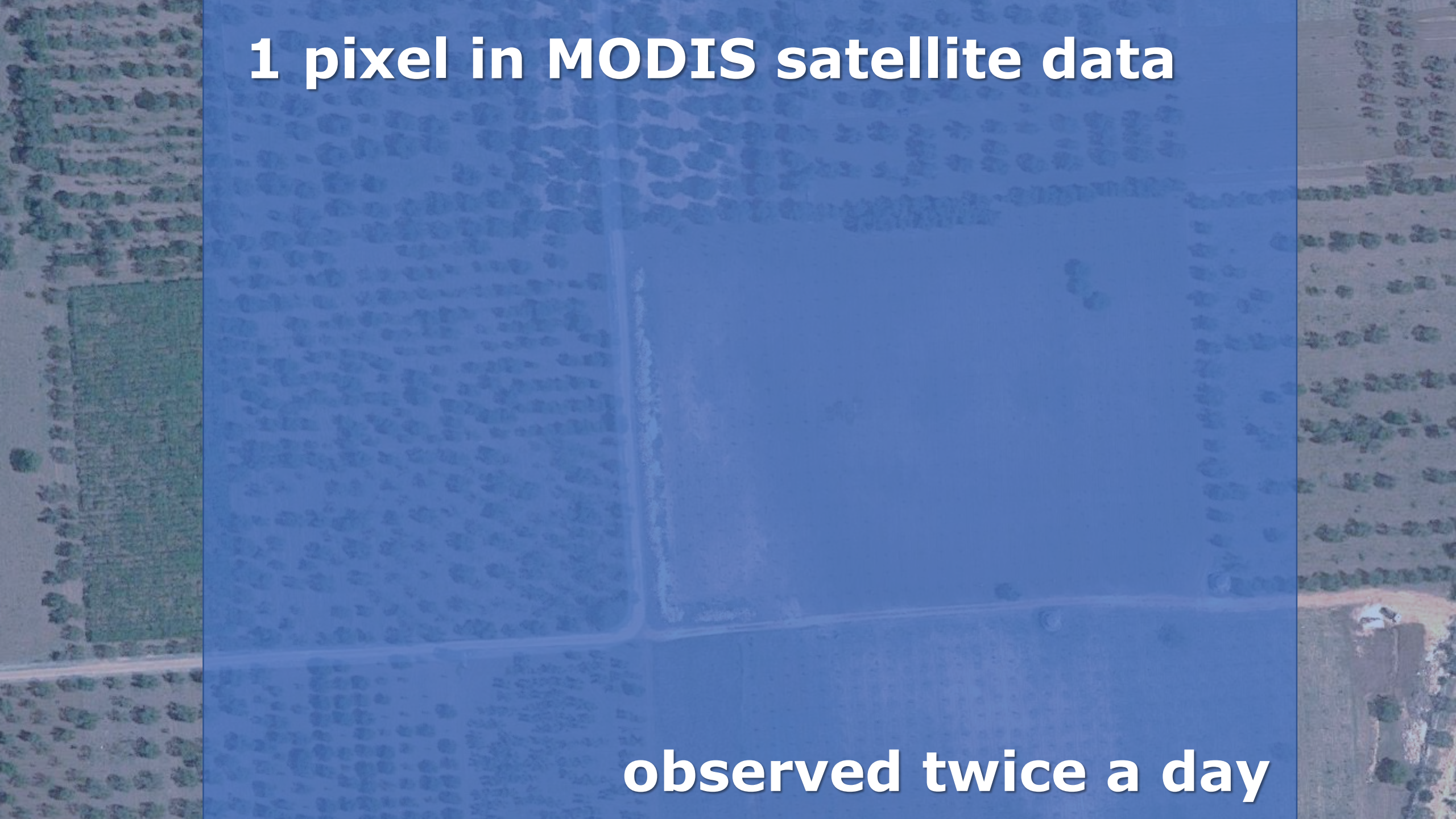
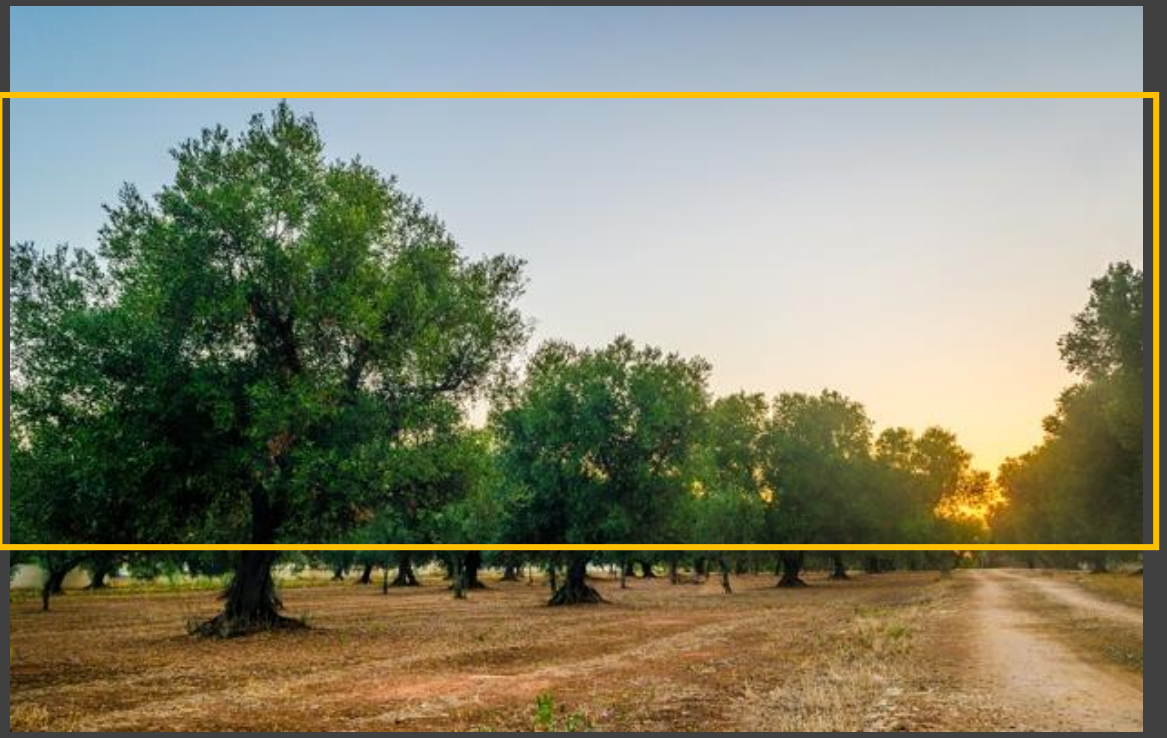

1 pixel in MODIS satellite data
observed twice a day

Olive orchard

Severely damaged olive orchard

Olive orchard

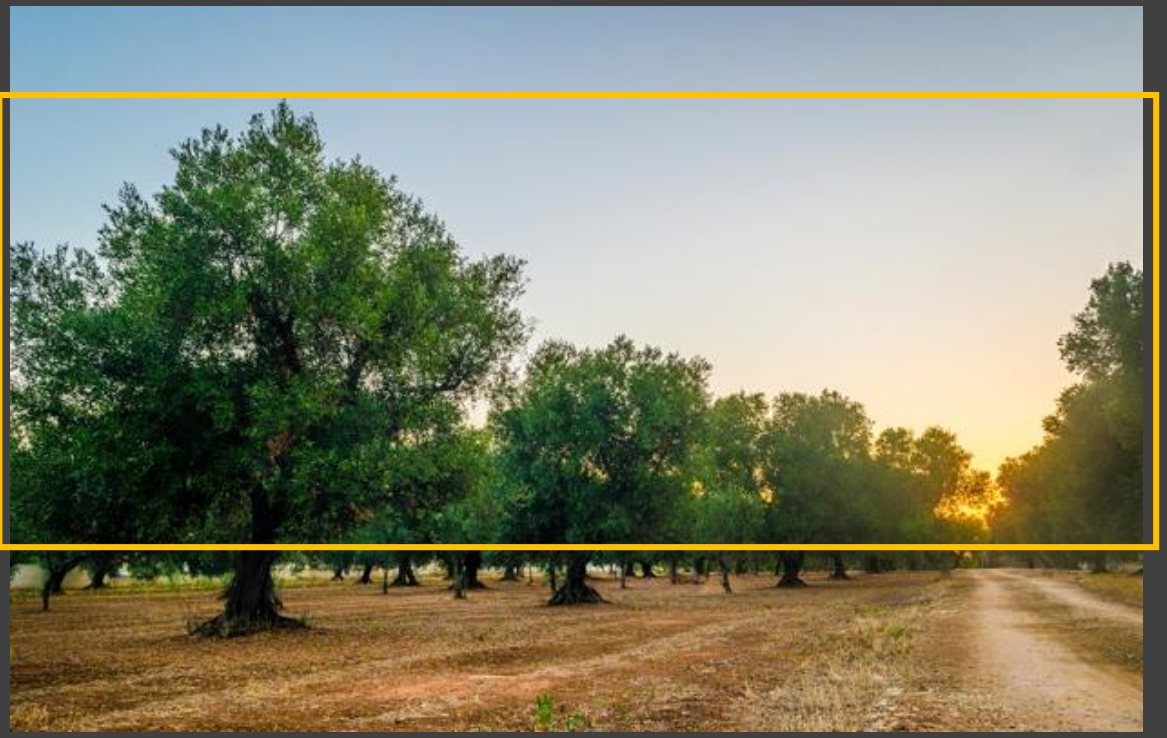


Evergreen crowns & deep roots

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

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We work at the level of orchards, not trees

Infected area + buffer zone[i]

27 188 olive orchards[ii]
covering 2 261 km^2

[i] as of August 2018

[ii] based on Regione Puglia land cover map 2011

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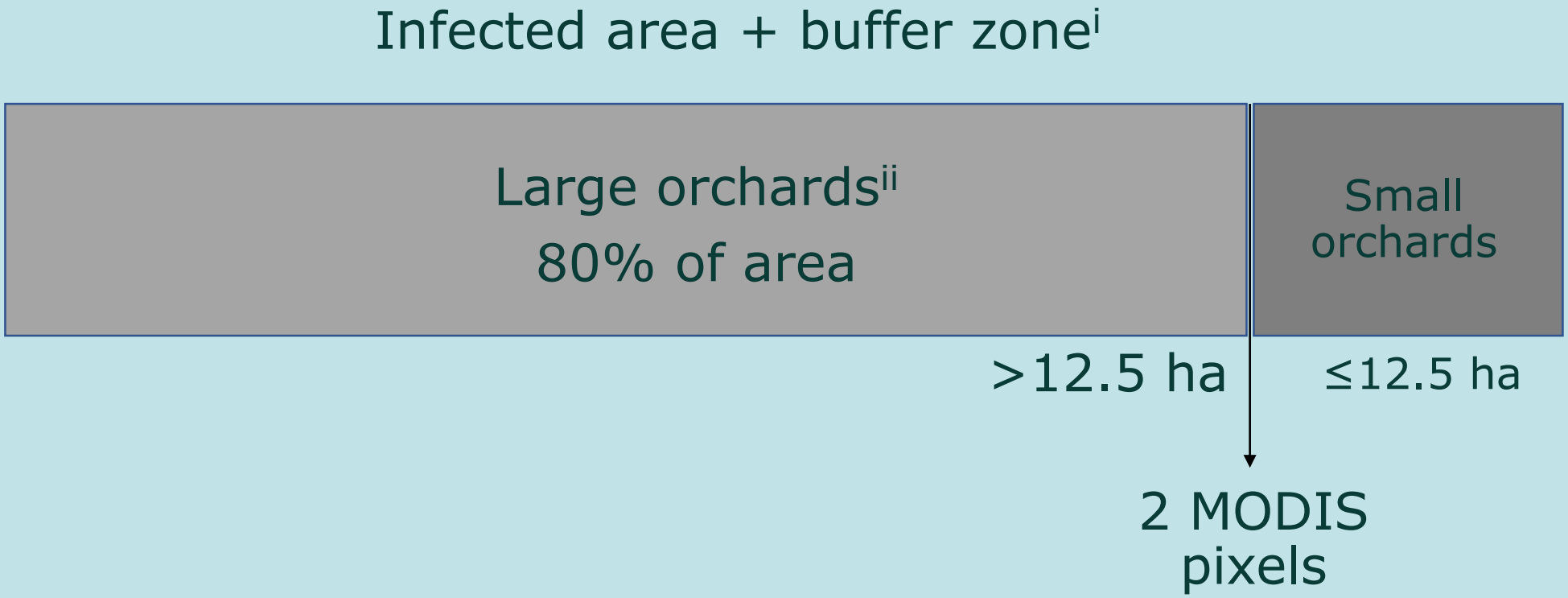
We focus on large orchards



[i] as of August 2018

[ii] based on Regione Puglia land cover map 2011

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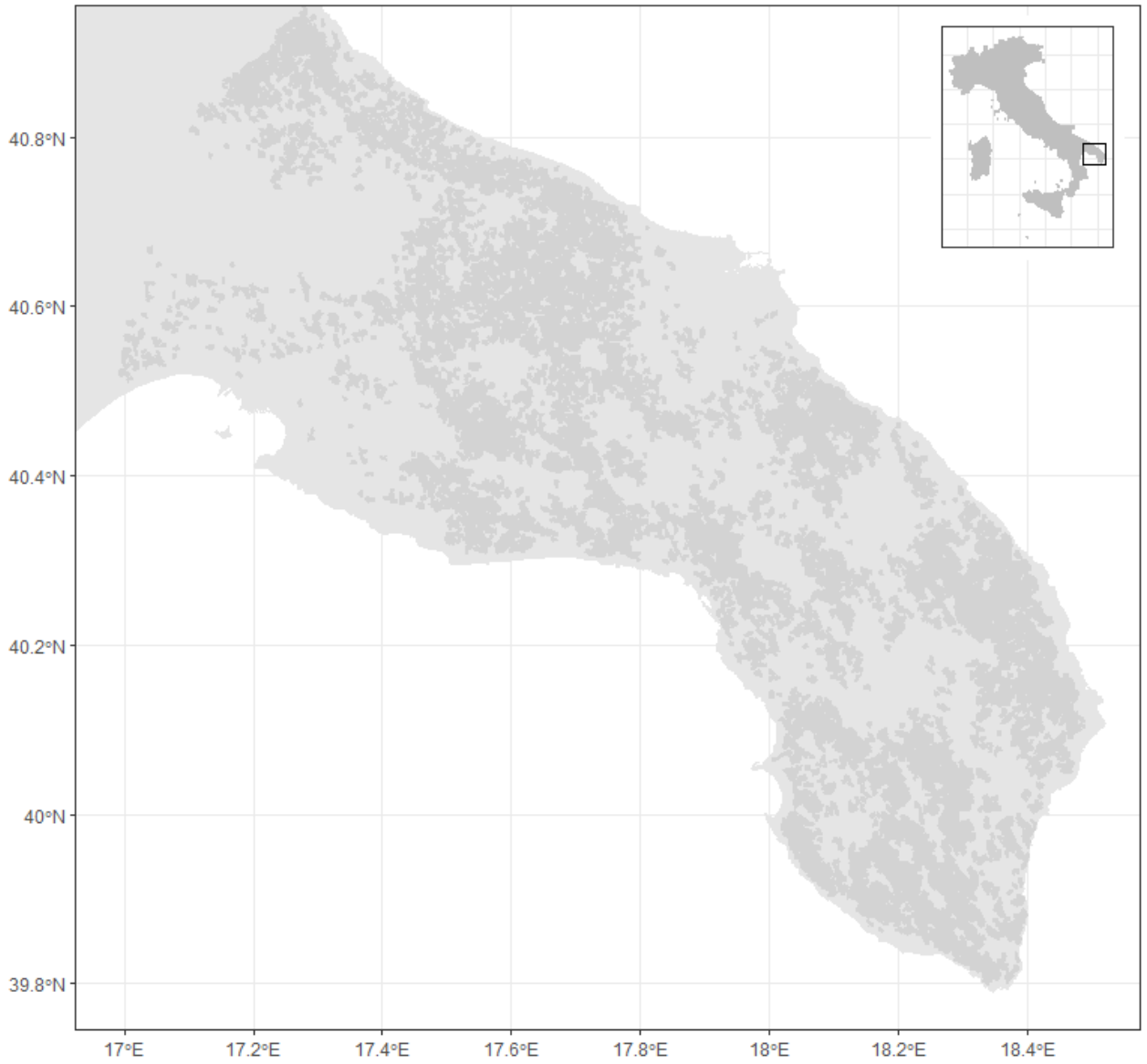
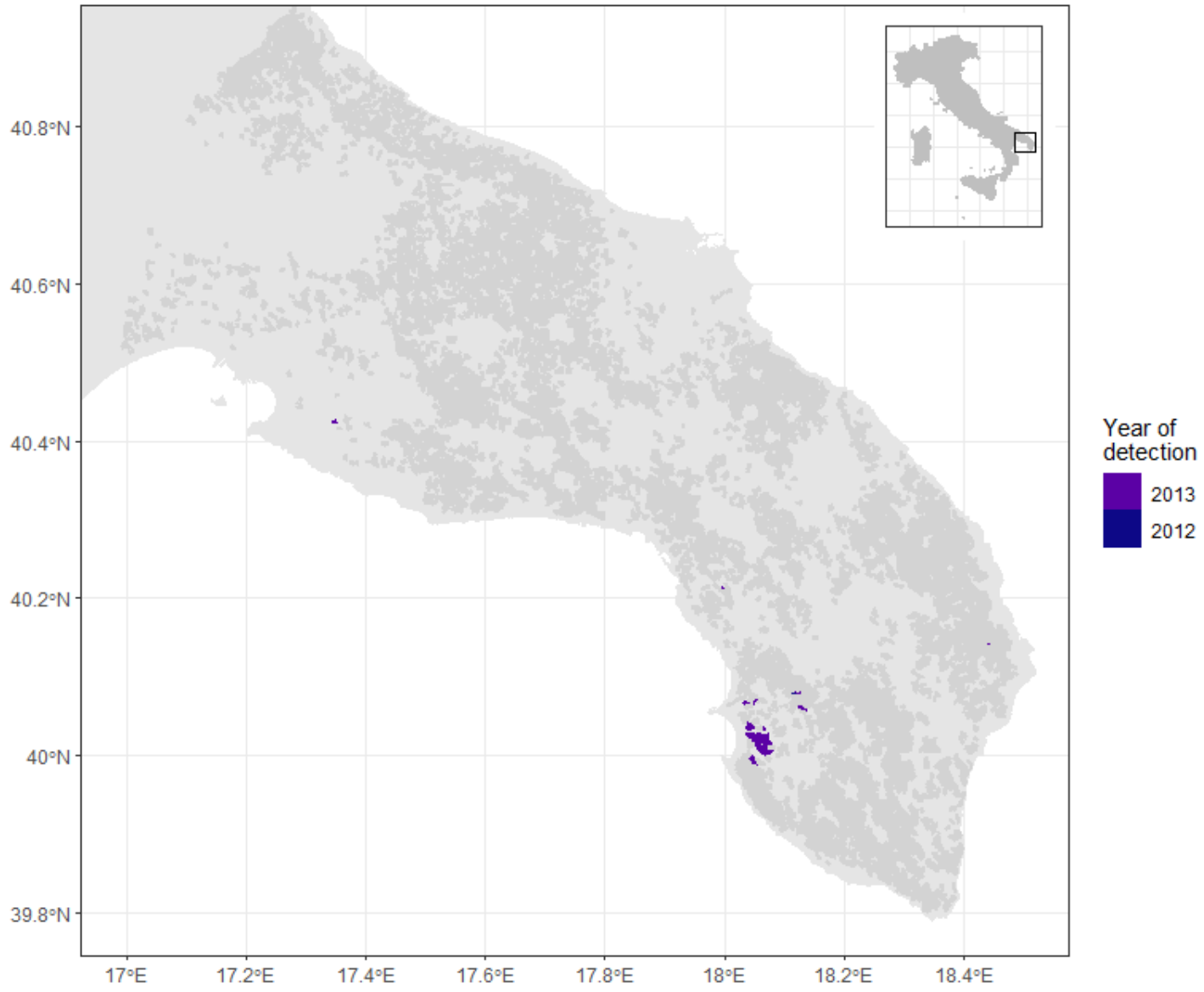
Large orchards

3135 large olive orchards in the infected + buffer zone



The first damage detections

near Galipolli in 2012-2013



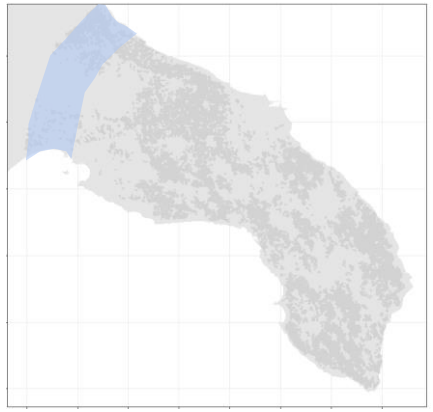
Does our method work?

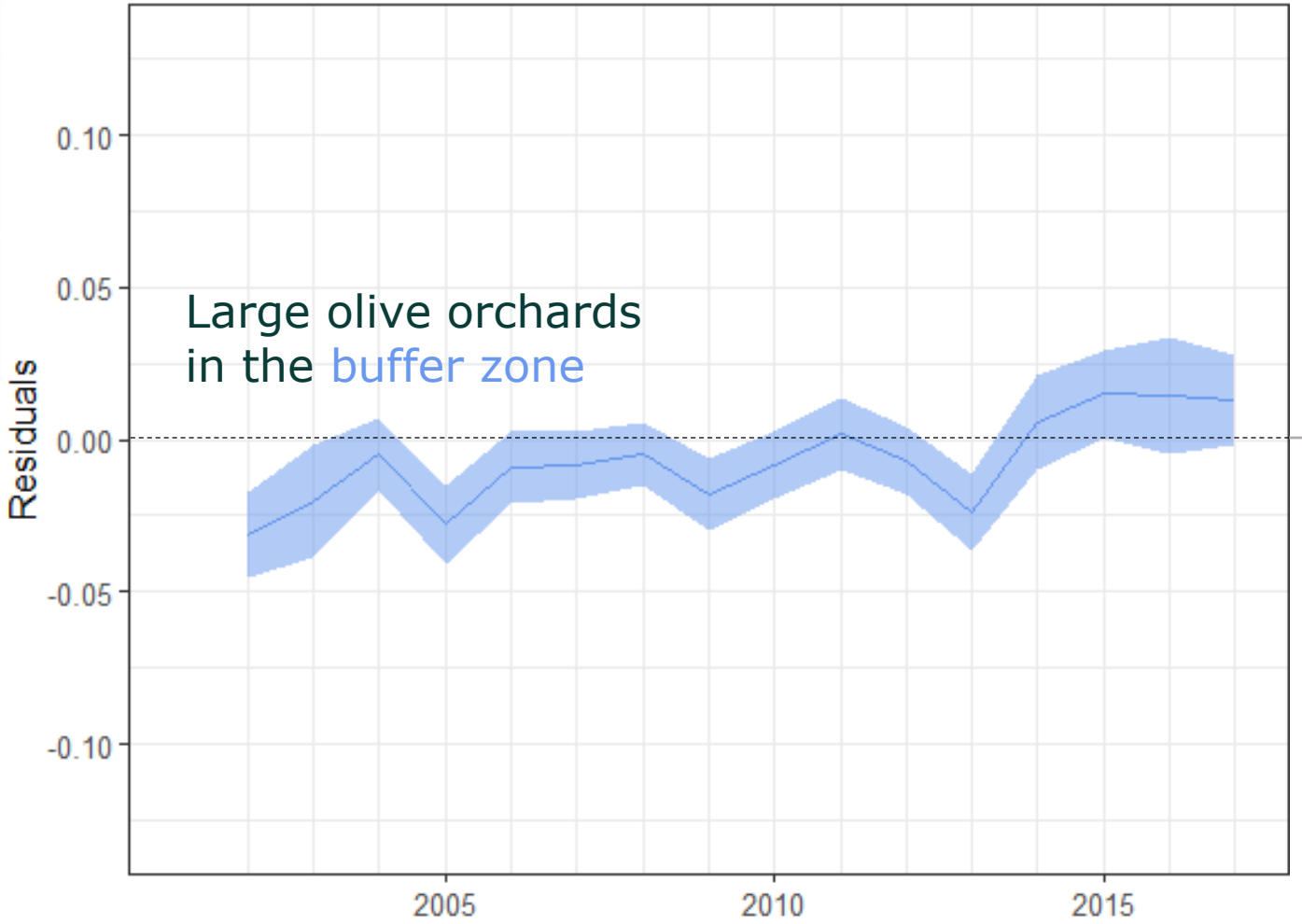
Two independent sources of validation data

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

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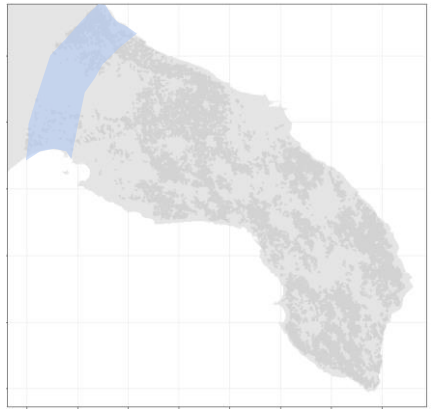
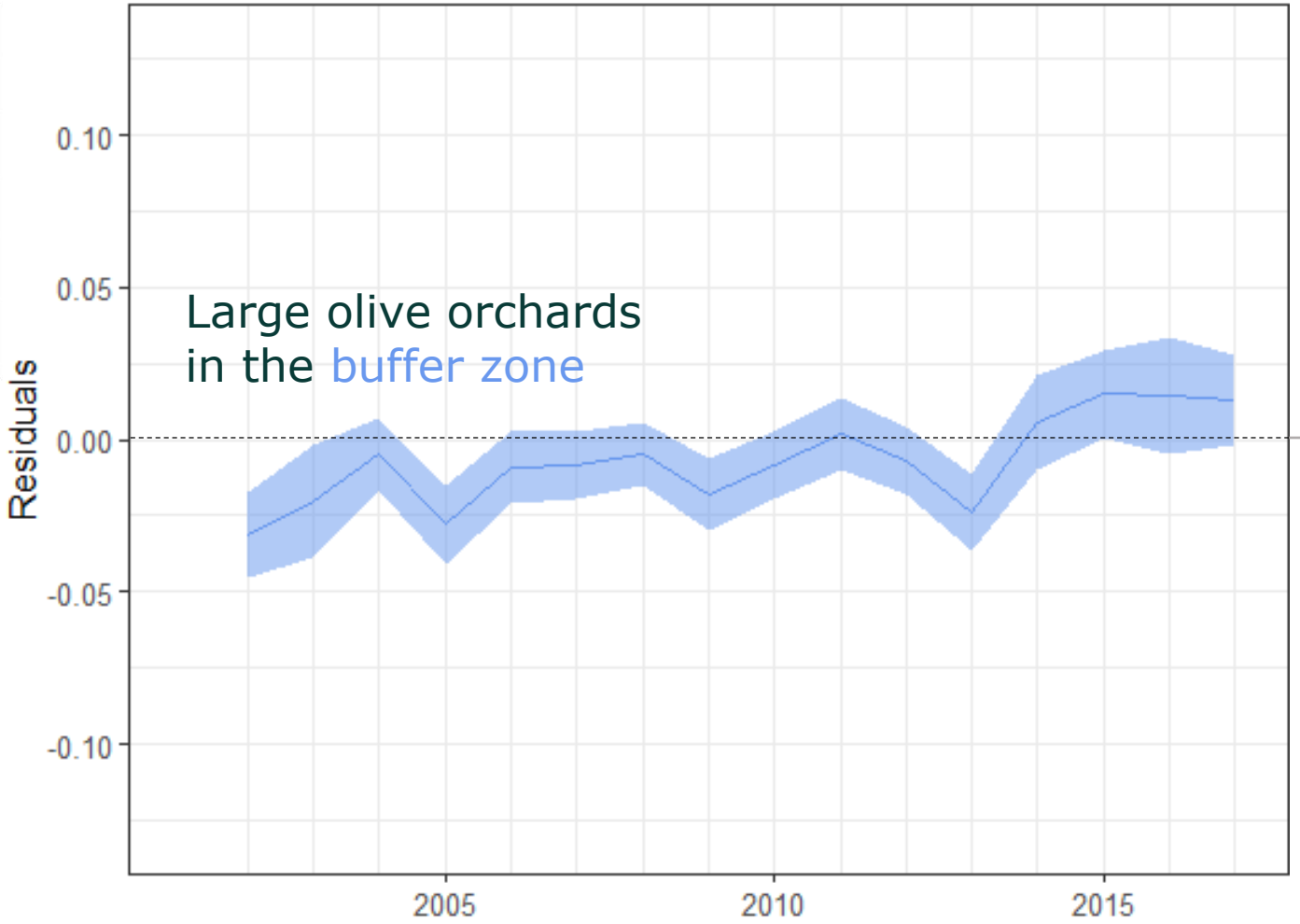
Validation 1: using **official monitoring data**





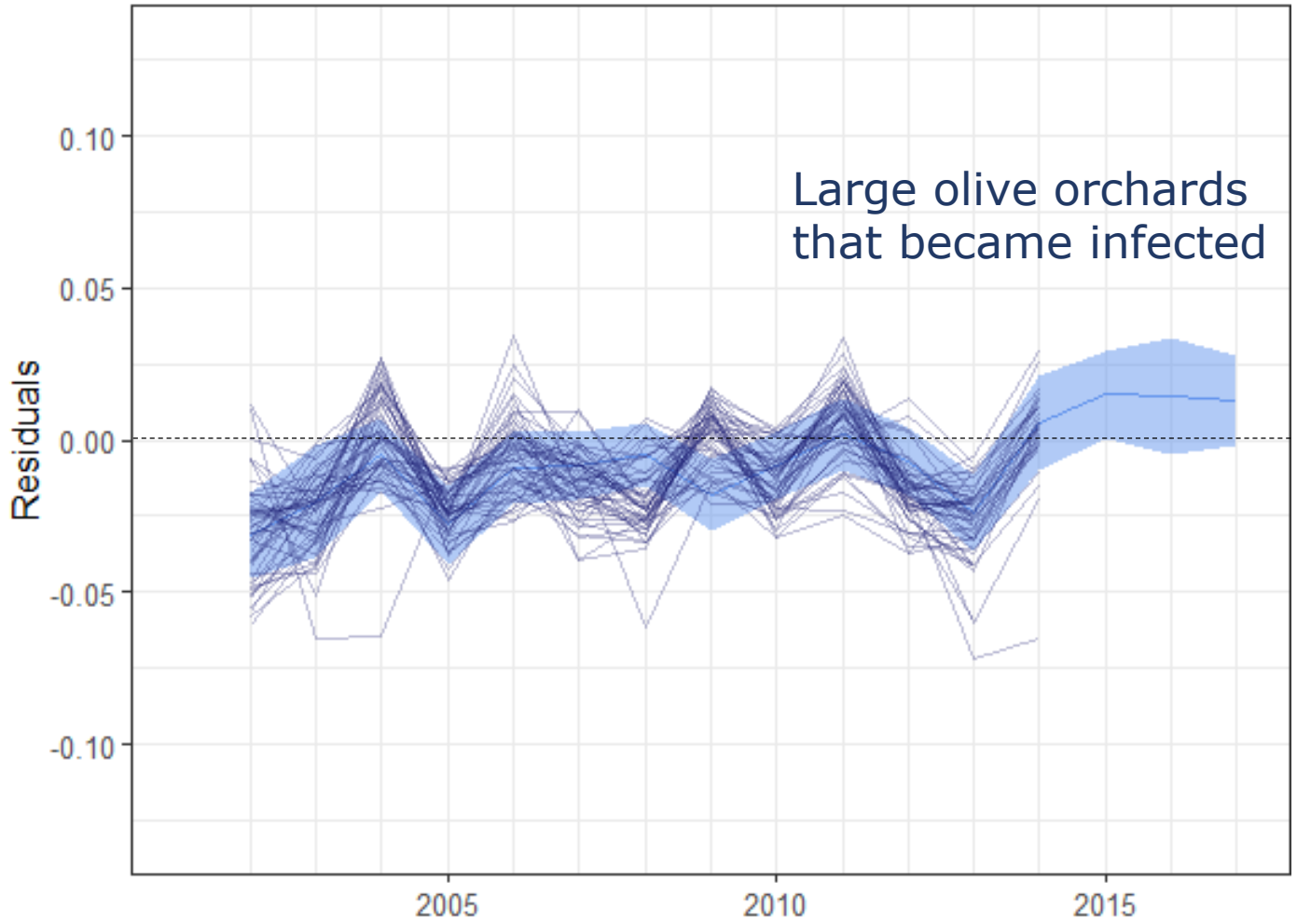
More productive
than expected

Expected value of a healthy olive orchard

Less productive
than expected

European Commission

Validation 1: using **official monitoring data**

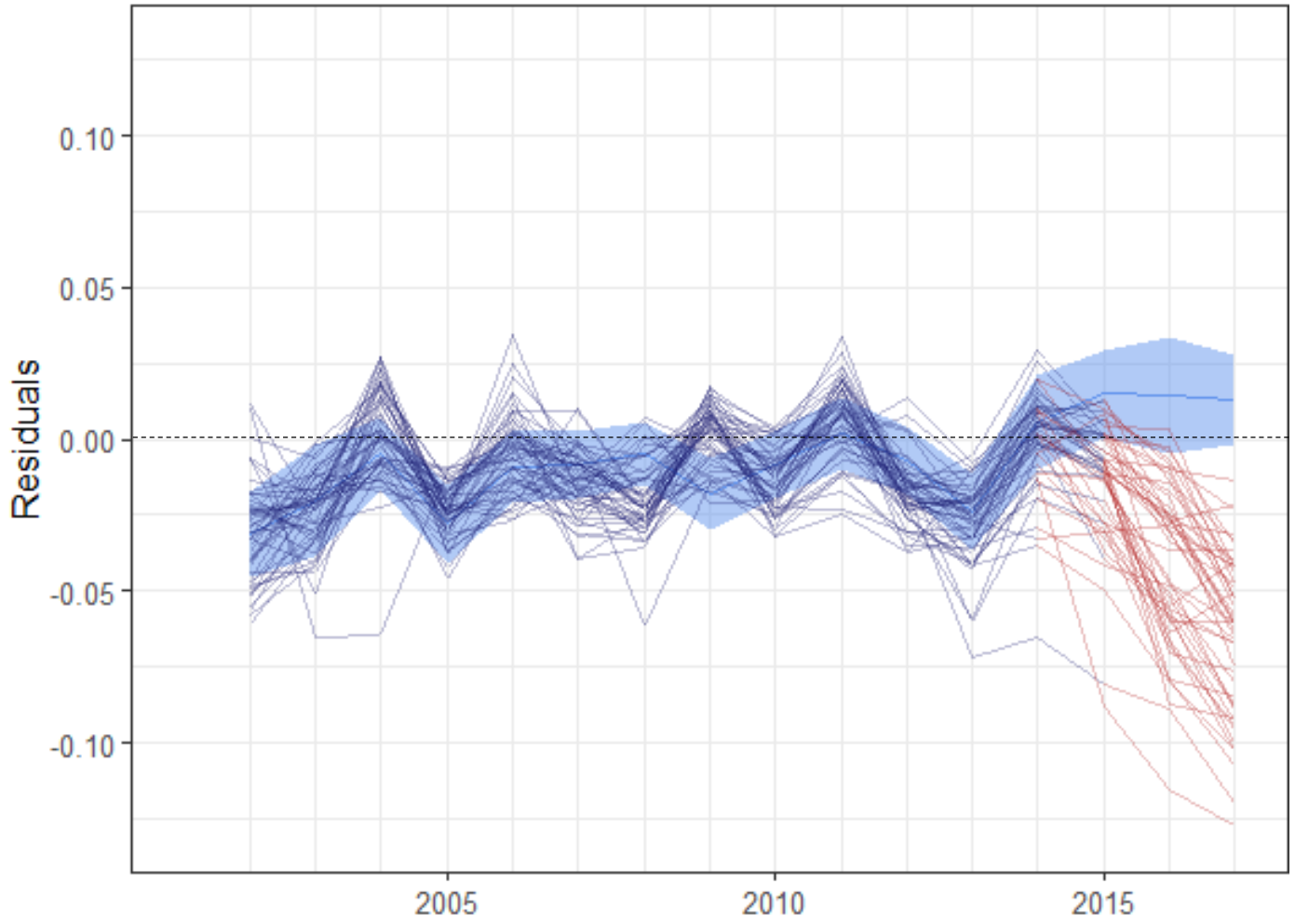


More productive
than expected

Less productive
than expected

European
Commission

Validation 1: using **official monitoring data**



More productive than expected

Infected olive orchards

Less productive than expected

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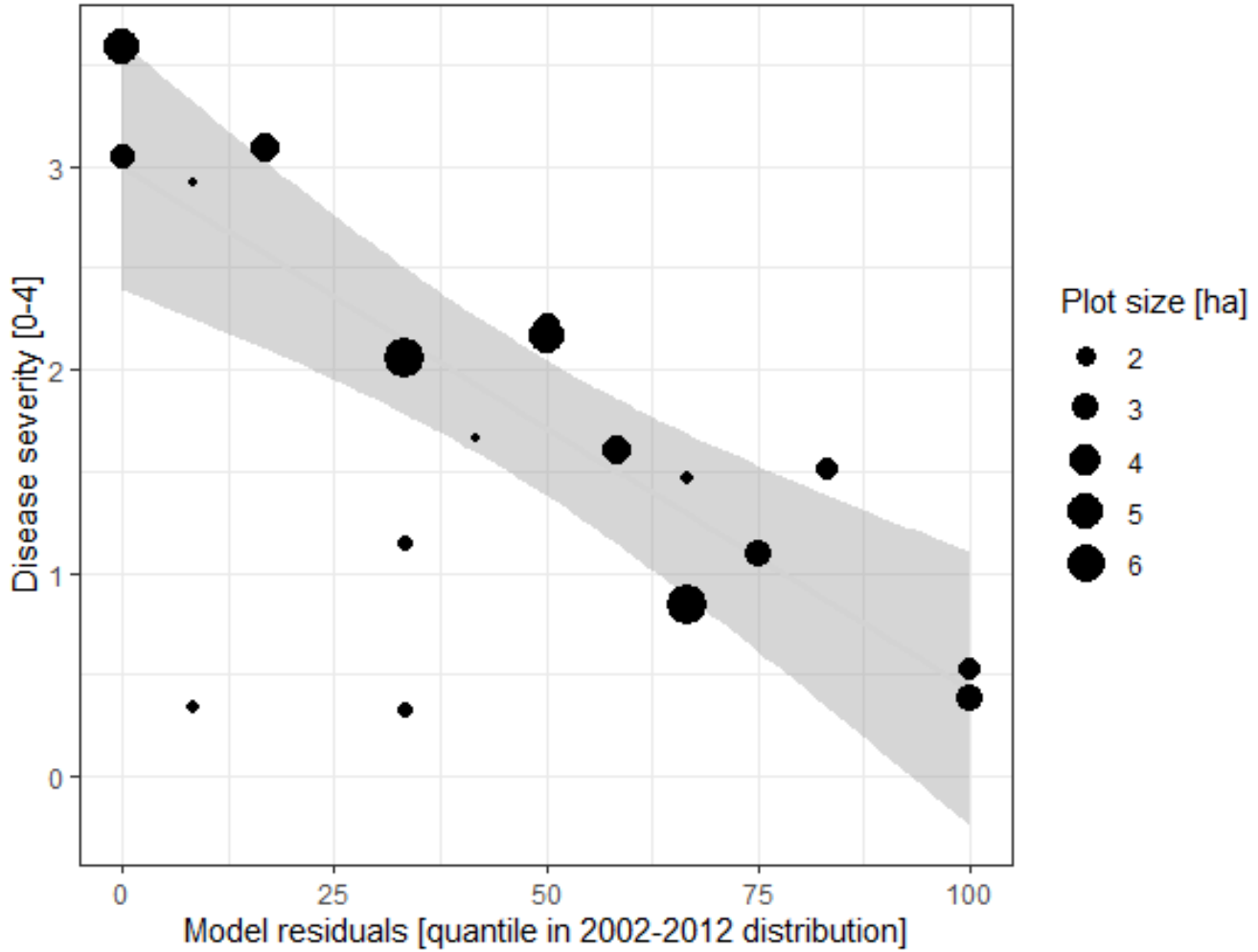
Validation 2: using **field observations**



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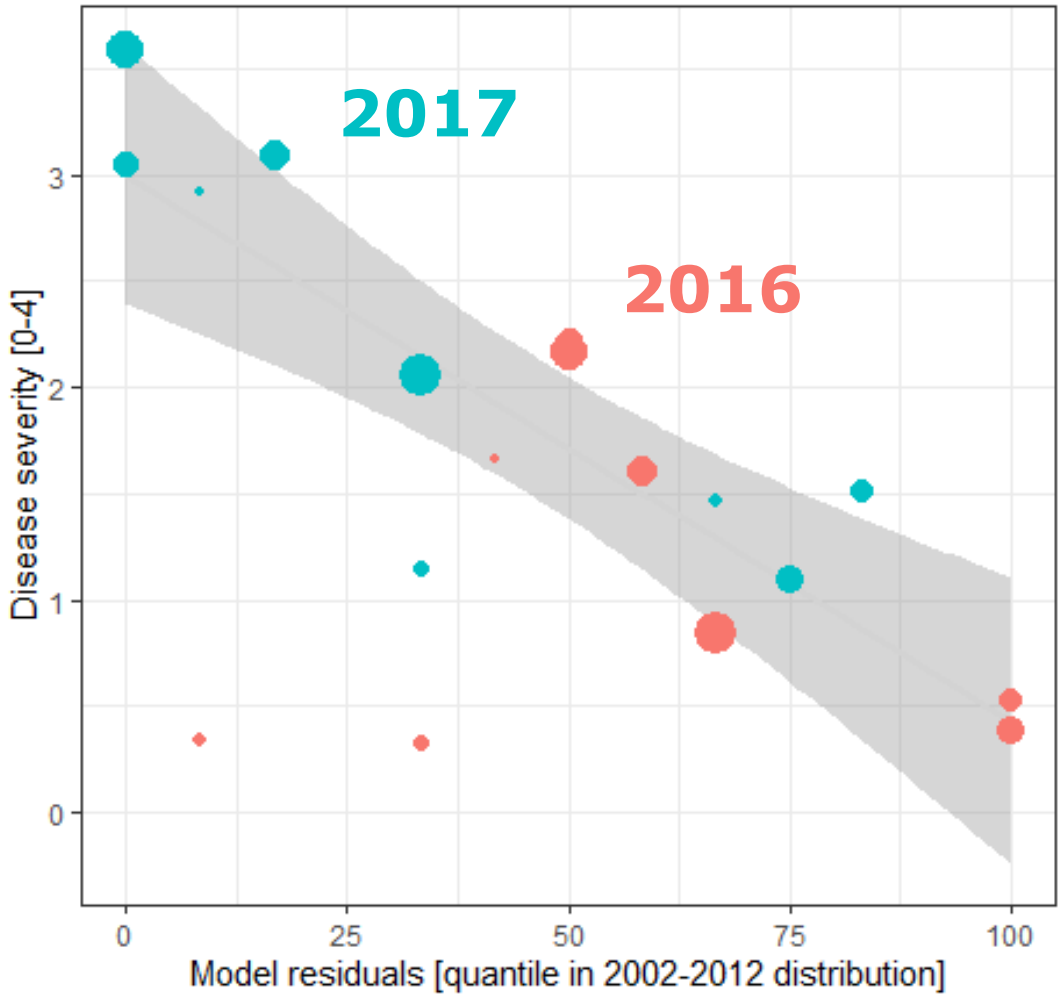

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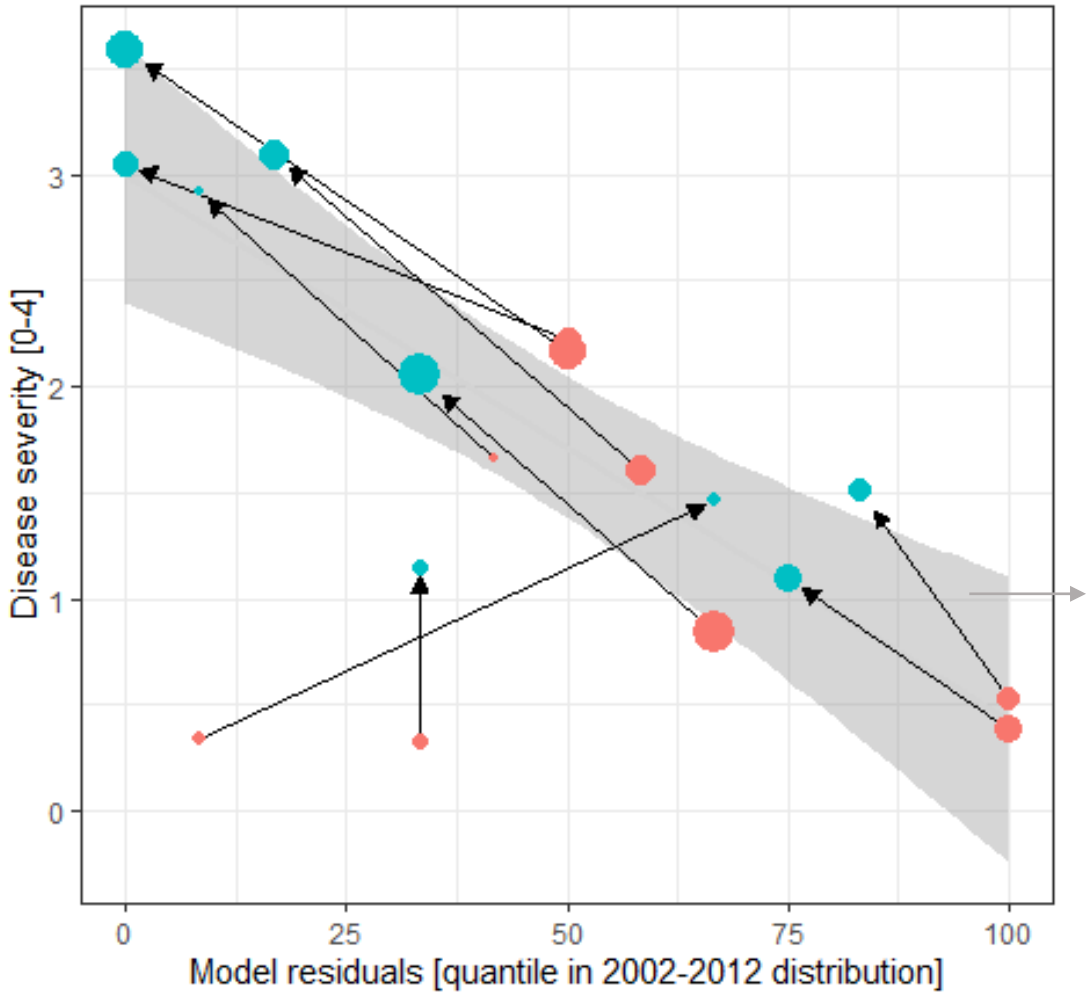
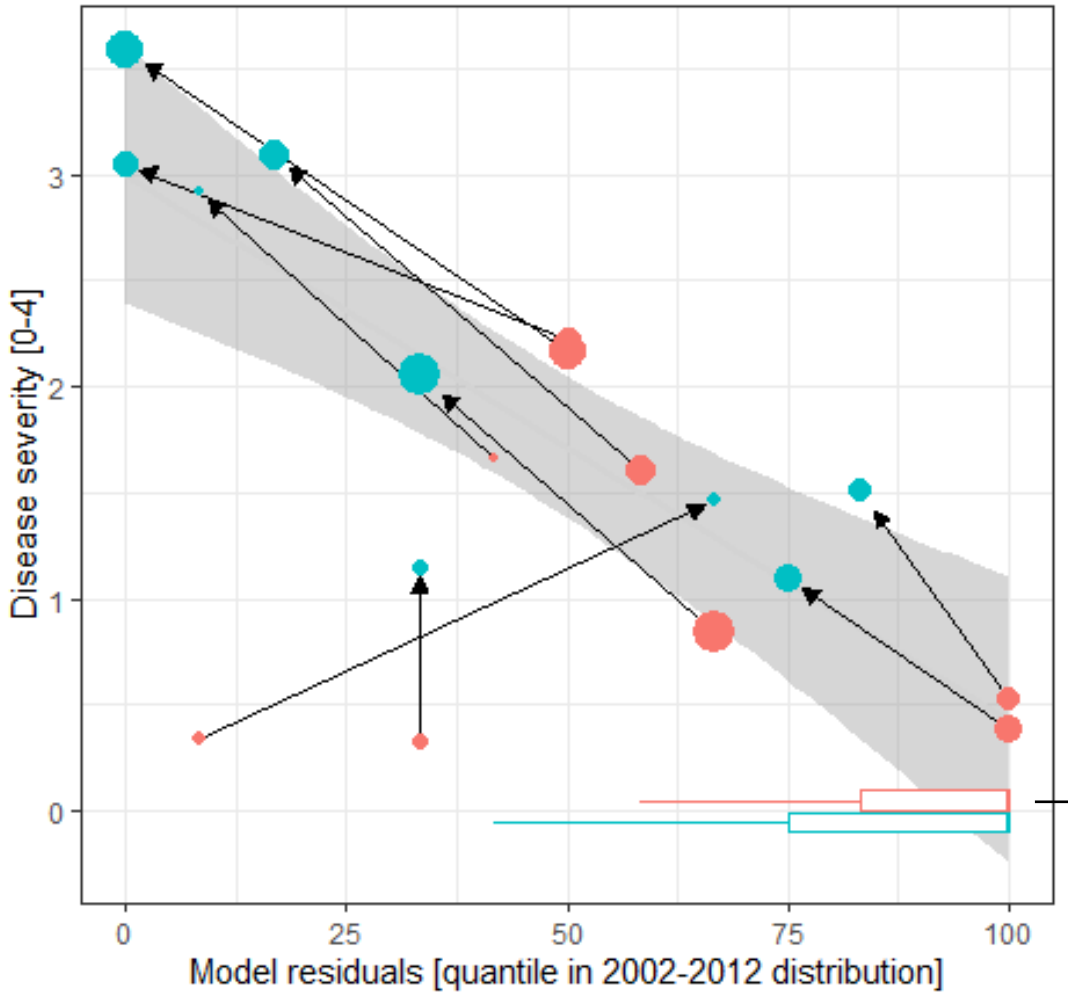
Validation 2: using **field observations**



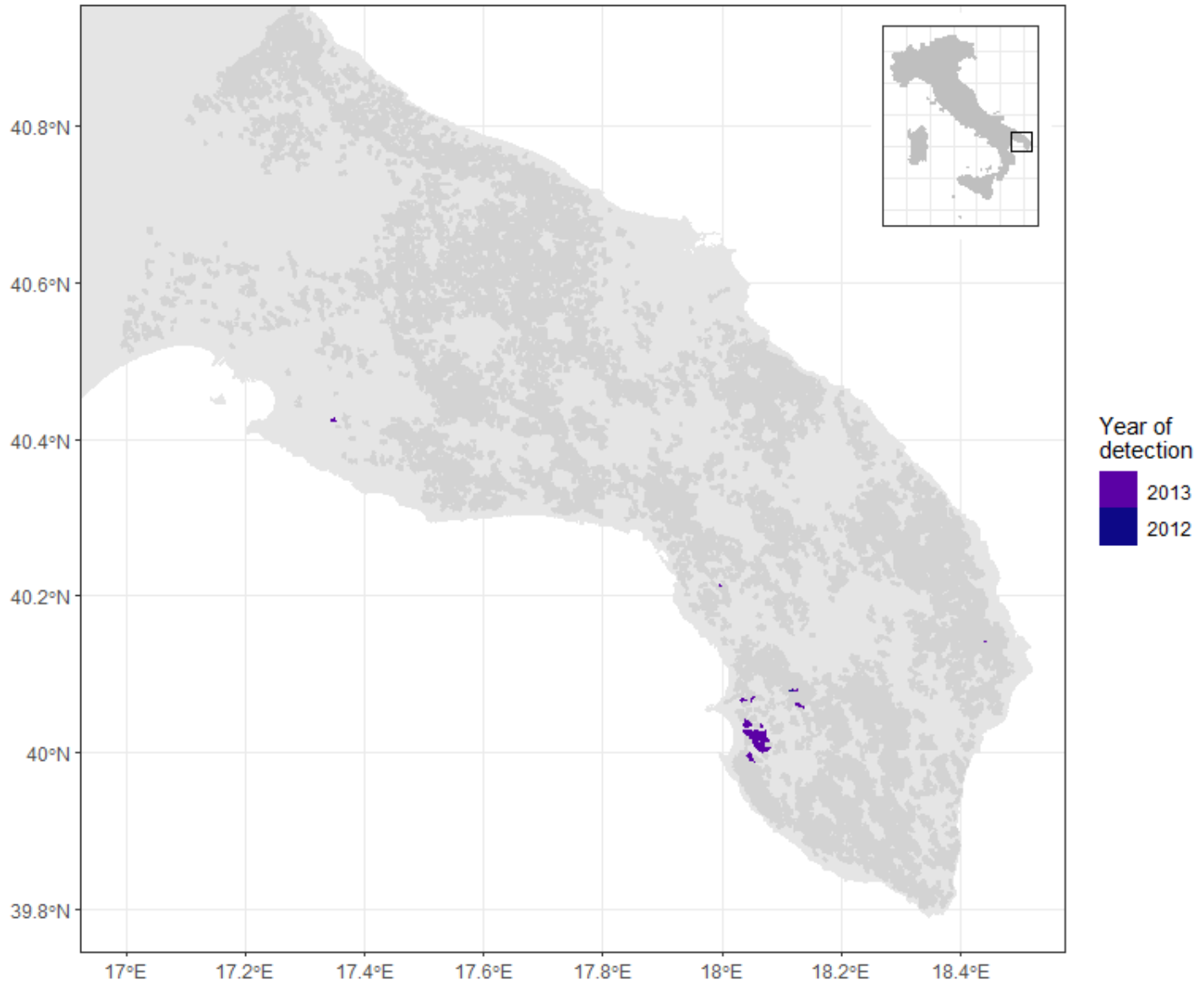
Arrows connect
the same plots
in different years

Validation 2: using **field observations**

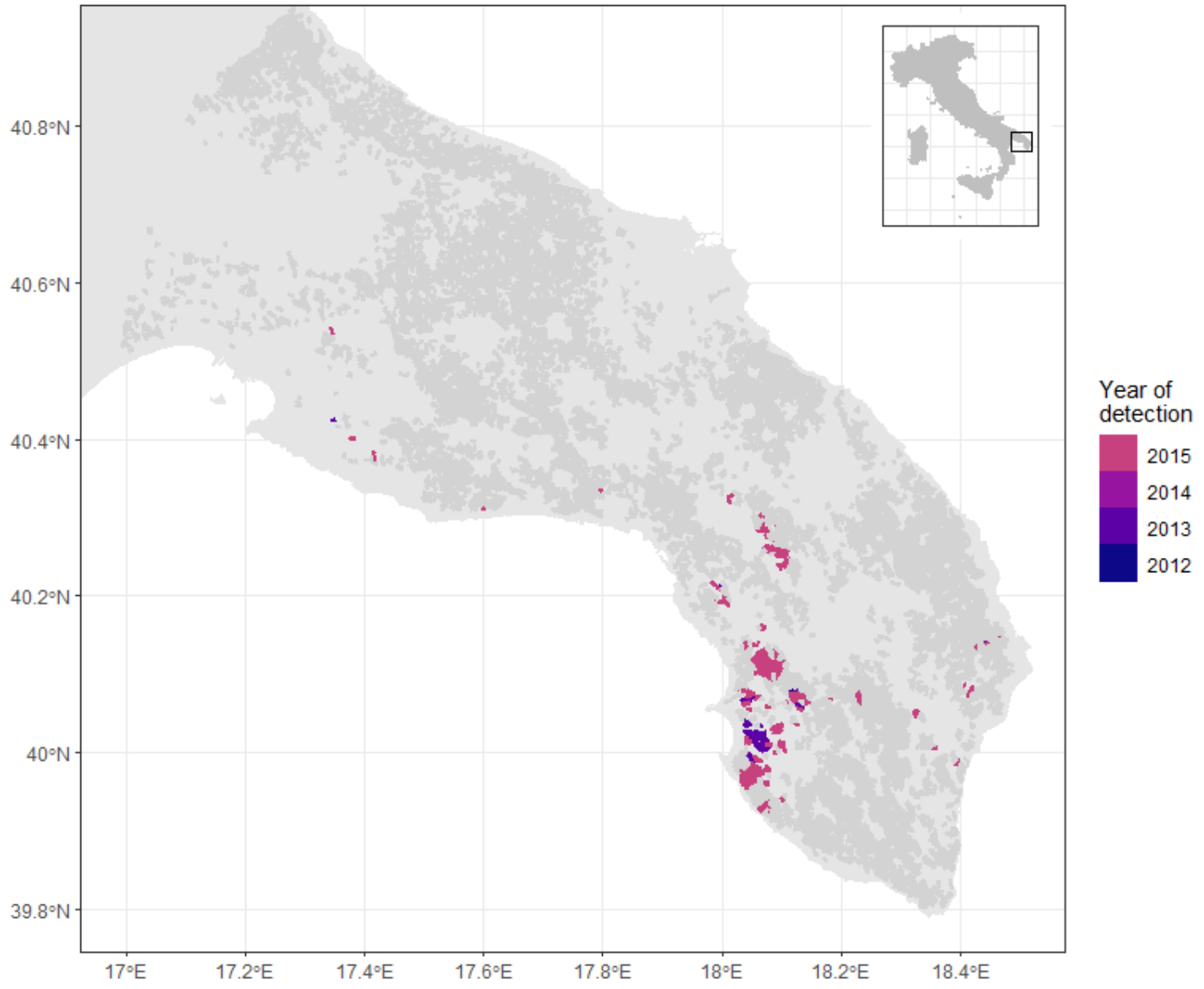


Uninfected orchards
(buffer zone)

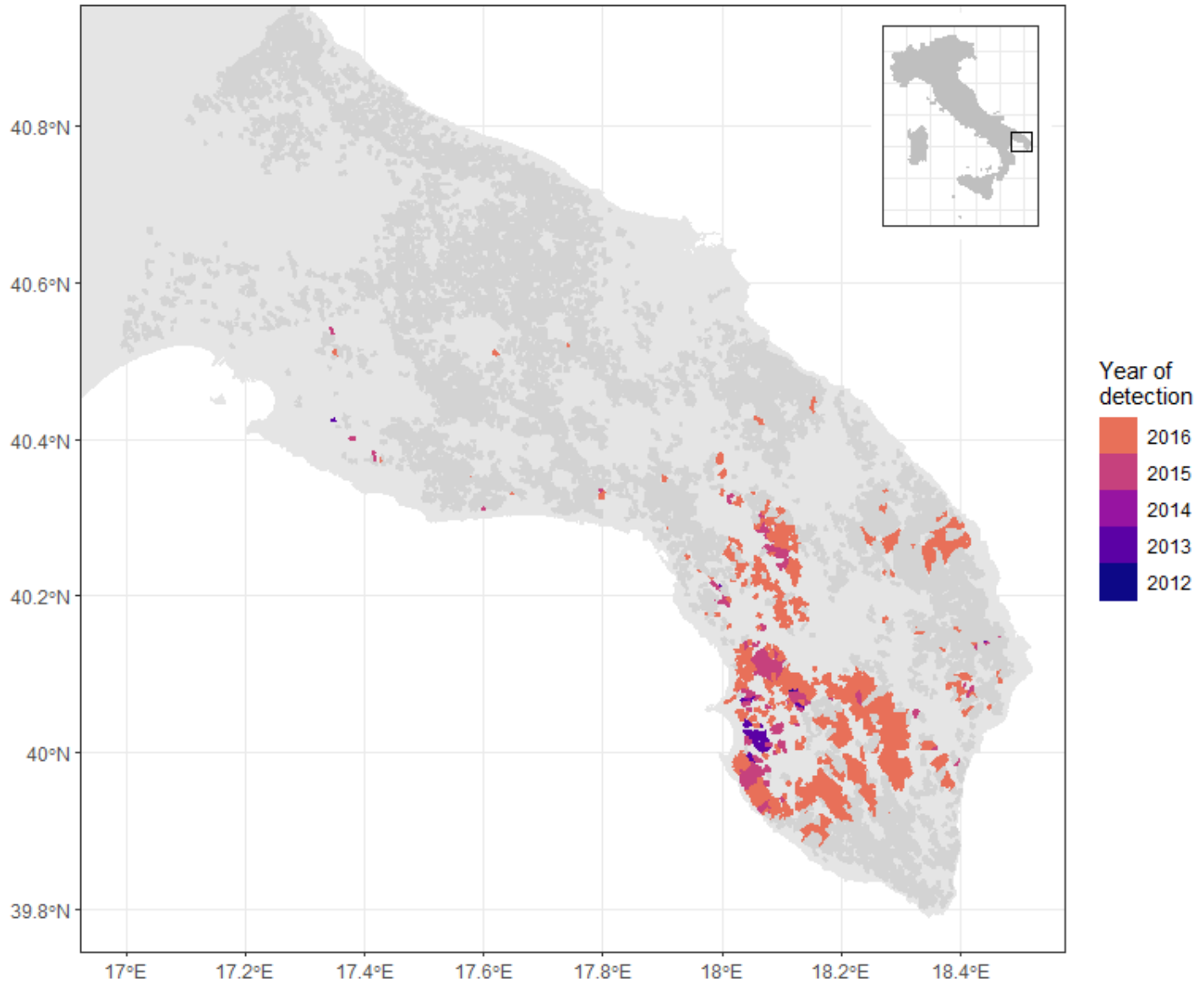
Severely damaged large olive orchards



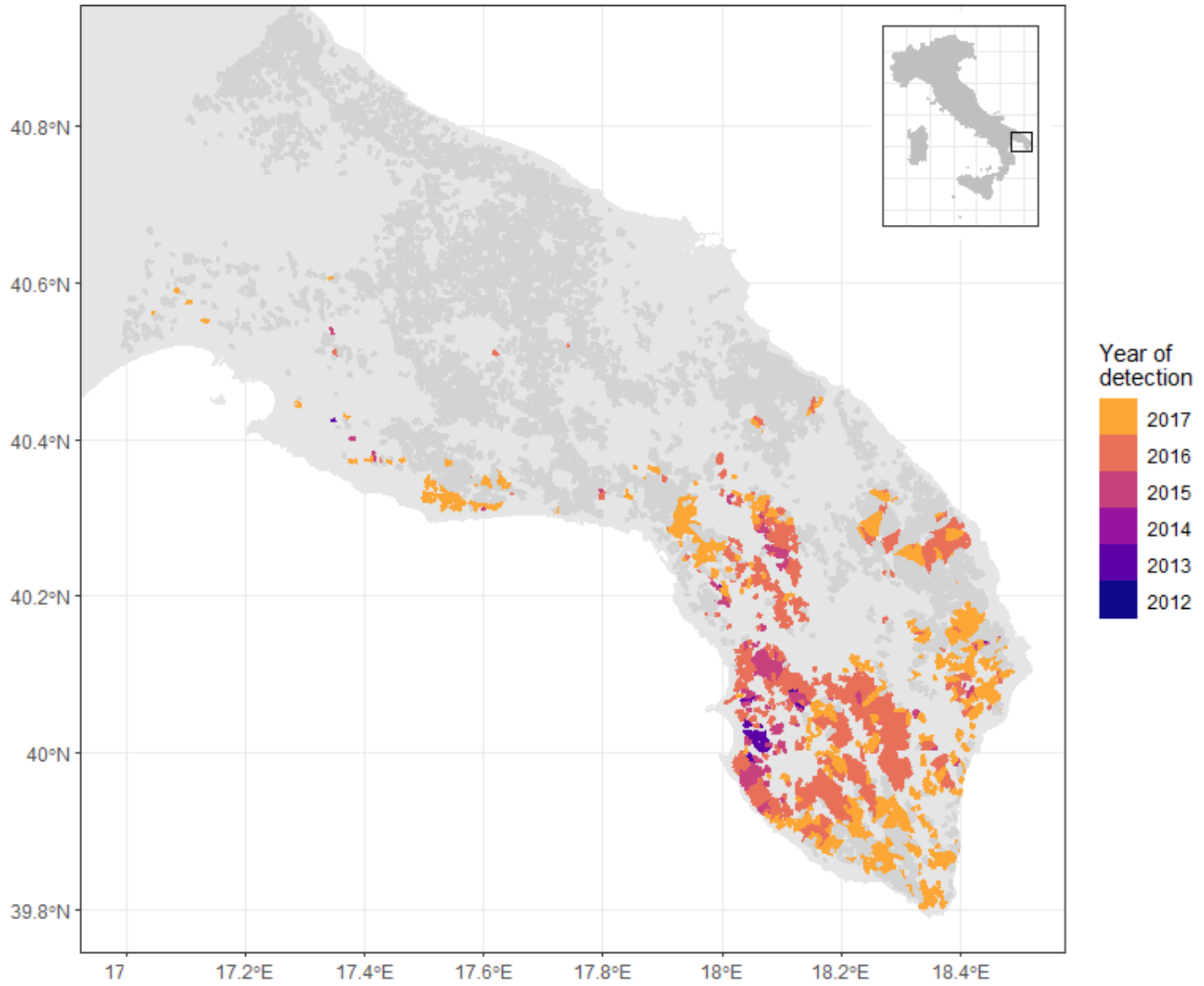
Severely damaged large olive orchards

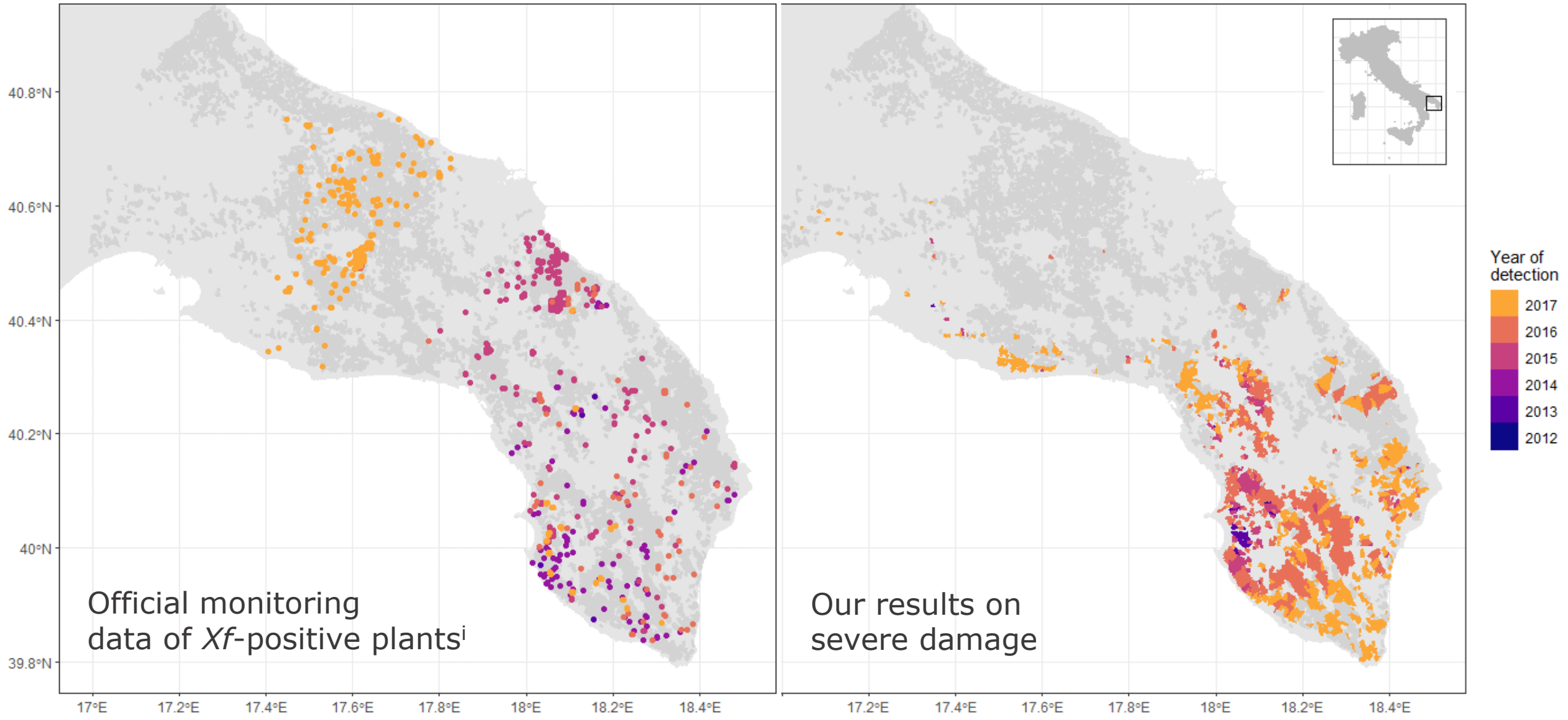


Severely damaged large olive orchards



Severely damaged large olive orchards

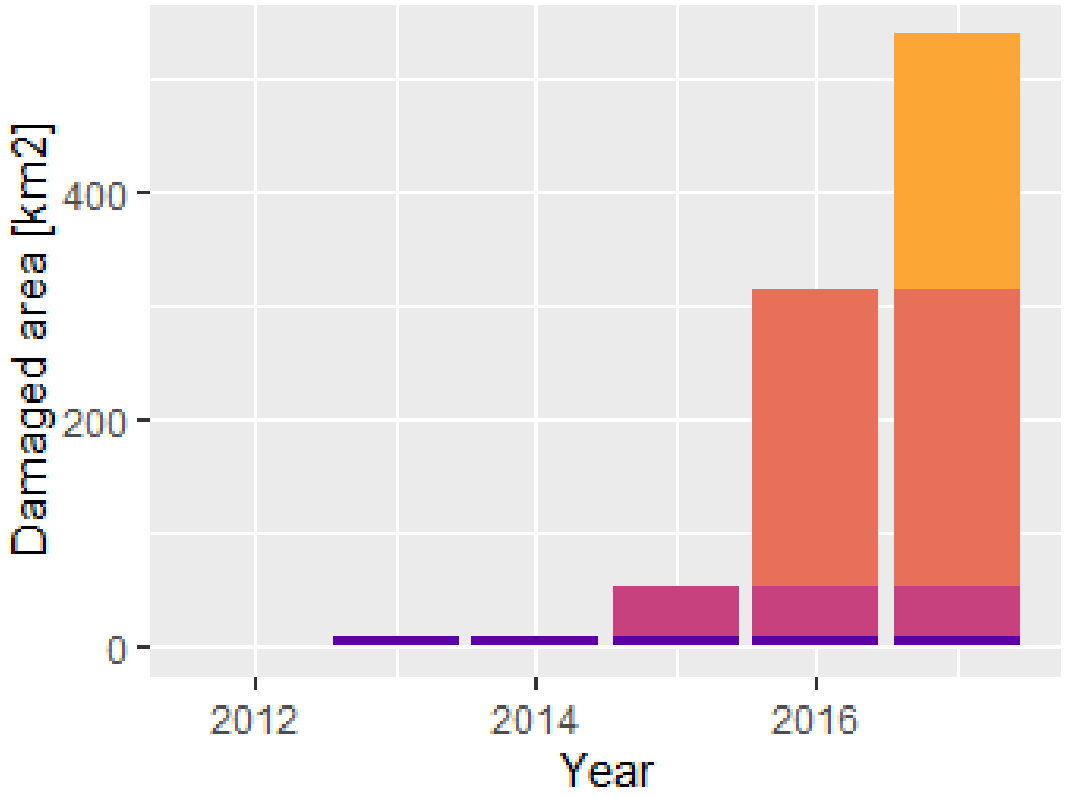




[i] Data source: Regione Puglia

How big is the detected damaged area?

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



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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 km²** were damaged
- Update to 2019 possible by the end of this year

Thank you

Any questions?

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