PLURIFOR PROJECT

Chestnut health monitoring by aerial photography using Unmanned Aerial Vehicle

Luis Martins; João P. Castro; João J. Sousa; Ricardo Bento; Luís Pádua
lmartins@utad.pt

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The chestnut in Portugal

The chestnut tree is a multipurpose specie in PORTUGAL which is cultivated for fruit or timber production.

In the last few years, Ink Disease and Chestnut Blight had dramatic economic and ecological consequences.

Causes to chestnut decline

- In spite of the decrease of chestnut areas from 80000 ha in the 50´s to 45000 ha today, chestnut production remains very important in Portugal.

- Biotic or abiotic factors are associated to the chestnut decline.

PREDISPOSING OR INCINTING FACTORS

- Climate changes;

- Soils shallow and poor;

- Soil compaction;

- Intensive management practices.

BIOTIC AGENTS (diseases and plagues)

Abiotic causes related to chestnut decline

An rare addition of organic material in chestnut orchards

Soil tillage in Chaves Region

Low magnesium contents in young trees (Padrela Region)

Deep soil tillage (Padrela Region)

Trounc damage caused by excessive insulation

(A)

Xyloboro dispar (insect) in a young tree

(B)

Young chestnut trees affected by *Phytophthora cinnamomi* in Padrela Region

Chestnut ink disease

CHESTNUT MORTALITY OCCURS:

– Young and Adult chestnut of plantations

– Old chestnut

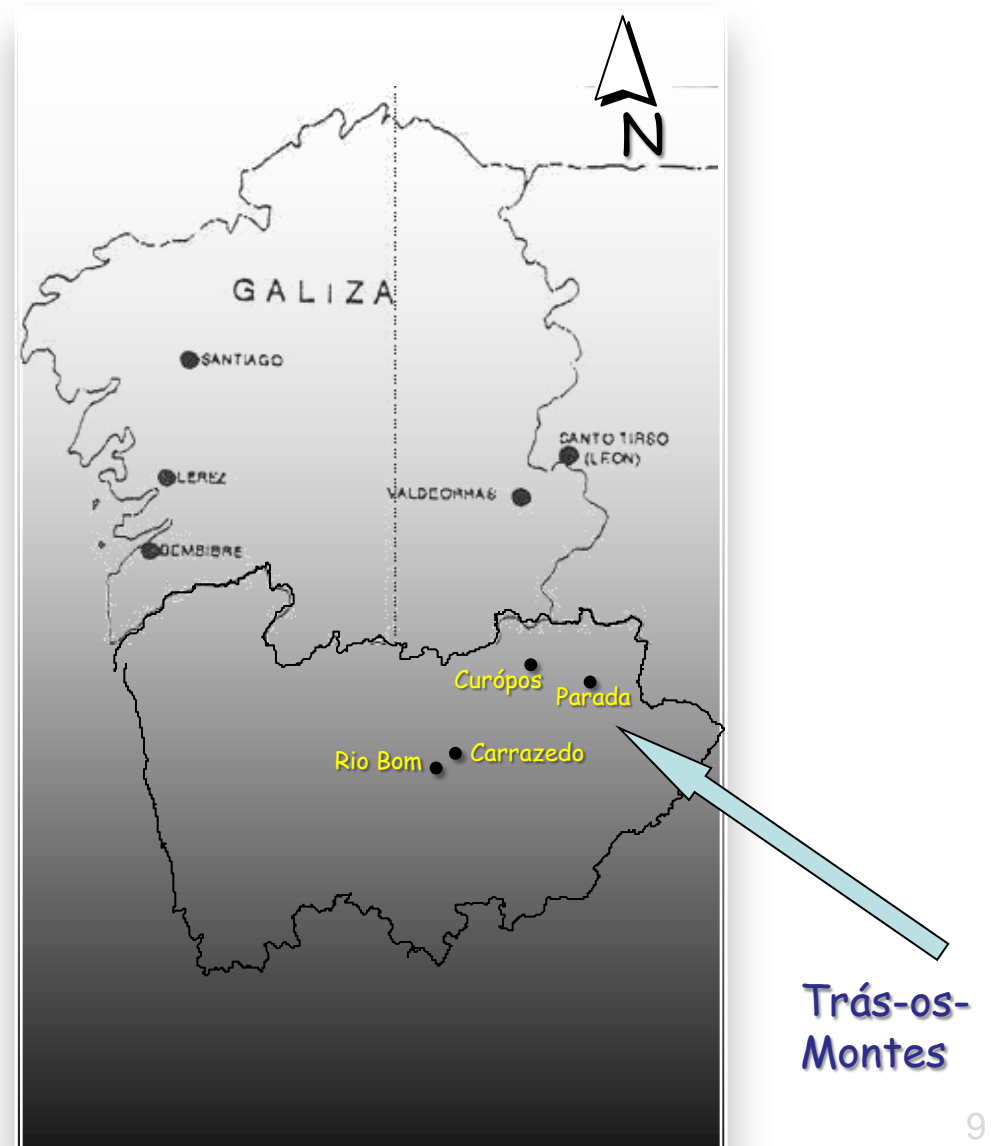Symptoms can be detected by remote sensing
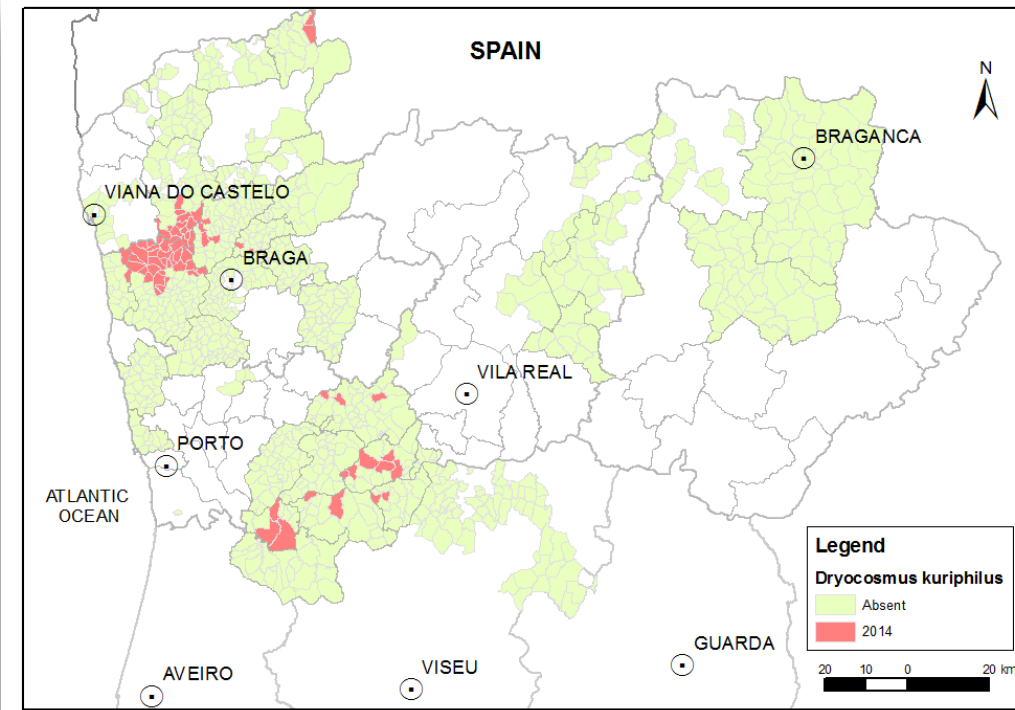
– **Dieback**

– **Defoliation**

– **Discoloration**

– **Crown asymmetry**

Chestnut blight

1988 – first *Cryphonectria parasitica* isolations in Portugal.

Trás-os-Montes

Dryocosmus kuriphilus in Portugal, a new Chestnut plague

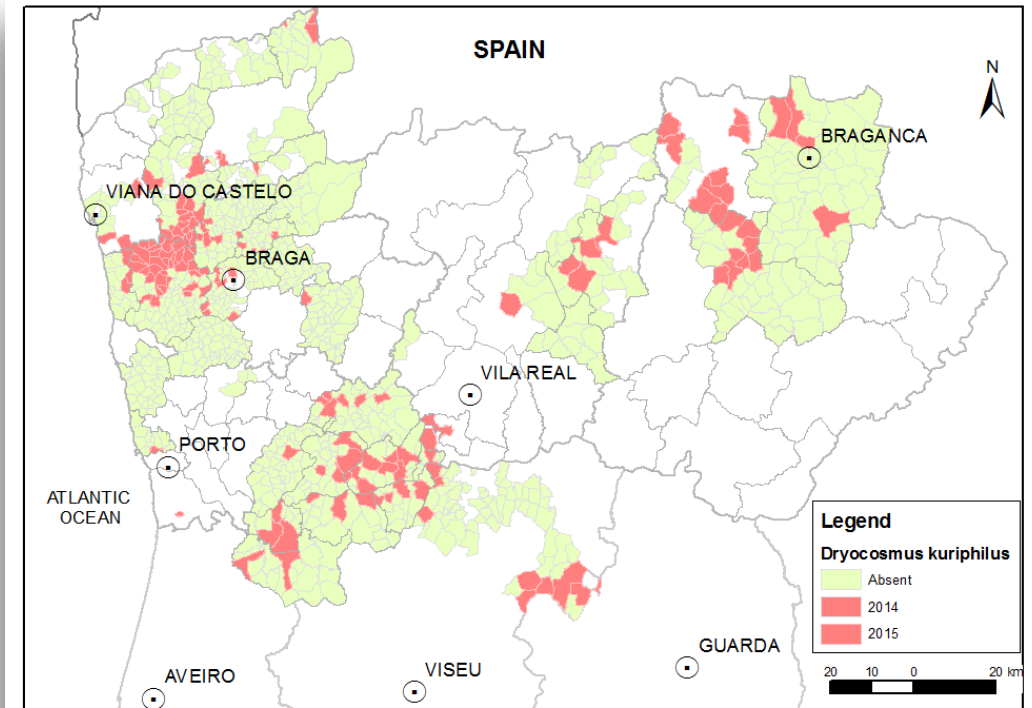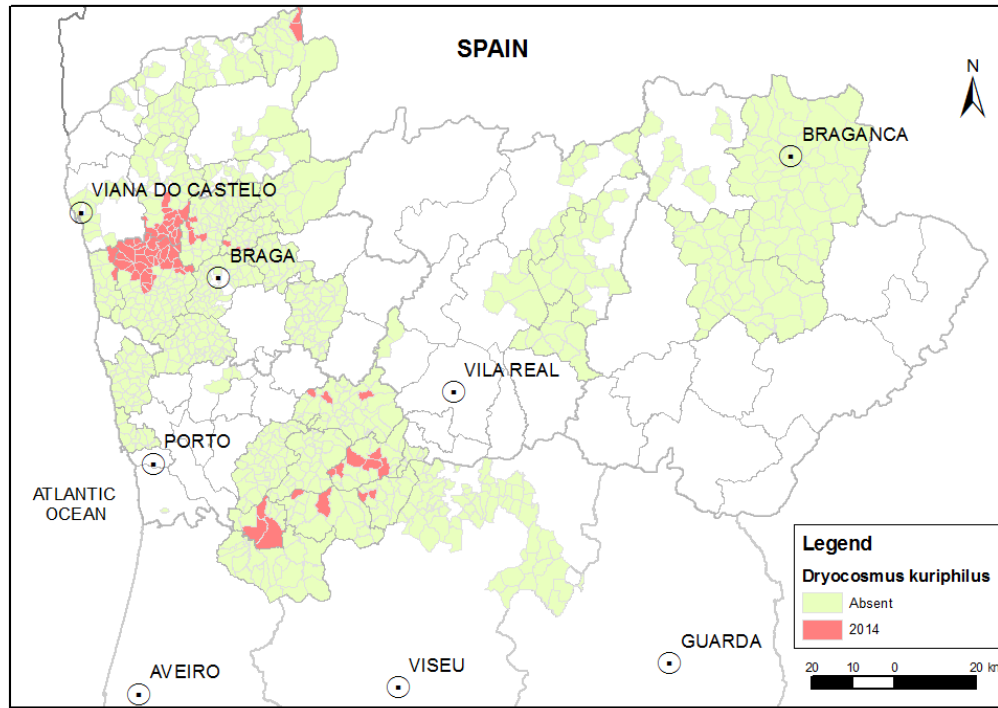**2014**
- 75 affected areas

China

Chestnut gall wasp

Dryocosmus kuriphilus in Portugal, a new Chestnut plague

2014
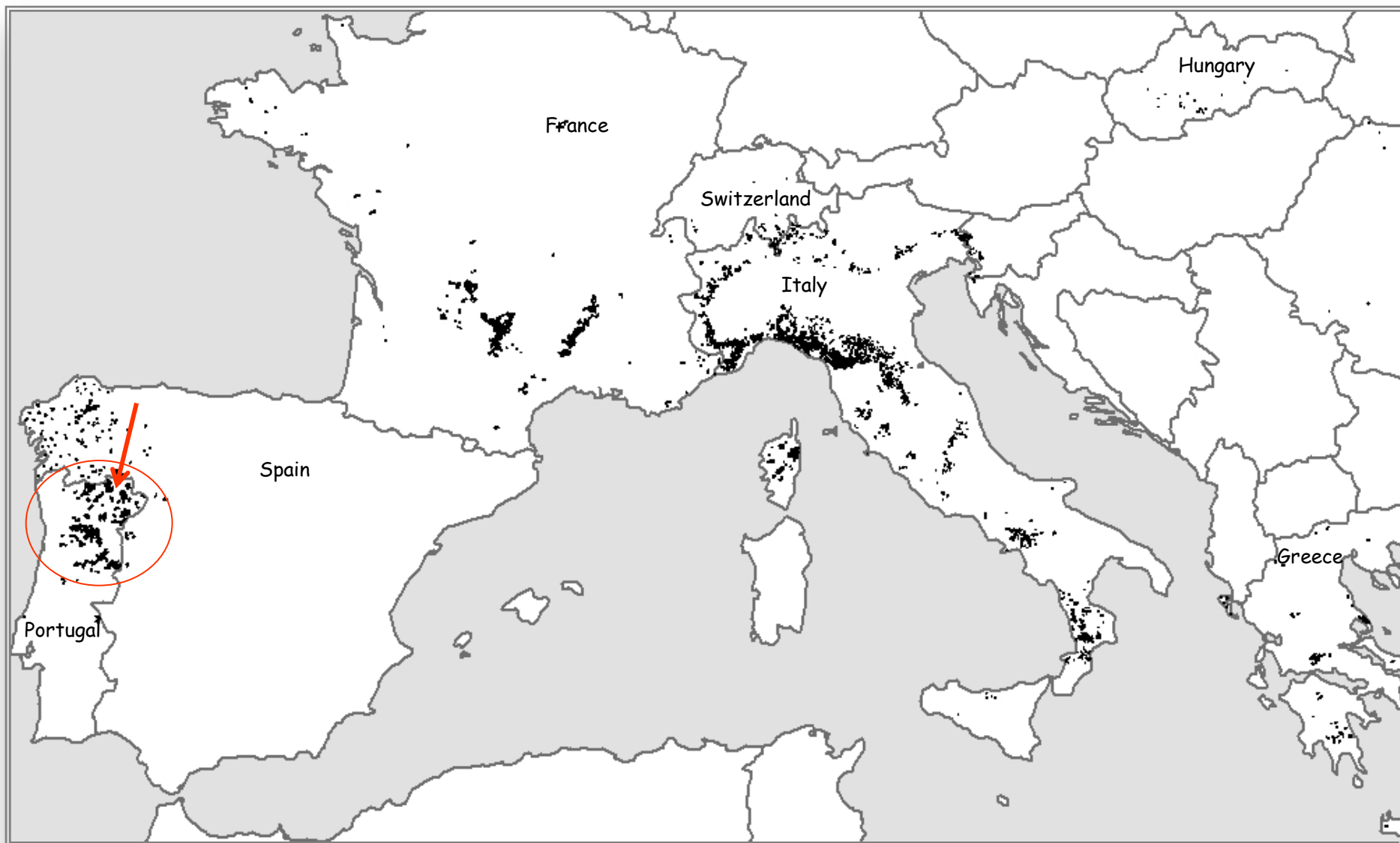- 75 affected areas

2015
- 150 affected areas
- The affected are increased 3,4 times

China

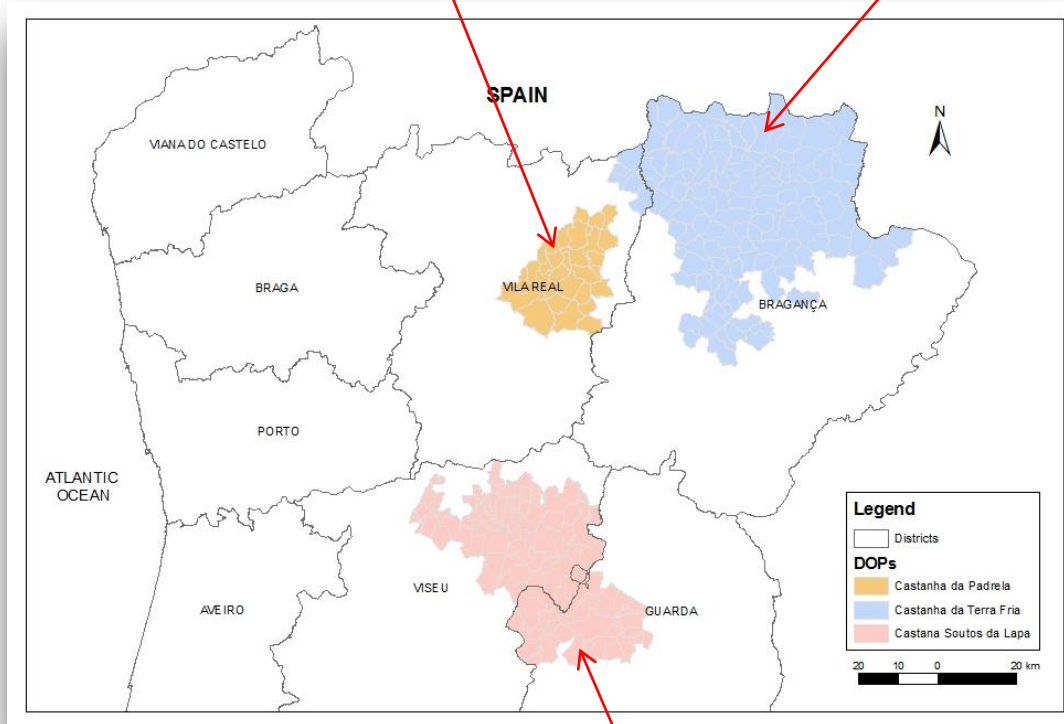**Monitoring of chestnut health condition**

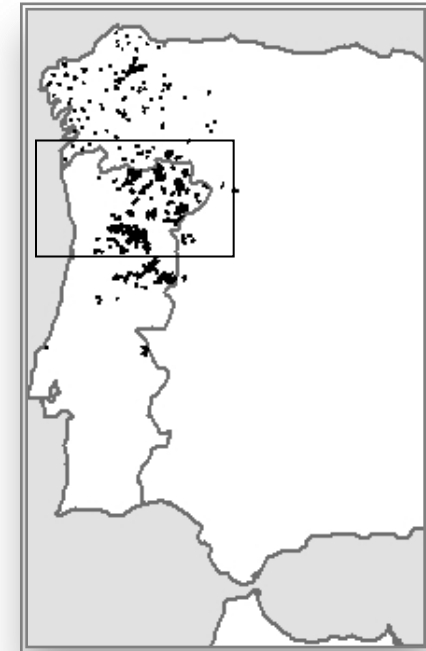## Monitoring of chestnut health condition
Study area

Castanha da Padrela

Castanha da Terra Fria

Castanha dos Soutos da Lapa

Three relevant areas in North
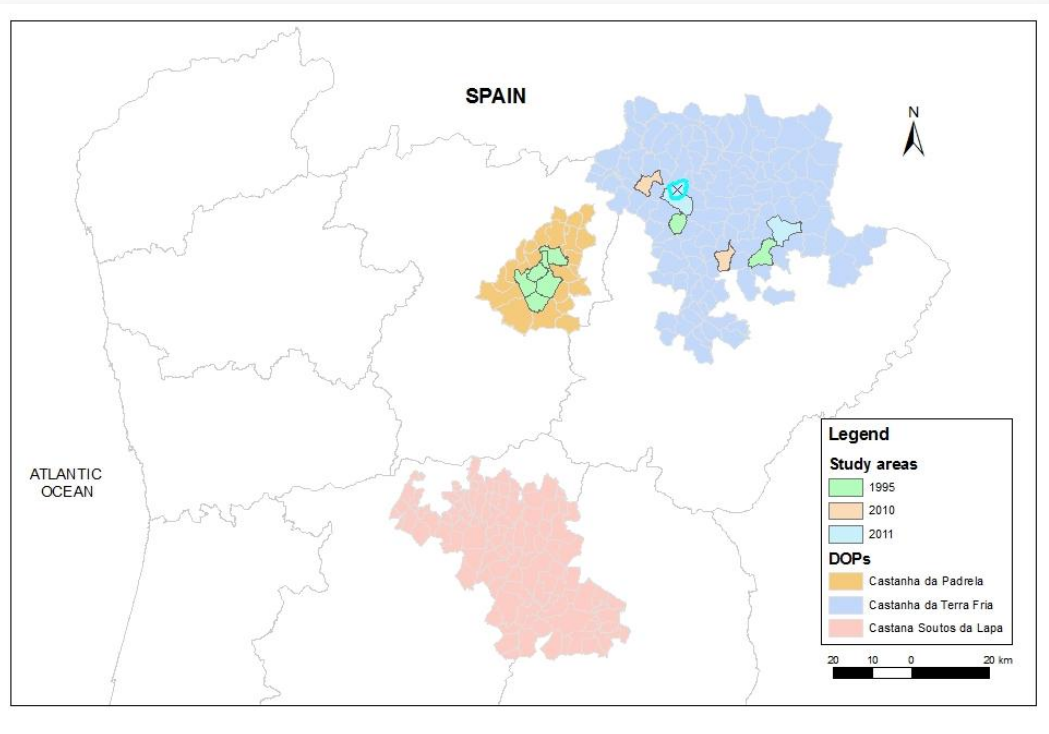Portugal for chestnut production

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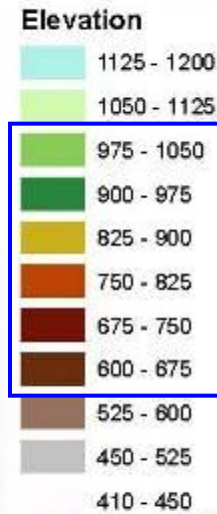# CHESTNUT ORCHARDS IN PADRELA REGION

Chestnut orchards is a specific agroforestry system in the North of Portugal
In this region the production is about 80 % of the Portuguese chestnut marked.
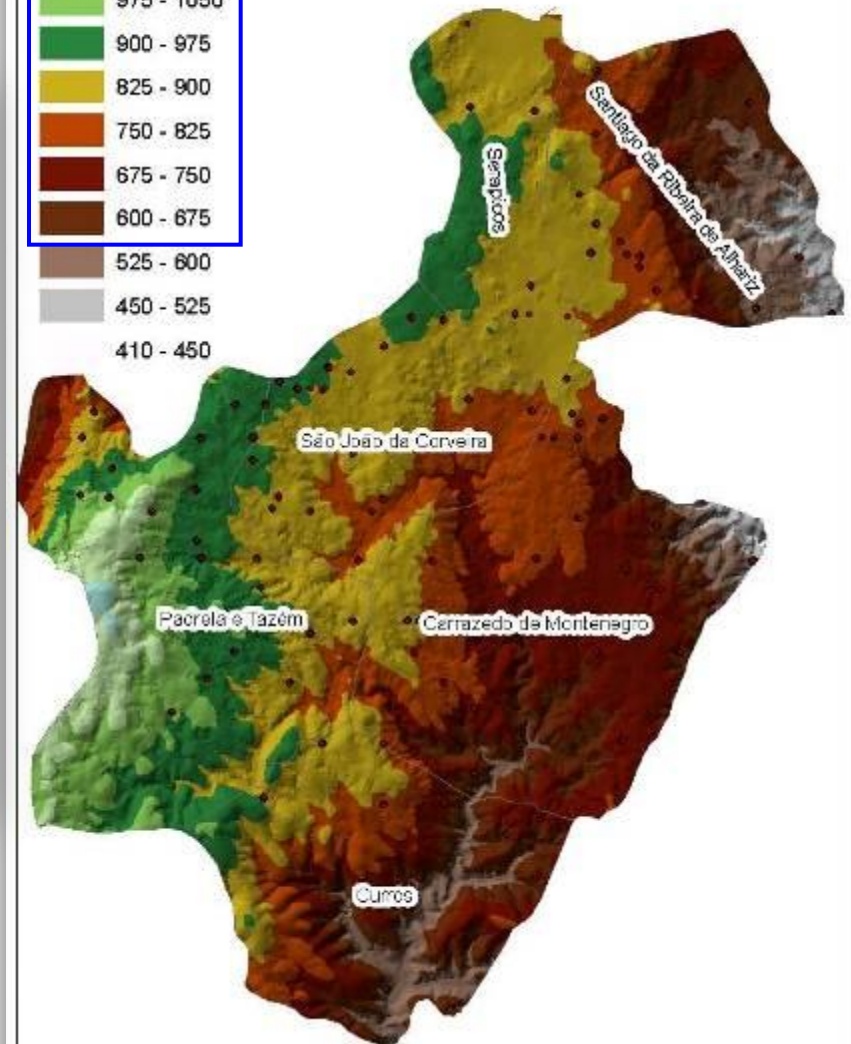
Monitoring of chestnut health condition
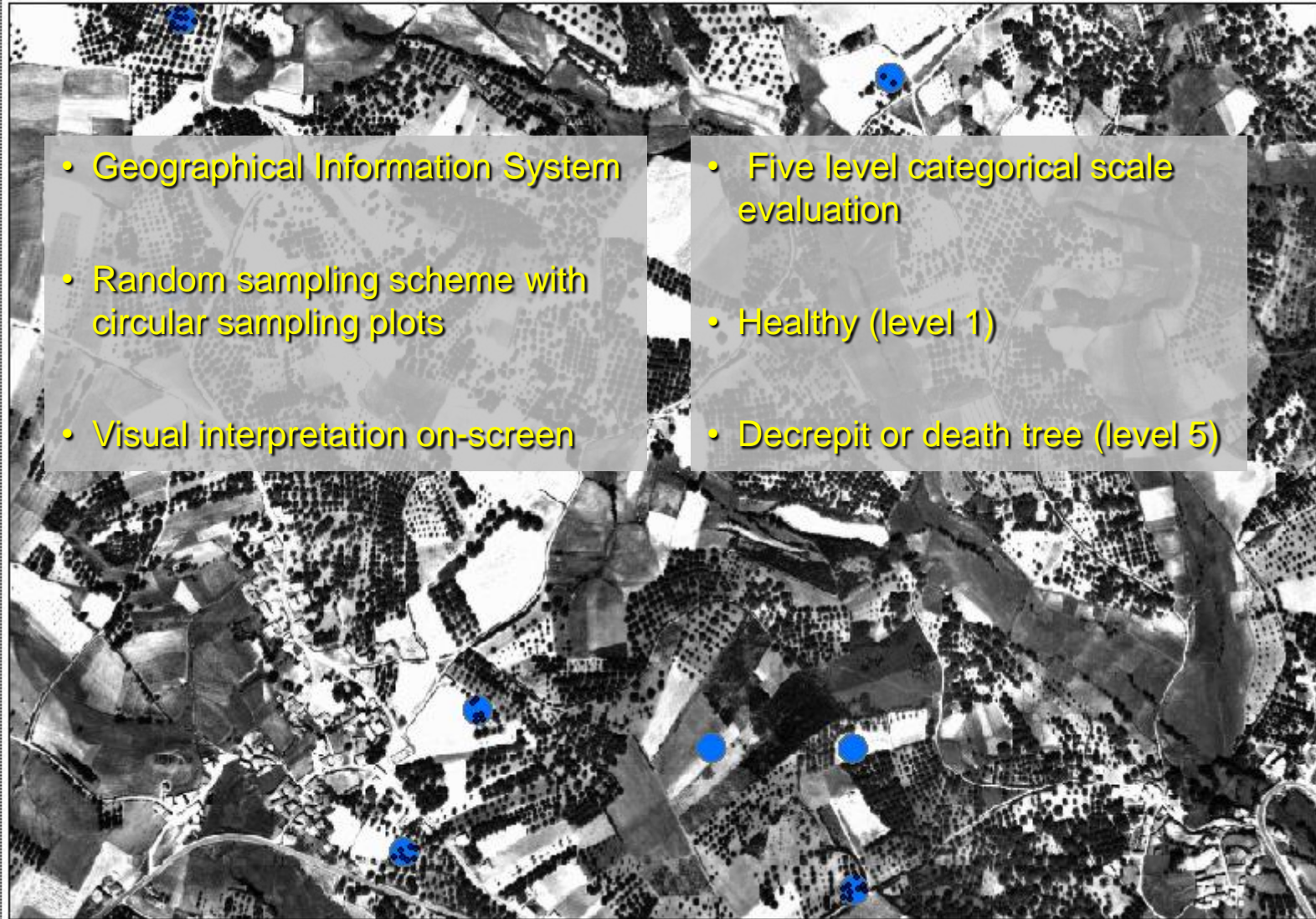
Study area

Serra da Padrela (DOP)
North-east of Portugal
Trás-os-Montes region

Legend
tin_padrela_clip
Elevation

- 1125 - 1200
- 1050 - 1125
- 975 - 1050
- 900 - 975
- 825 - 900
- 750 - 825
- 675 - 750
- 600 - 675
- 525 - 600
- 450 - 525
- 410 - 450

SPAIN

N

ATLANTIC OCEAN

Legend
Study areas
- 1995
- 2010
- 2011

DOPs
- Castanha da Padrela
- Castanha da Terra Fria
- Castana Soutos da Lapa

20 10 0 20 km

Serapicos
Santiago da Ribeira de Alhariz
São João da Corveira
Padrela e Tazém
Carrazedo de Montenegro
Curros

REMOTE SENSING AND CHESTNUT
HEALTH CONDITION EVALUATION

- Geographical Information System

- Random sampling scheme with circular sampling plots

- Visual interpretation on-screen

- Five level categorical scale evaluation

- Healthy (level 1)

- Decrepit or death tree (level 5)

1986 - Panchromatic B&W

REMOTE SENSING AND CHESTNUT
HEALTH CONDITION EVALUATION
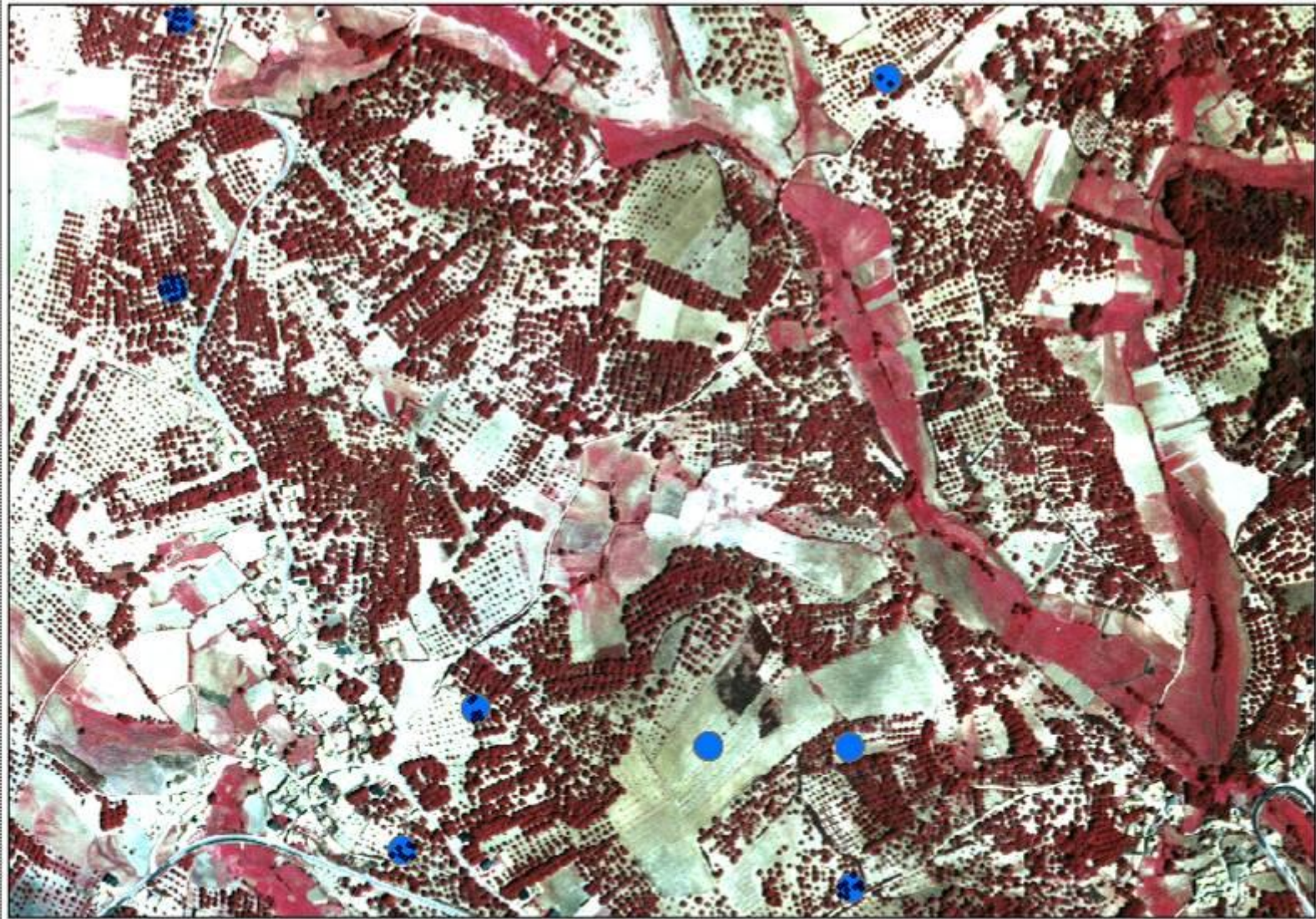
1995 - Infrared false colour
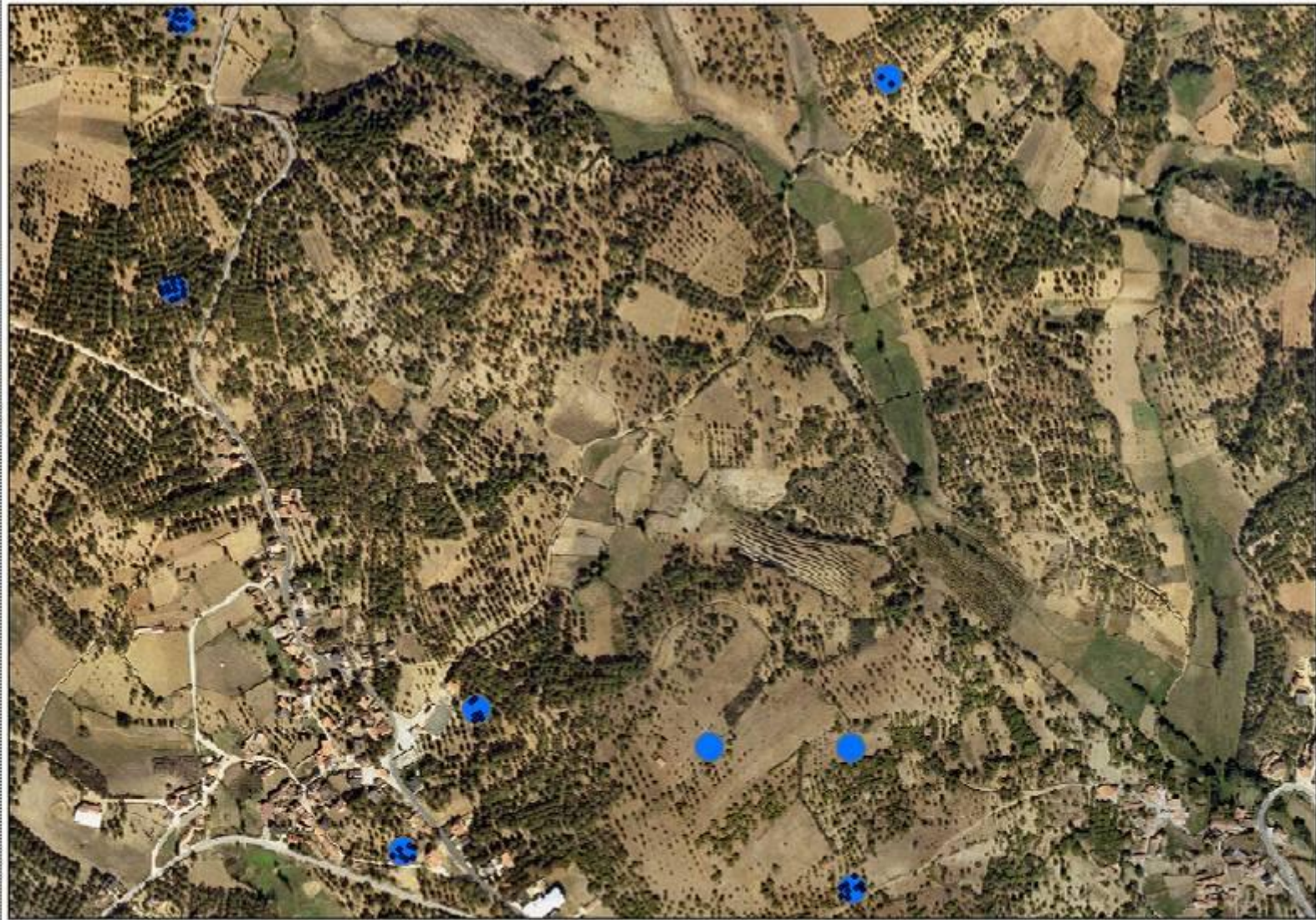
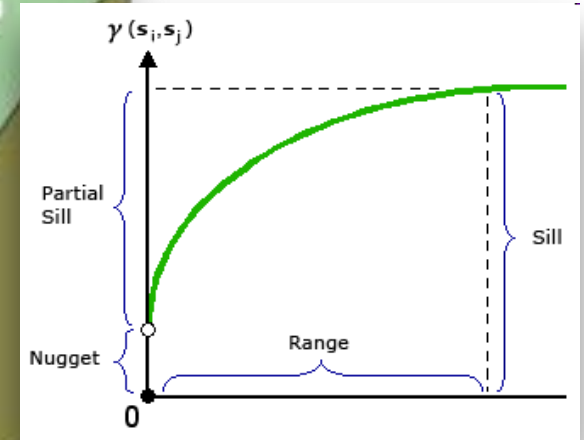2006 - Normal colour

GEOSTATISTICS

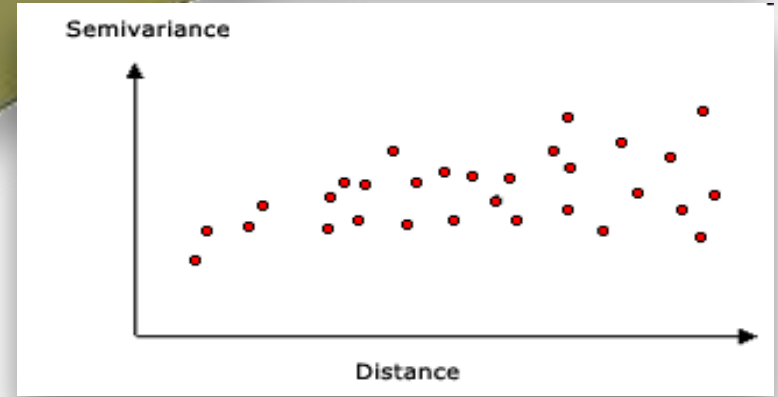**Close objects tend to be spatially correlated and assume similar characteristics**
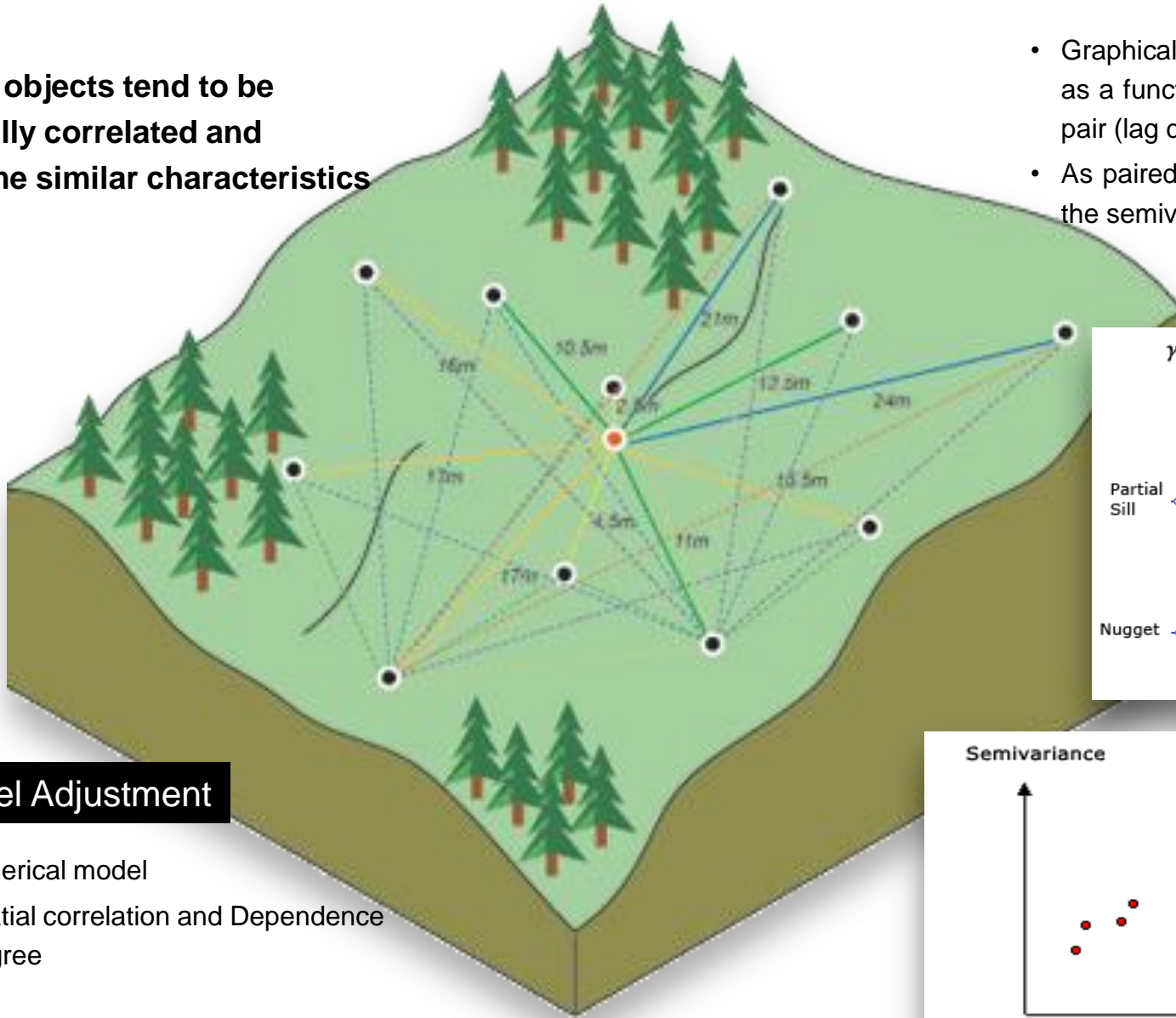
- Graphical representation of similarity pairs, as a function of the distance between each pair (lag distance - h)

- As paired data values become less similar, the semivariogram increase in value.
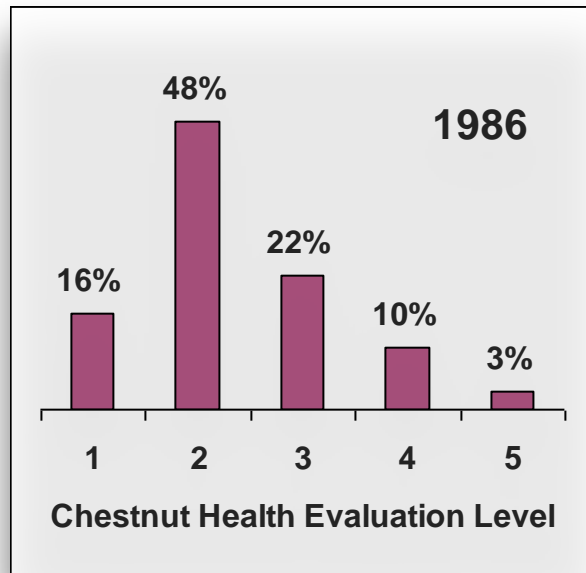
Model Adjustment

- Spherical model
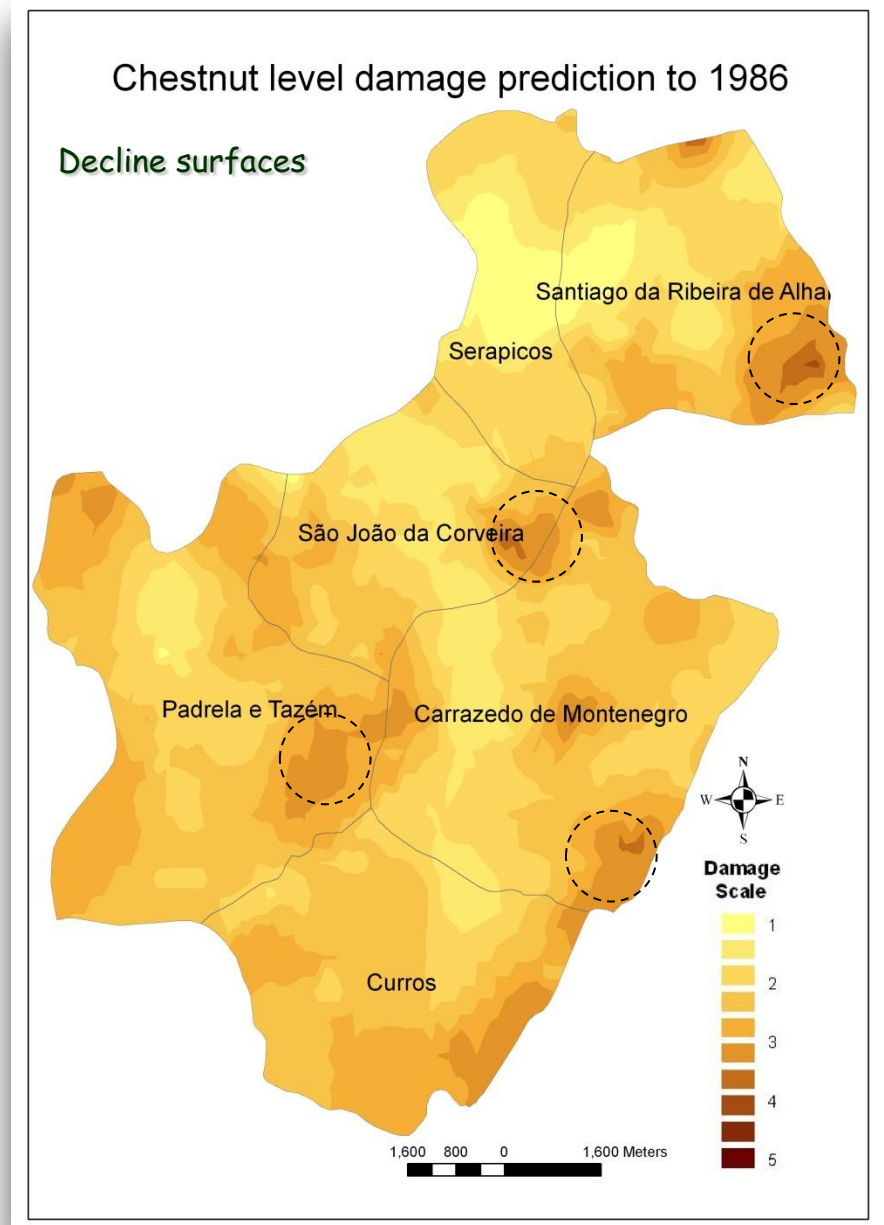- Spatial correlation and Dependence Degree

1986

48%

22%

16%

10%

3%

| 1 | 2 | 3 | 4 | 5 |

Chestnut Health Evaluation Level

Chestnut level damage prediction to 1986

Decline surfaces

Santiago da Ribeira de Alhā...

Serapicos

São João da Corveira

Padrela e Tazém

Carrazedo de Montenegro

Curros
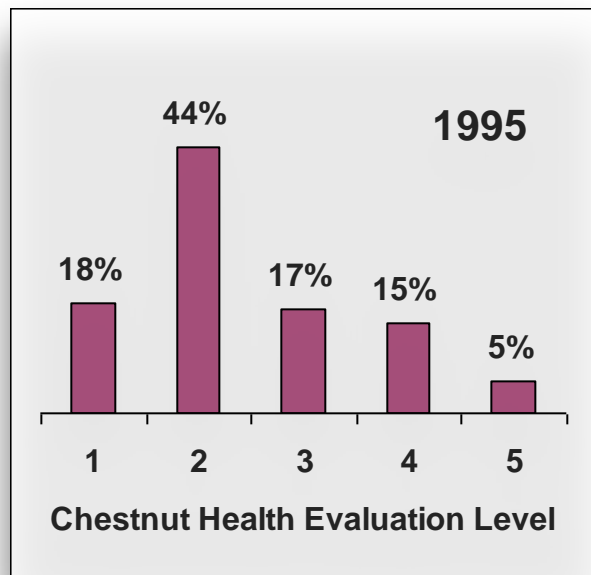
Damage Scale

1

2

3

4

5

1,600   800   0   1,600 Meters

- Detected 4 foci of chestnut decline, mostly related to ink disease.

- The mortality of chestnut in 1986 was 3%

20

44%

1995

18%

17%

15%

5%

| 1 | 2 | 3 | 4 | 5 |

Chestnut Health Evaluation Level

Chestnut level damage prediction to 1995

Decline surfaces

Santiago da Ribeira de Alha

Serapicos

São João da Corveira

Padrela e Tazém

Carrazedo de Montenegro

Curros

Damage
Scale

1
2
3
4
5

1,600   800   0   1,600 Meters
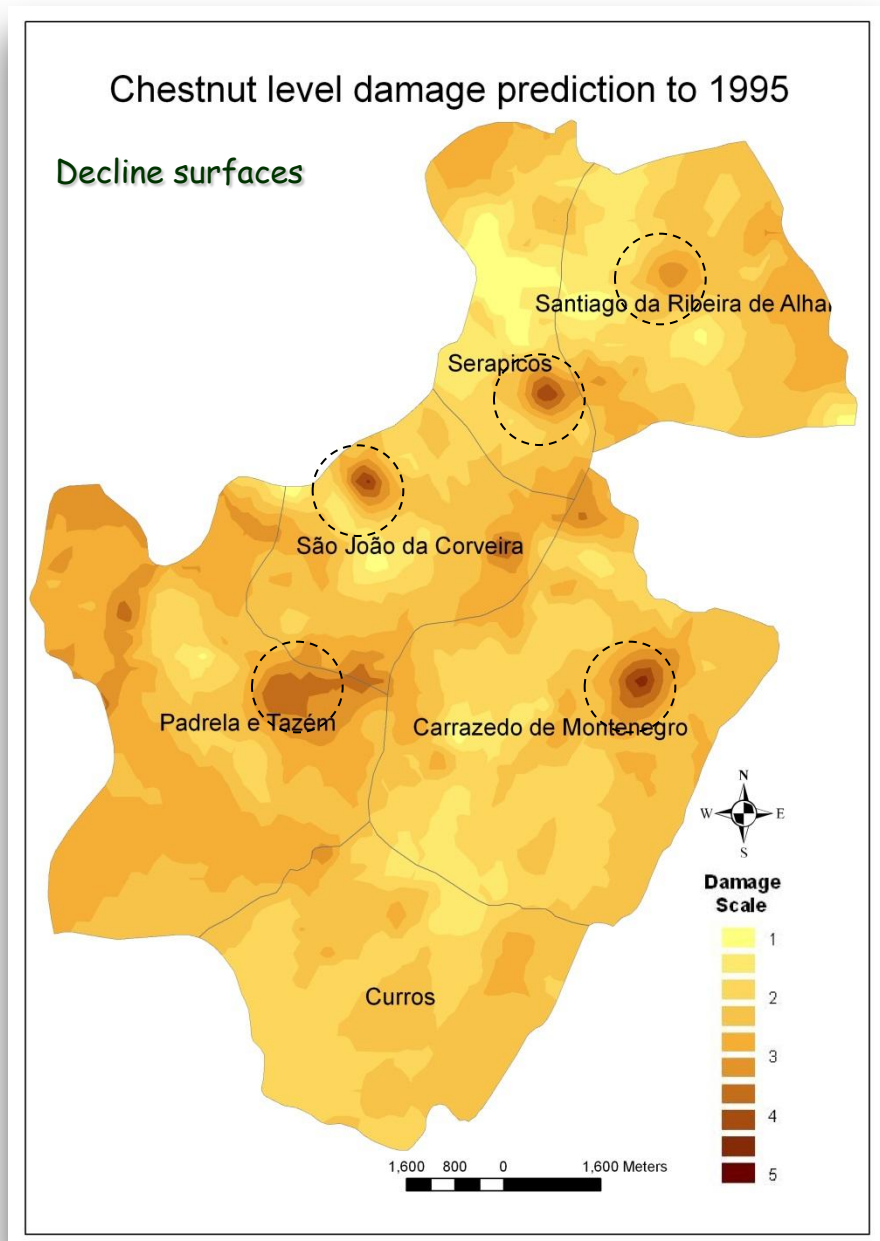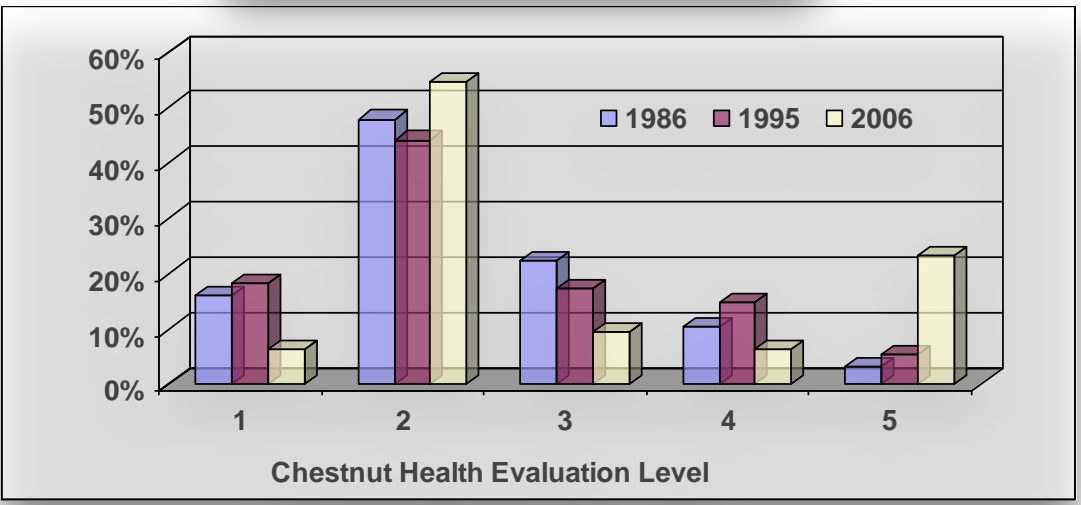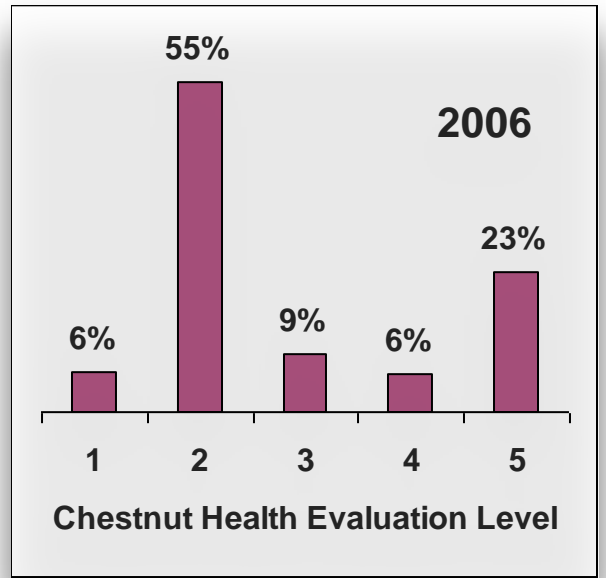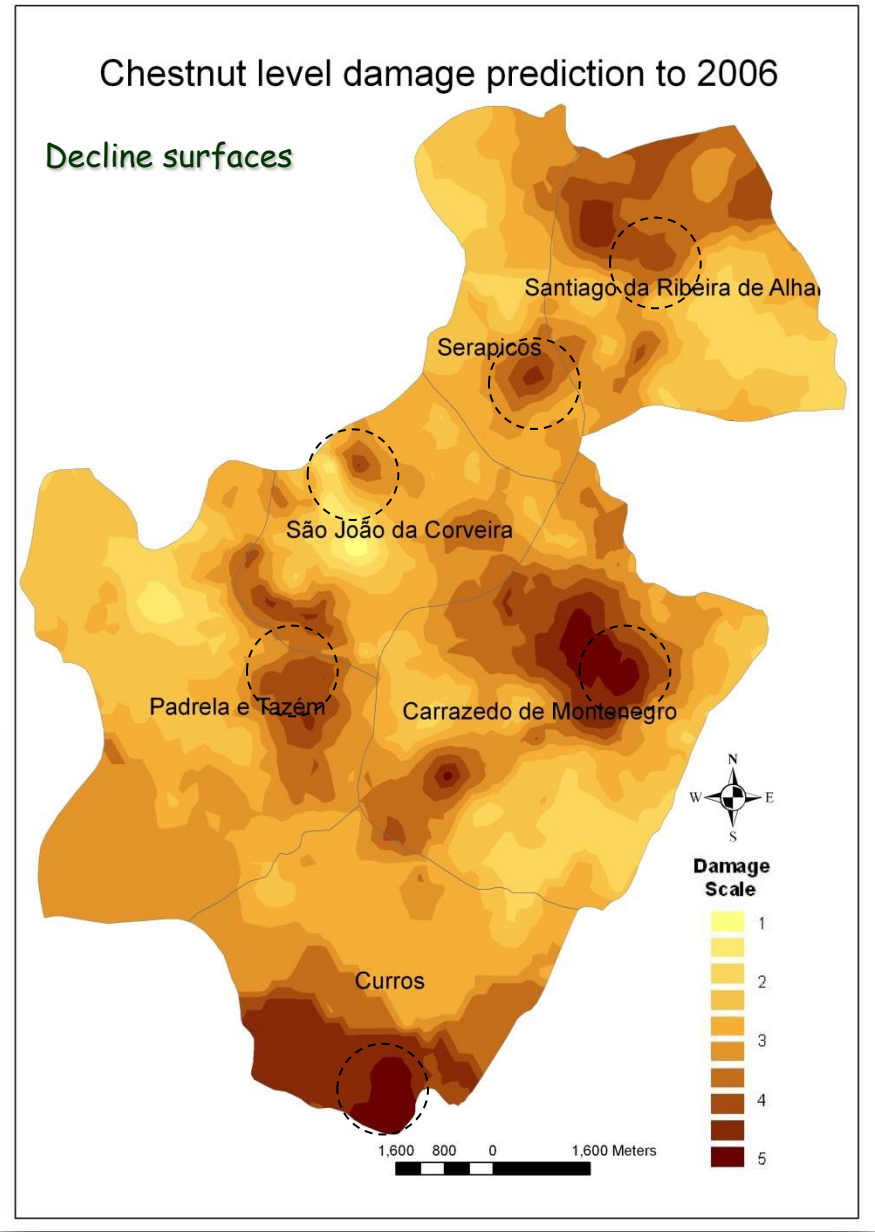
- Detected 5 foci of chestnut decline, mostly related to ink disease.

- The mortality of chestnut in 1986-1995 was 5%

55%

2006

23%

6%   9%   6%

1   2   3   4   5

Chestnut Health Evaluation Level

60%
50%
40%
30%
20%
10%
0%

☐ 1986 ■ 1995 ☐ 2006

1   2   3   4   5

Chestnut Health Evaluation Level

Chestnut level damage prediction to 2006

Decline surfaces

Santiago da Ribeira de Alha

Serapicõs

São João da Corveira

Padrela e Tazém   Carrazedo de Montenegro

Curros

N
W   E
S

Damage Scale
1
2
3
4
5

1,600 800   0   1,600 Meters

- Detected 6 foci related to ink disease and chestnut blight.
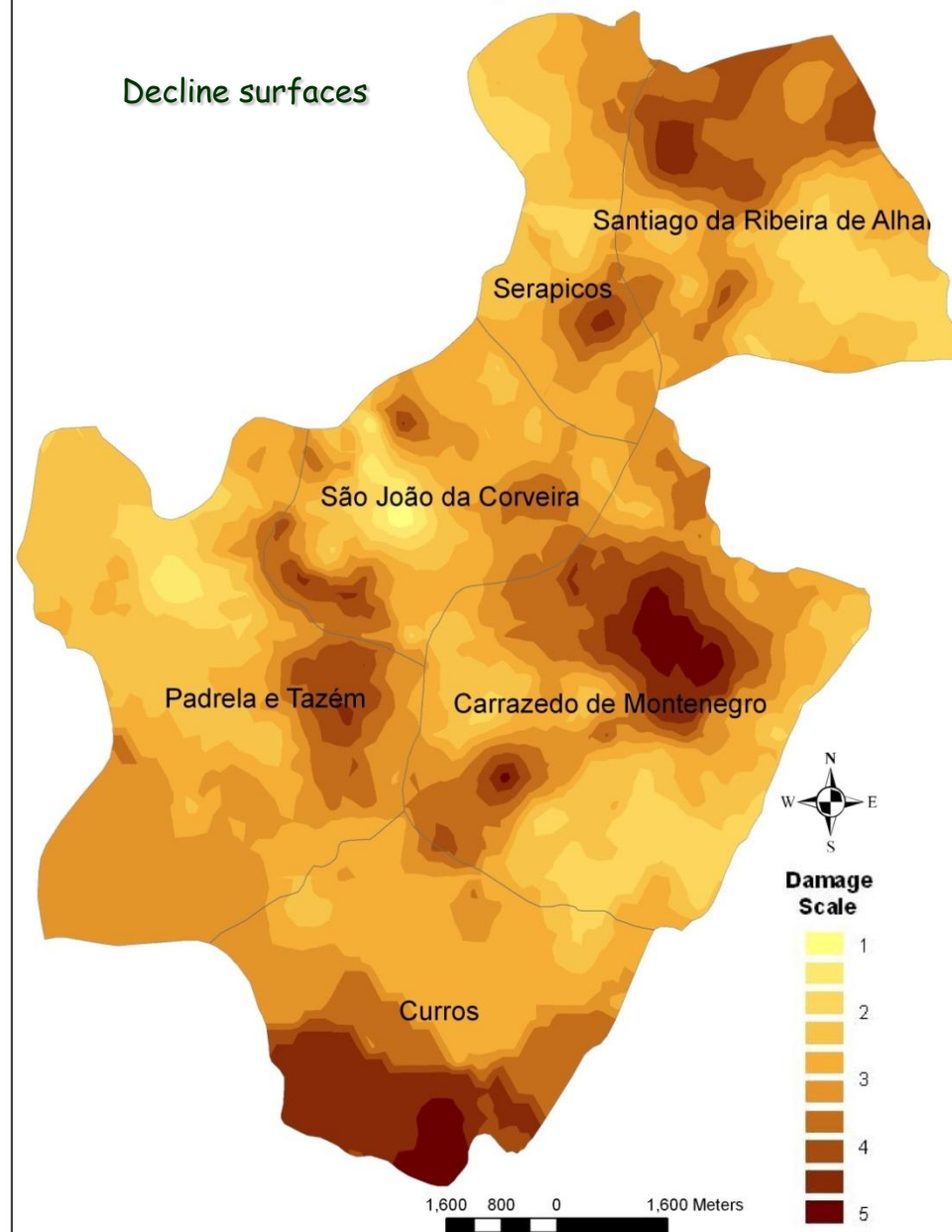
- The mortality of chestnut in 1995-2006 was 23%

- Higher rate spread of chestnut decline observed in 2006, particularly in areas with the same altitude and smooth slope, where the soil tillage is more frequent.

- The chestnut area increased 47%
  - Plantations has been higher than mortality

- Reasons of the increased decline:
  - Chestnut blight incidence
  - Management practices
  - Climate factors

Chestnut level damage prediction to 2006

Decline surfaces

Santiago da Ribeira de Alha

Serapicos

São João da Corveira

Padrela e Tazém

Carrazedo de Montenegro

Curros

Damage Scale
1
2
3
4
5

1,600 800 0 1,600 Meters

Monitoring of chestnut health condition using an Unmanned Aerial Vehicle

Vinhais and Padrela regions

2014

Infrared photography (V. Peregrinos, 22/07/14)

2014

Normal colour photography - RGB

Drone (UAV)
eBee - SensFly

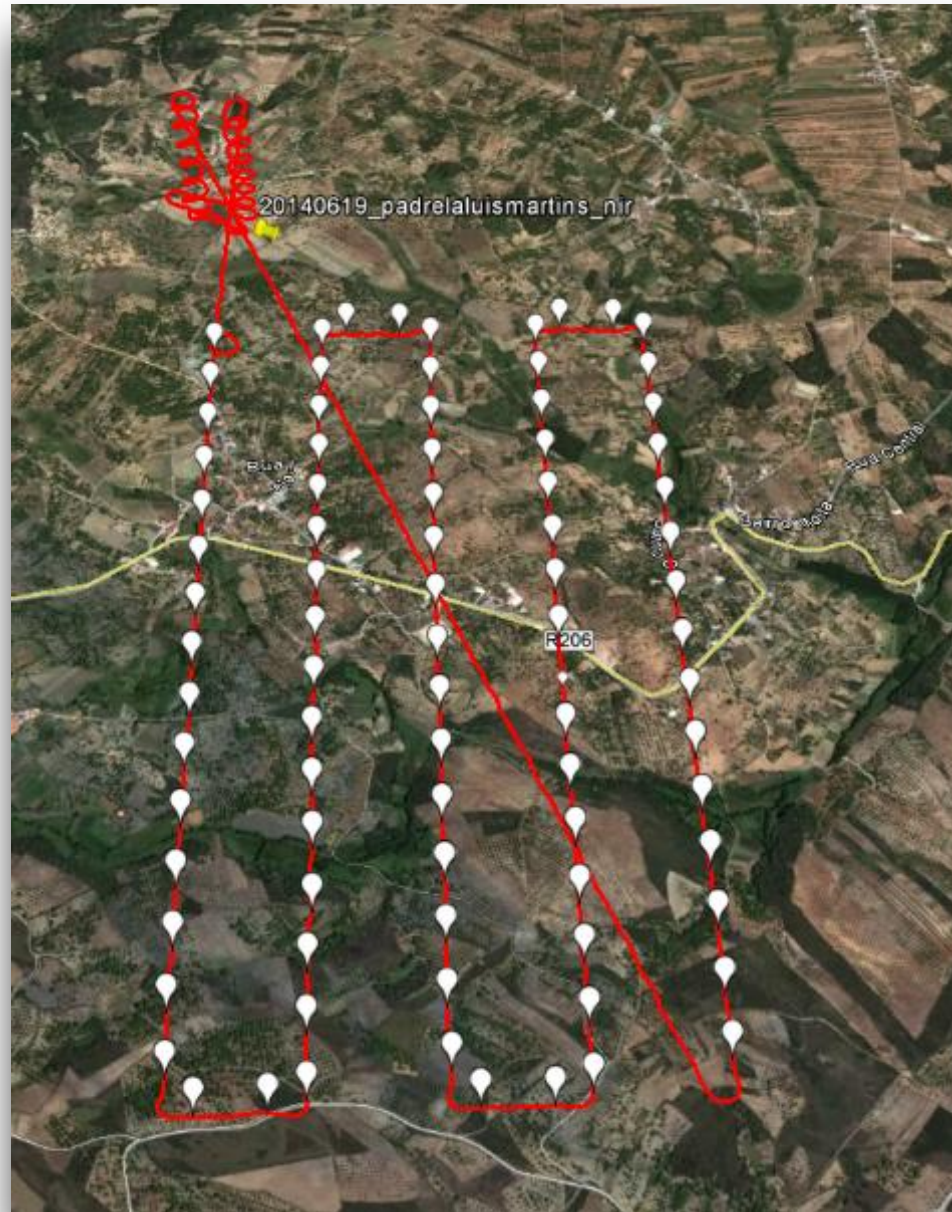Drone flight preparation (June 2014)
João Paulo Castro; Ricardo Bento; Joaquim Sousa

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Vinhais region

Vinhais

Vilar de Peregrinos

Penhas Juntas

0 1 2 4 km

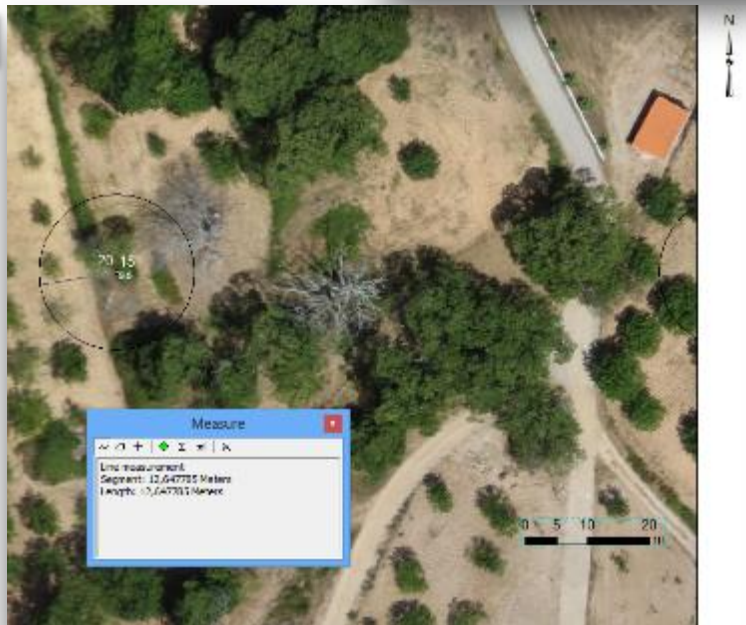**UAV flight**
July 2014

- Four (N-S) flight lines

- 350 m flight height

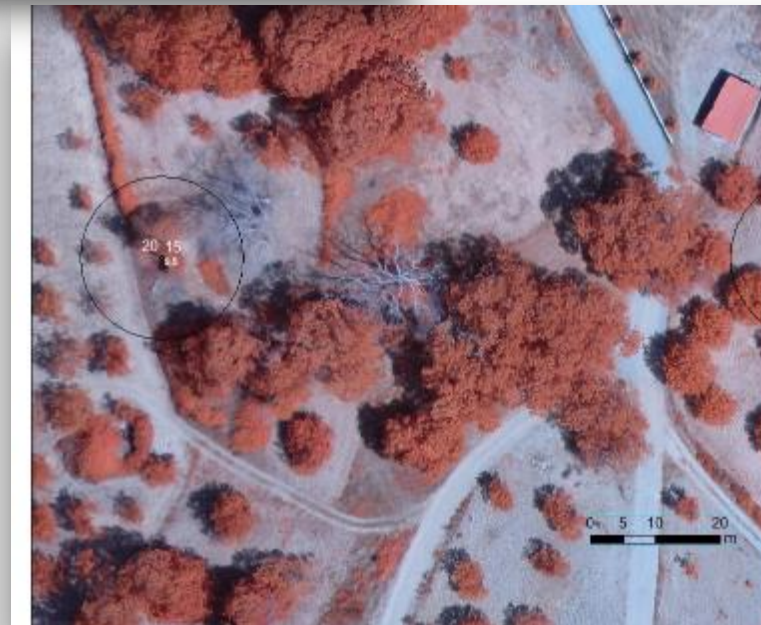- 15 cm pixel (ground) resolution

2006

Normal colour aerial photography (tripulated aircraft)

2014

Normal colour aerial photography (UAV)
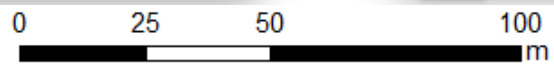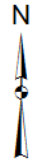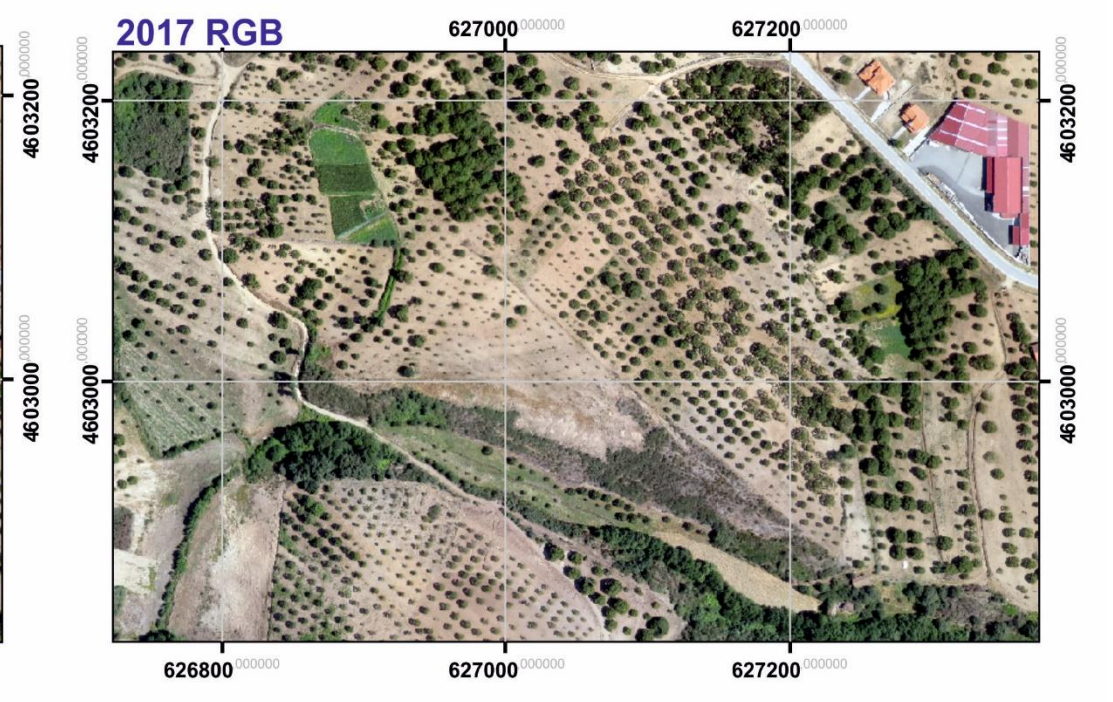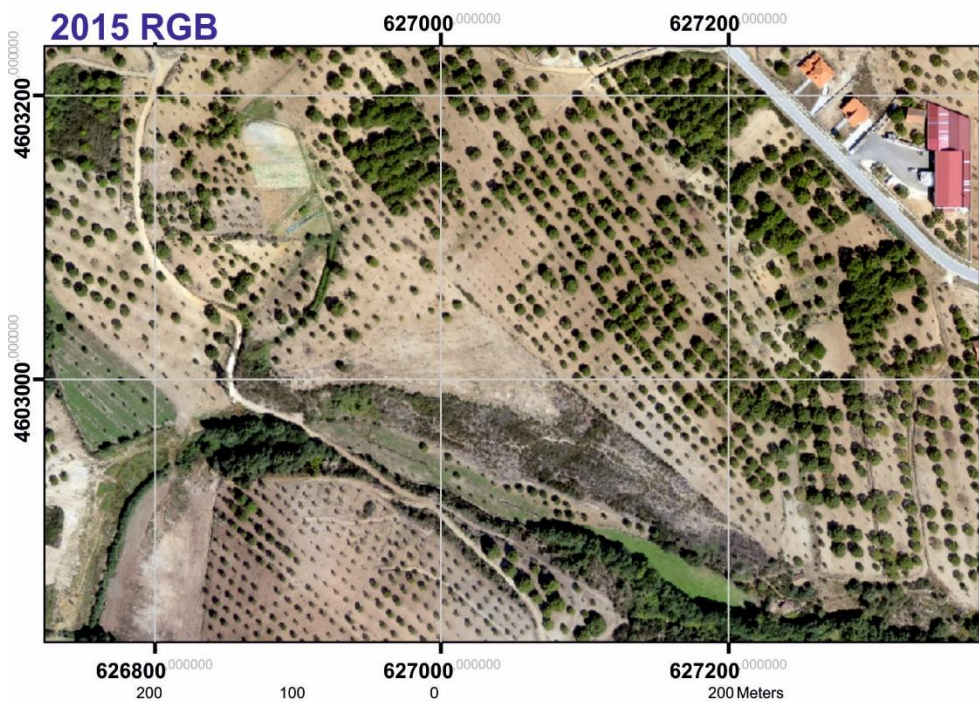
2014

Infrared aerial photography (UAV)

27

2006

2014

30 10
8

40 15
7,5

Lameiro 5

5 10
10,5

20 15
9,5

15 50
13,5

N
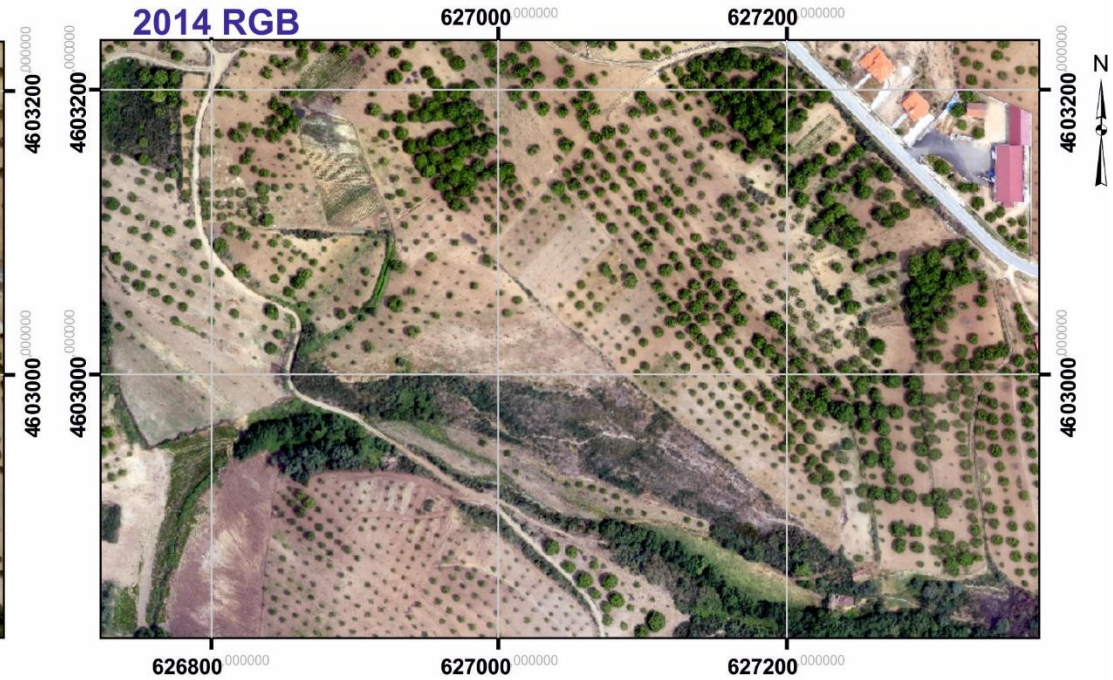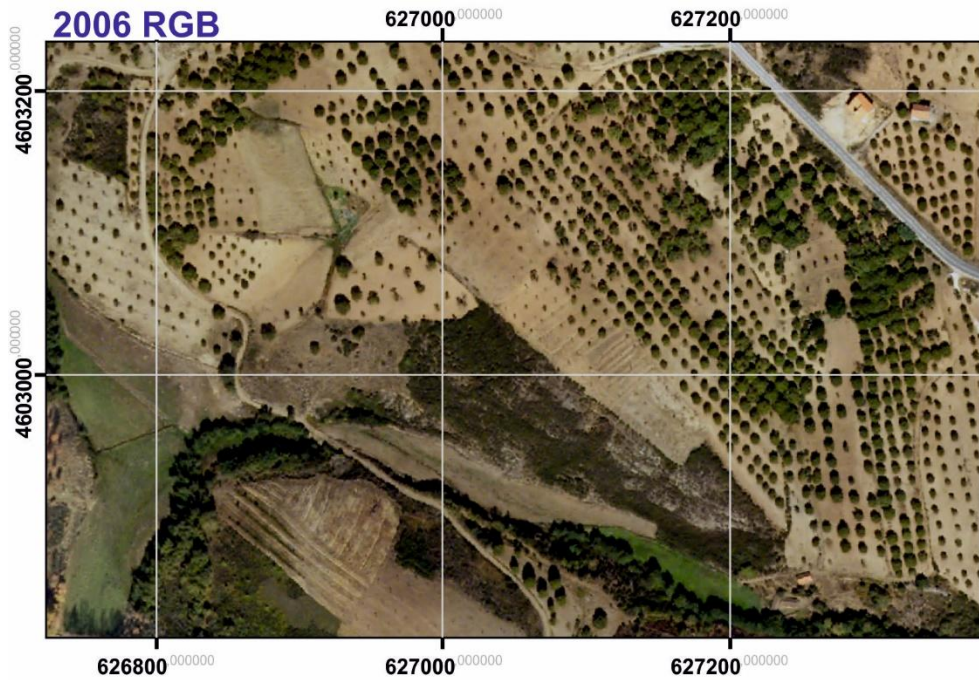
National flight : 50 cm resolution

eBee: 10 cm resolution

28

0   25   50   100
m

2006 RGB · 2014 RGB · 2015 RGB · 2017 RGB

2006-2014   2014-2015   2015-2017

N

500 250 0 500 Meters
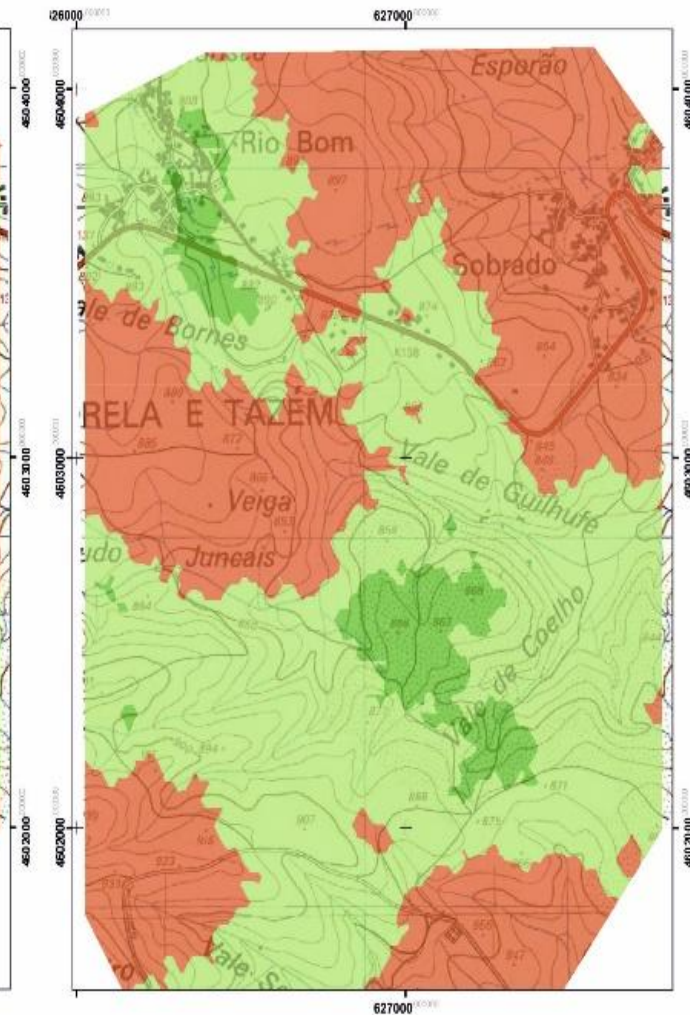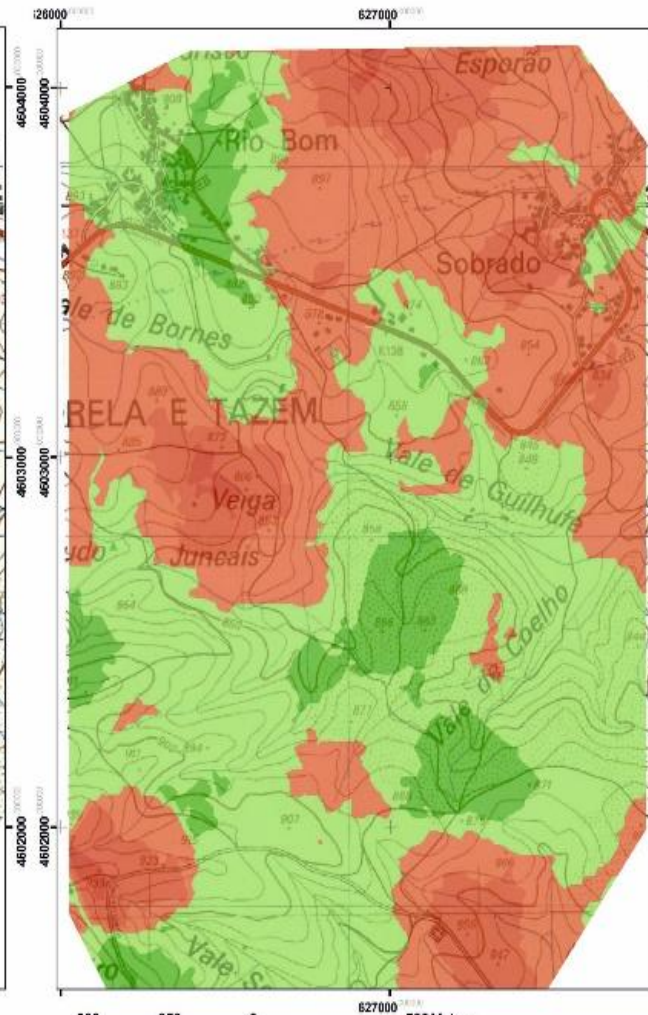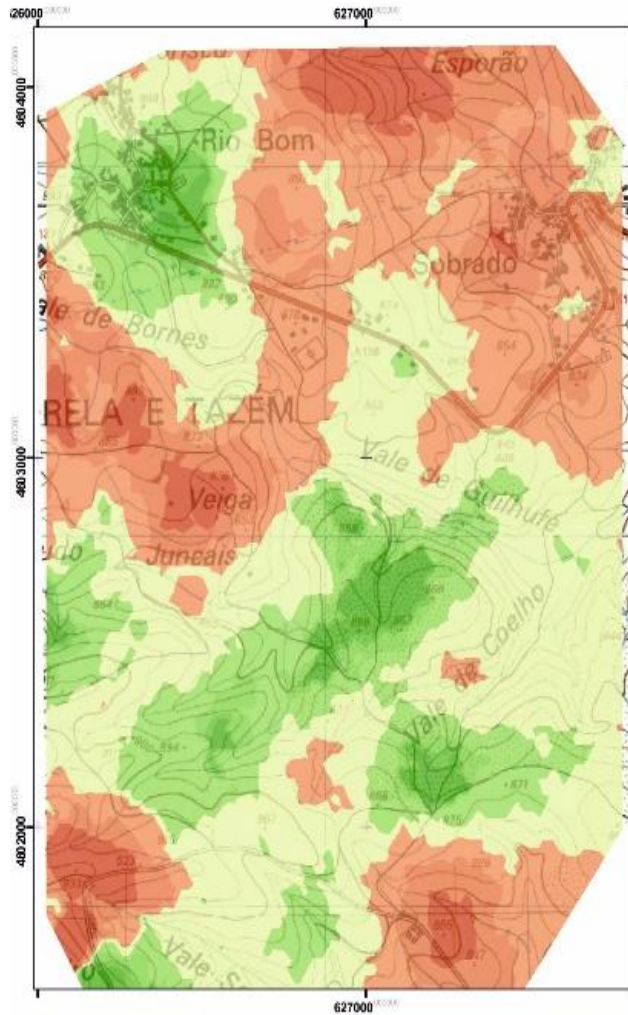
LEGEND

Prediction Map / Filled Contours

■ 1,5 – 7,0	■ 9,5 – 10,0	■ 11,0 – 11,5
■ 7,0 – 8,0	□ 10,0 – 10,5	■ 11,5 – 12,5
■ 8,0 – 9,5	■ 10,5 – 11,0	■ 12,5 – 14,0

30
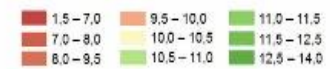
Padrela region

Chestnut (2006 a 2017)
Canopy area and health condition

Chestnut area and decline	2006		2014		2015		2017	
Other cultures	191 (44%)		135 (31%)		143 (33%)		091 (21%)	
Chestnut area (ha)	247 (56%)		303 (69%)		295 (67%)		347 (79%)	
- Chestnut area decline				135 (55%)		182 (60%)		104 (35%)
- Chestnut area growth				112 (45%)		121 (40%)		191 (65%)
- Chest. area variation				056 (+18%)		-008 (-3%)		052 (15%)
Chestnut Area (ha)		247 ha		303 ha		295 ha		347 ha
TOTAL (ha)	438 ha		438 ha		438 ha		438 ha	

- In the period 2006-2017 occurred new chestnut plantations (100 ha; 40,5%), due to the eight multifunctional value of chestnut tree.

- The decline of chestnut was 56%.

- The biotic agents were the principal causes of the mortality and *C. sativa* decline, who was confirmed by field observations.

Monitoring of chestnut health condition using an Unmanned Aerial Vehicle

There are advantages on using UAV for the study purposes

- Due to the low flying heights, resulting high resolution imagery, and lower image acquisition costs, compared to piloted aircraft or satellite images;

- UAV cover wide areas, and are virtually undetectable (flights 300 m, up ground), so animals won't be disturbed;

- The electric UAVs, do not have polluted emissions, resulting no negative impacts to the environment.

Use of Technology for Monitoring and Field Managing

Thank you

Luís Miguel Martins, UTAD
lmartins@utad.pt