Portugal's 2017 Pedrógão Grande Disaster in Context of Extreme Event Analysis

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Pedrógão Grande wildfire: Portuguese society in incredulous and shock state

The previous worst single wildfire events in Portugal

Year	Number of fatalities	
	Civillians	Firefighters
1966	0	25
1985	0	14
1986	3	13
2017	**65**	**1**

The previous worst years in terms of fatalities

Year	Fatalities
2003	21
2005	22
2012	13
2017	**112**

Outline

1. Pedrógão Grande (PG): an extreme wildfire that occurred out of the critical fire season

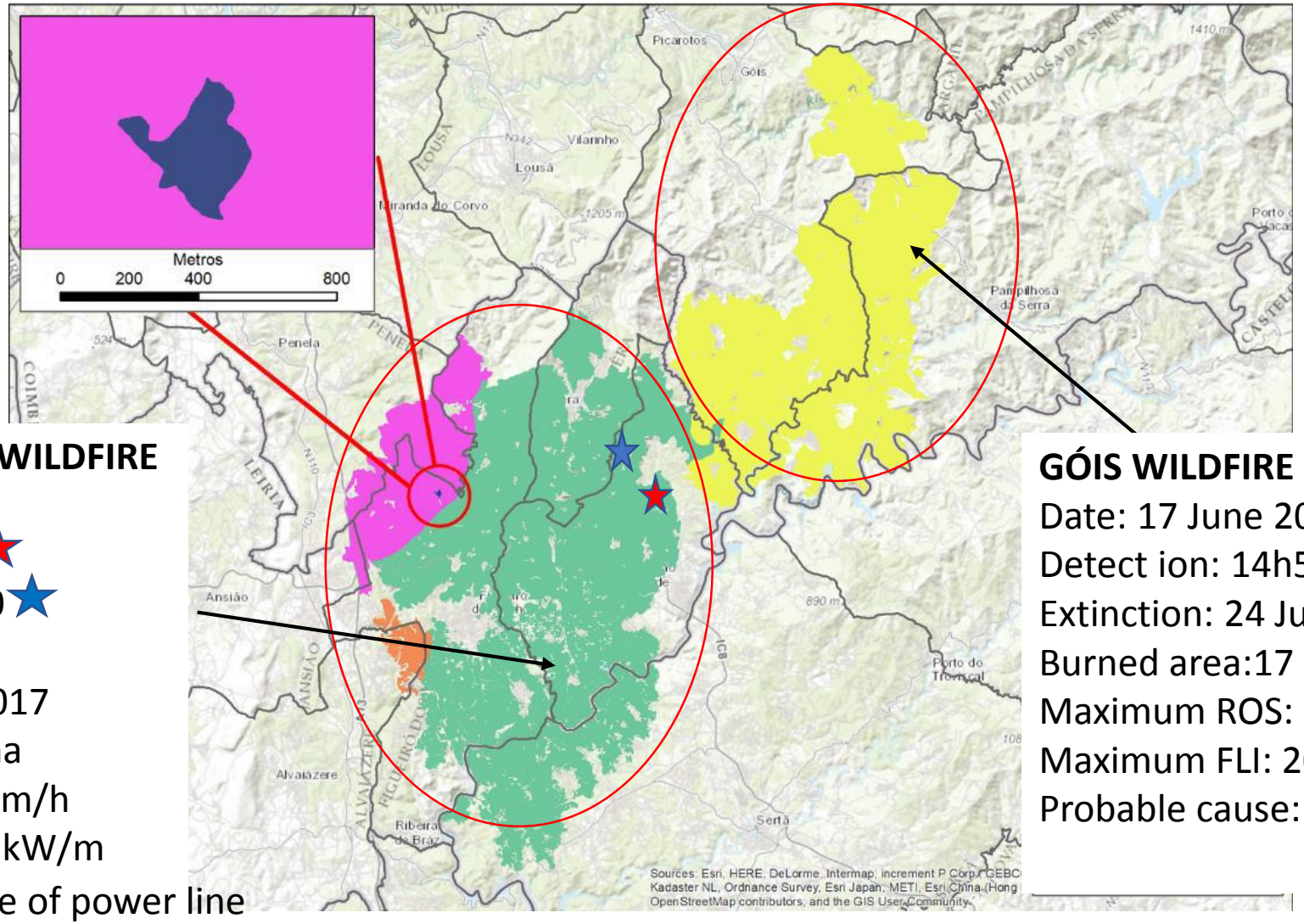
2. PG wildfire behavior: characteristics and contributing conditions

3. The social impacts of PG wildfire

4. Why PG wildfire turned into a disaster?

5. Final remarks

1. Pedrógão Grande: an extreme wildfire that occurred out of the critical fire season



PEDRÓGÃO GRANDE WILDFIRE
Date: 17 June 2017
Ignition time: 14h30
Second ignition: 16:00
Detection time:14H43
Extinction: 24 June 2017
Burned area: 28 914 ha
Maximum ROS: 15.3 km/h
Maximum FLI: 60,000 kW/m
Probable cause: Failure of power line

GÓIS WILDFIRE
Date: 17 June 2017
Detect ion: 14h52
Extinction: 24 June 2017
Burned area:17 521 ha
Maximum ROS: 1.8km/h
Maximum FLI: 20,000 kW/m
Probable cause: Lightning

Source: Map from ADAI/LAETA 2017; data from CTI, 2017

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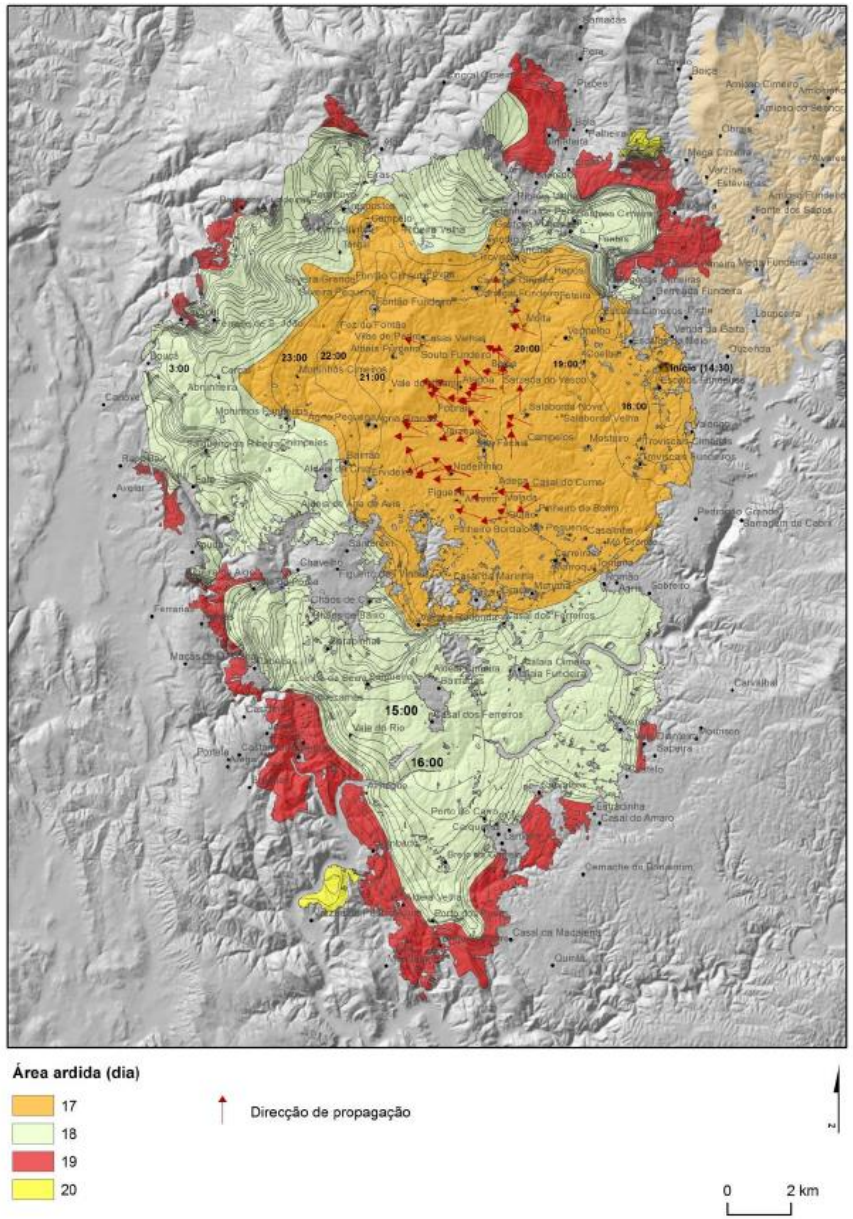
1st ignition - Escalos Fundeiros- - 14h30, 17th June

Distance between ignition points: 2.8 km

2nd ignition - Regadas –16h 17th June

2. PG wildfire behavior: characteristics and contributing conditions

Fire behavior characteristics



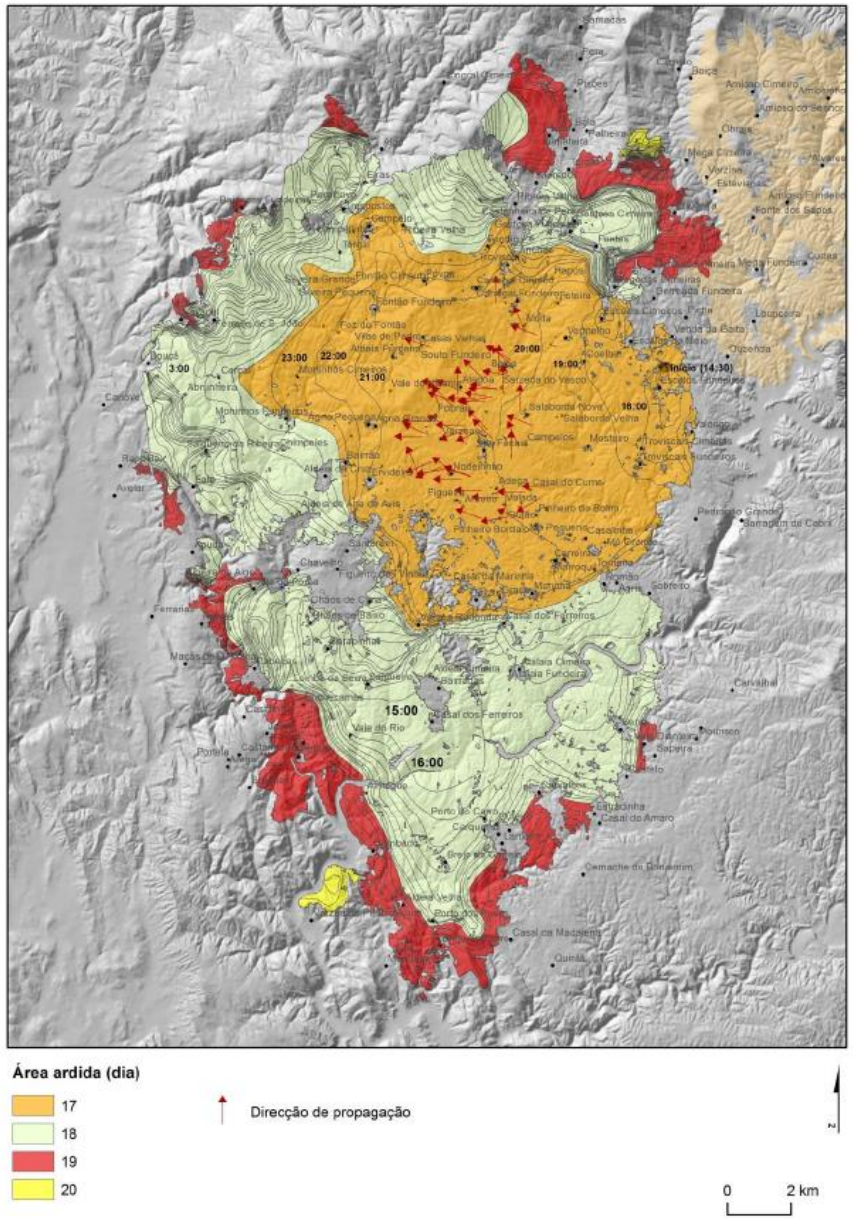
Source:CTI, 2017

Time interval, burned area during the interval	Environmental conditions	Fire behavior
17th June 14:30-16:00 **25 ha**	Very low fuel moisture (~4%) Low wind velocity with an increase of velocity	ROS - 0.47 km/h FLI – 2500 – 7000 kW/m
17th June 16:00 – 18:00 **390,79 ha**	Fuel moisture increasing. Velocity of wind increase, high convective instability	ROS – 1.2 Km/h FLI – 6,000 – 18,000 kW/m Spotting activity

Source: ADAI/LAETA, 2017

Time interval, burned area during the interval	Environmental conditions	Fire behavior
17th June 18:00 – 19:00 794. 88 **ha**	Fuel moisture continue to increase	ROS: 2.3 km/h FLI: 20,000 kW/m
17th June 19:00 – 20:00 2588.65 **ha**		ROS: 3.9 km/h FLI: 20,000 – 60000 kW/m

Source: Escola Tecnológica de Pedrógão Grande; Adai-LAETA, 2017



Time interval, burned area during the interval	Environmental conditions	Fire behavior
17th June 20:00 – 21:00 4458.57**ha**	Downburst 20:10 Possible Downburst 20:30	ROS: 5. 3 km/h For 10 minutes 15.3 km High spotting activity
17th- 18th June 21.00 – 03.00 **5,316 ha**	Lower temperature and higher humidity	ROS – 1.2 km/h
18th June 3:00-8:00 **1,818.62 ha**		
18th June 8:00 – 13:00 **1,733.13 ha**		
18th June 13:00 – 15:00 **1,443 há**		
18th June 15:00 – 17.00 **3,369 ha**		ROS: 3,8 km/h FLI: 40, 000 kW/m

Fire Category		Real Time Measurable Behavior Parameters			Real Time Observable Manifestations of EFB				Type of Fire and Capacity of Control *
		FLI* (kWm^{-1})	ROS (m/min)	FL (m)	PyroCb	Downdrafts	Spotting Activity	Spotting Distance (m)	
Normal Fires	1	<500	<5 <15 [b]	<1.5	Absent	Absent	Absent	0	Surface fire Fairly easy
	2	500–2000	<15 <30 [b]	<2.5	Absent	Absent	Low	<100	Surface fire Moderately difficult
	3	2000–4000	<20 [c] <50 [d]	2.5-3.5	Absent	Absent	High	≥100	Surface fire, torching possible Very difficult
	4	4000–10,000	<50 [c] <100 [d]	3.5-10	Unlikely	In some localized cases	Prolific	500–1000	Surface fire, crowning likely depending on vegetation type and stand structure Extremely difficult
Extreme Wildfire Events	5	10,000–30,000	<150 [c] <250 [d]	10-50	Possible	Present	Prolific	>1000	Crown fire, either wind- or plume-driven Spotting plays a relevant role in fire growth Possible fire breaching across an extended obstacle to local spread Chaotic and unpredictable fire spread Virtually impossible
	6	30,000–100,000	<300	50-100	Probable	Present	Massive Spotting	>2000	Plume-driven, highly turbulent fire Chaotic and unpredictable fire spread Spotting, including long distance, plays a relevant role in fire growth Possible fire breaching across an extended obstacle to local spread Impossible
	7	>100,000 (possible)	>300 (possible)	>100 (possible)	Present	Present	Massive Spotting	>5000	Plume-driven, highly turbulent fire Area-wide ignition and firestorm development non-organized flame fronts because of extreme turbulence/vorticity and massive spotting Impossible

Source:
Tedim, Leone et al., 2018

Contributing conditions

1. Climatic and weather

2. Landscape

3. Wildfire management

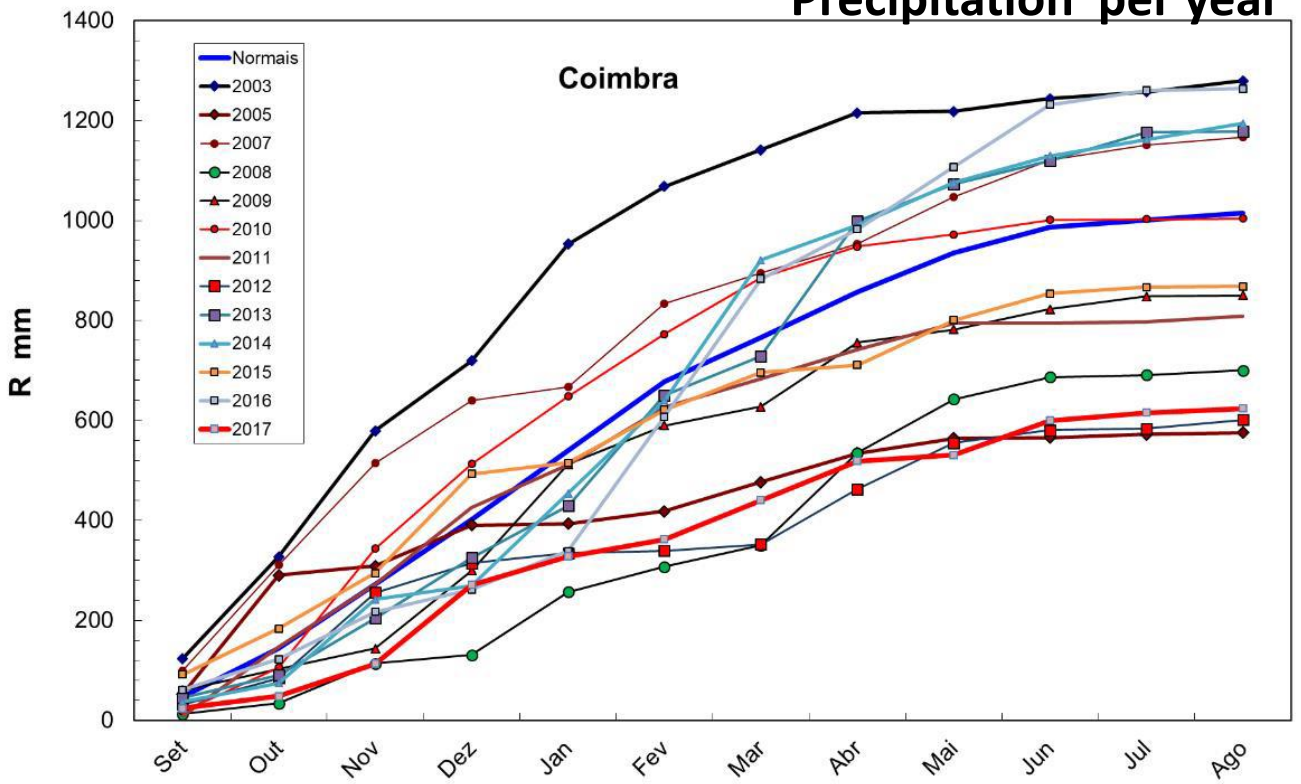
4. Social dynamics

1. Climatic and weather conditions

- Drought in Winter and Spring
- Heatwaves: in April (duration of 15-16 days); in May (between 20th and27th);
  in June (between 4th and 24th)

- Precipitation reduced to 50 - 75% of the mean
- Very hot and dry Spring
- June was very hot and dry
- Fuel aridity reached its maximum value in 2017, in Portugal
- Haines Index
  6 (scale until 6)
  12 (scale until 13)

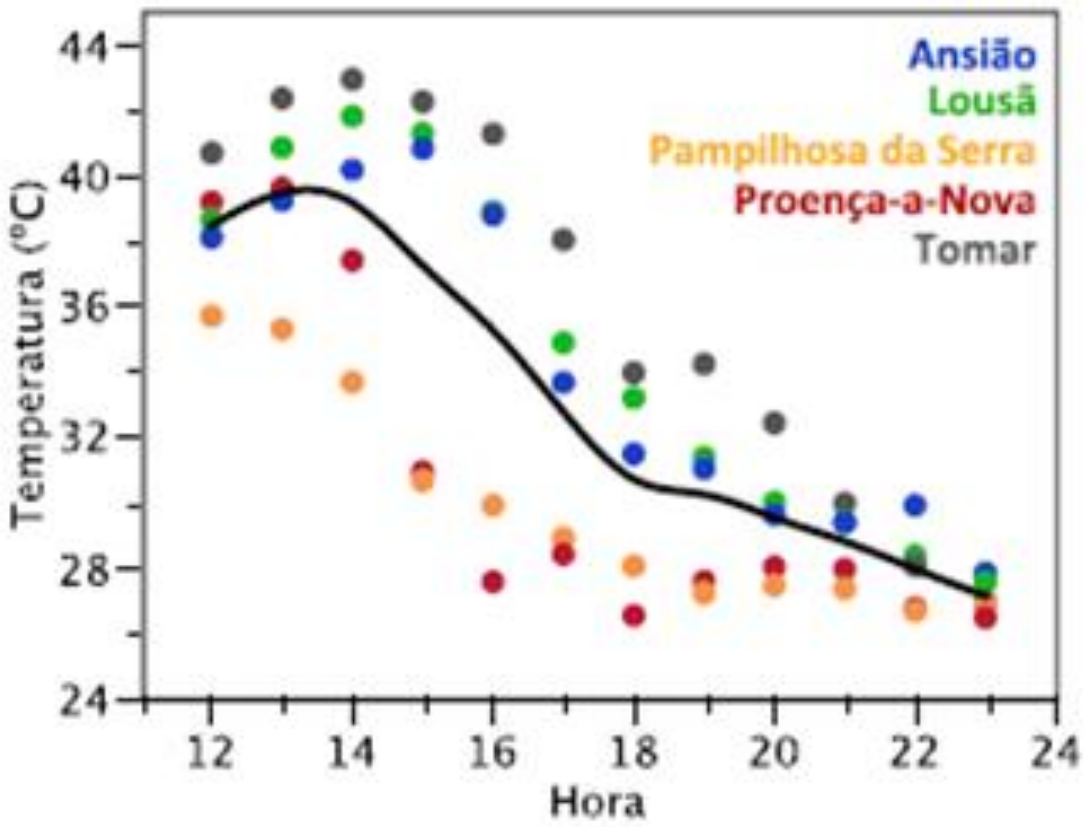
Precipitation per year



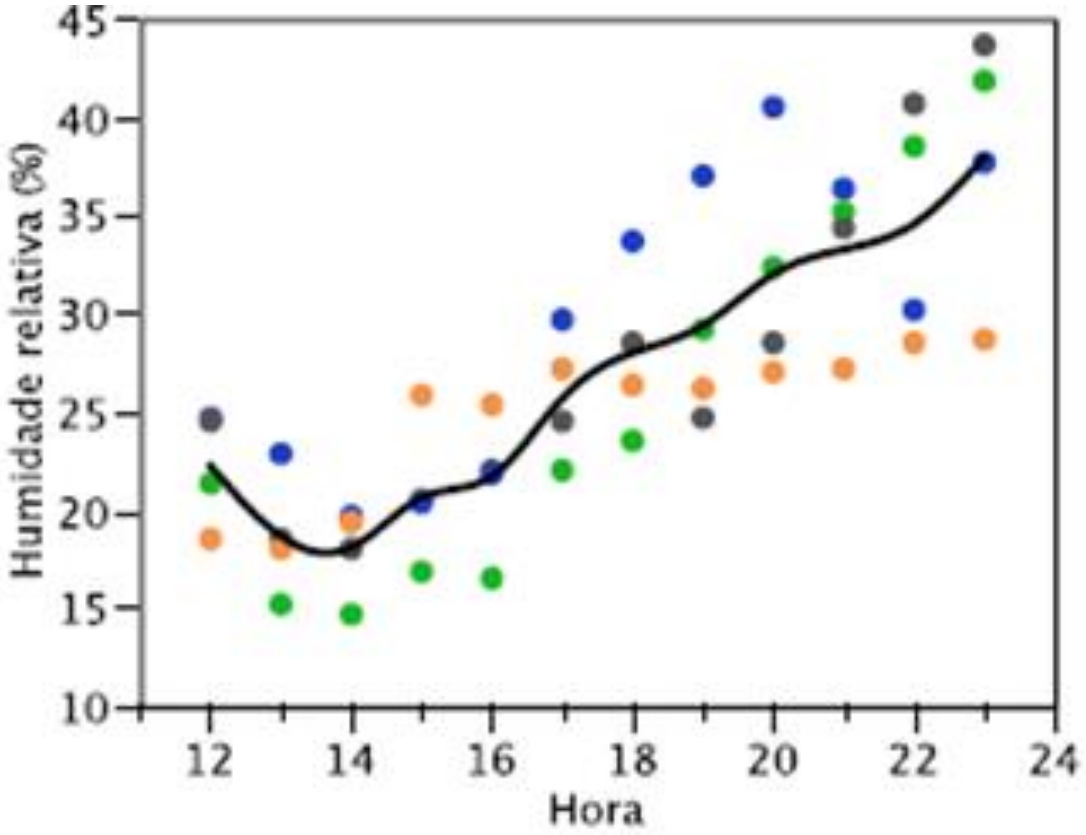
Source:Adai/LAETA, 2017

1. Climatic and weather conditions

Temperature during 17th of June



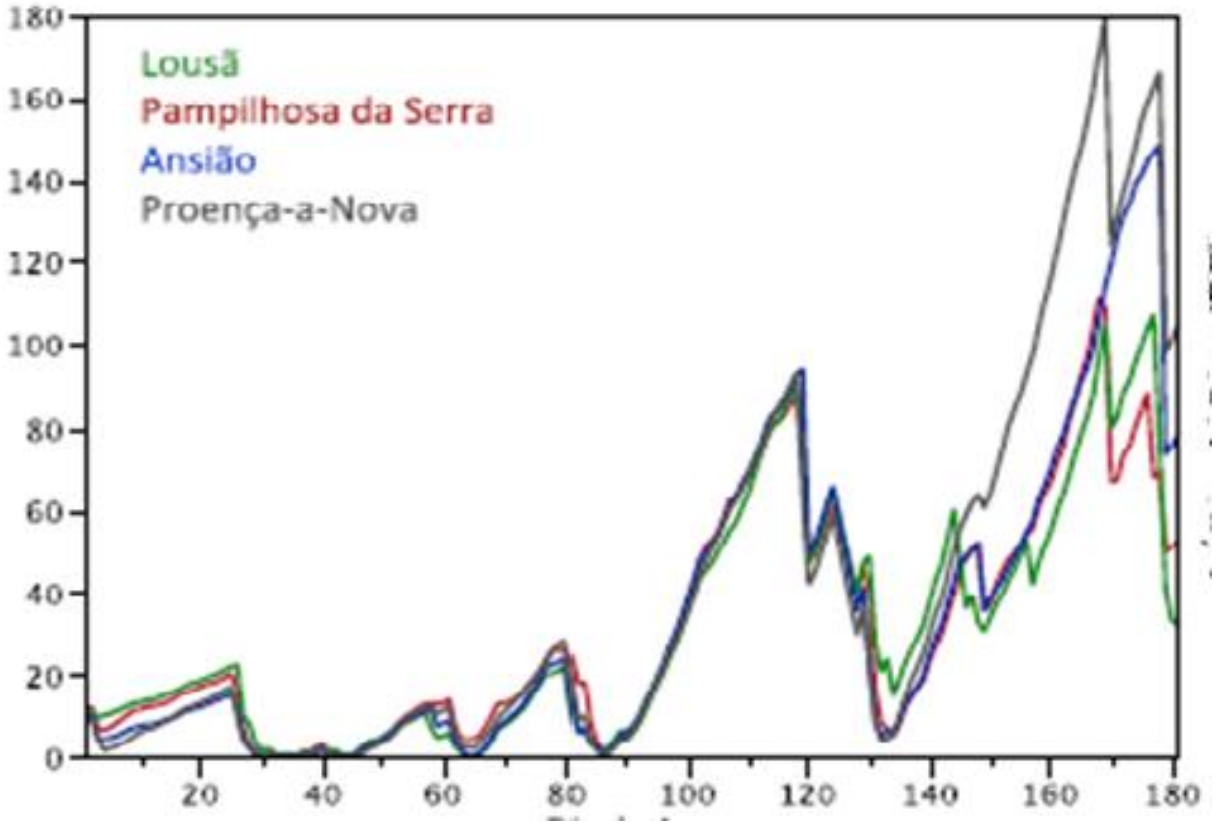
Humidity during 17th of June



Source:Adai/LAETA, 2017

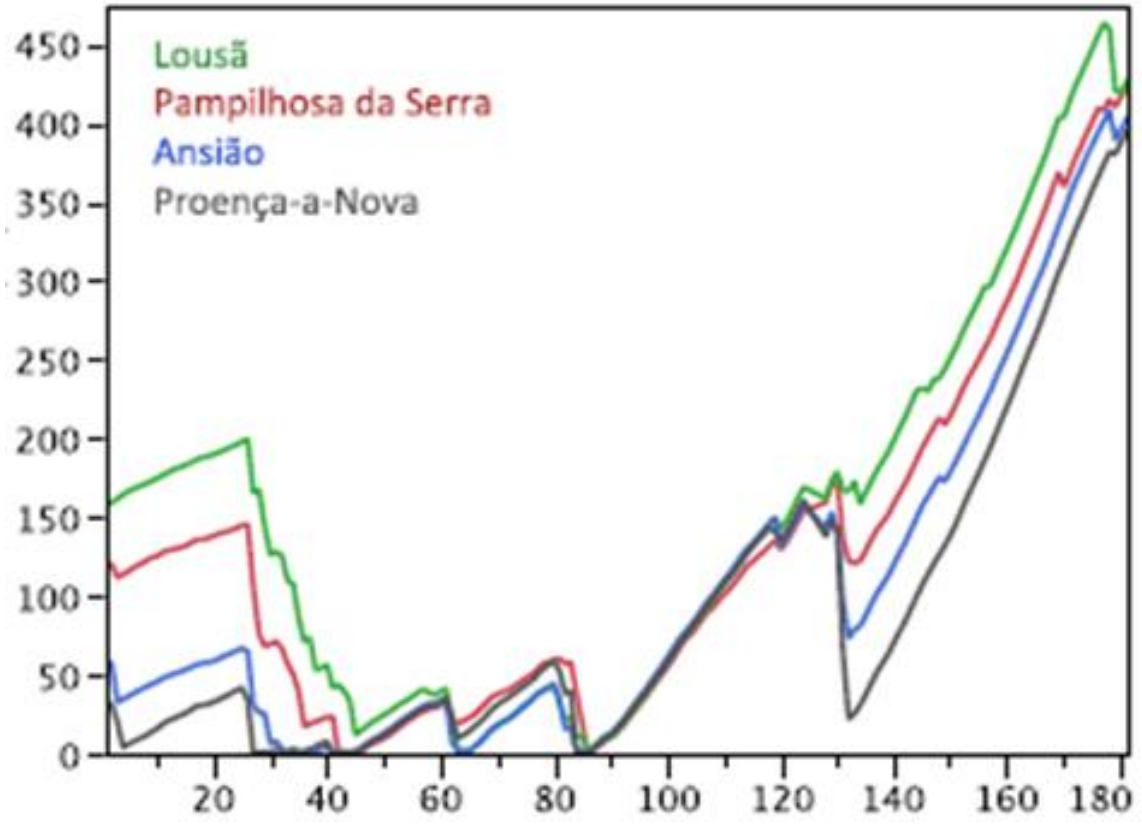
1. Climatic and weather conditions

Duff Moisture Code (DMC)



Days of the year

Drought Code (DC)

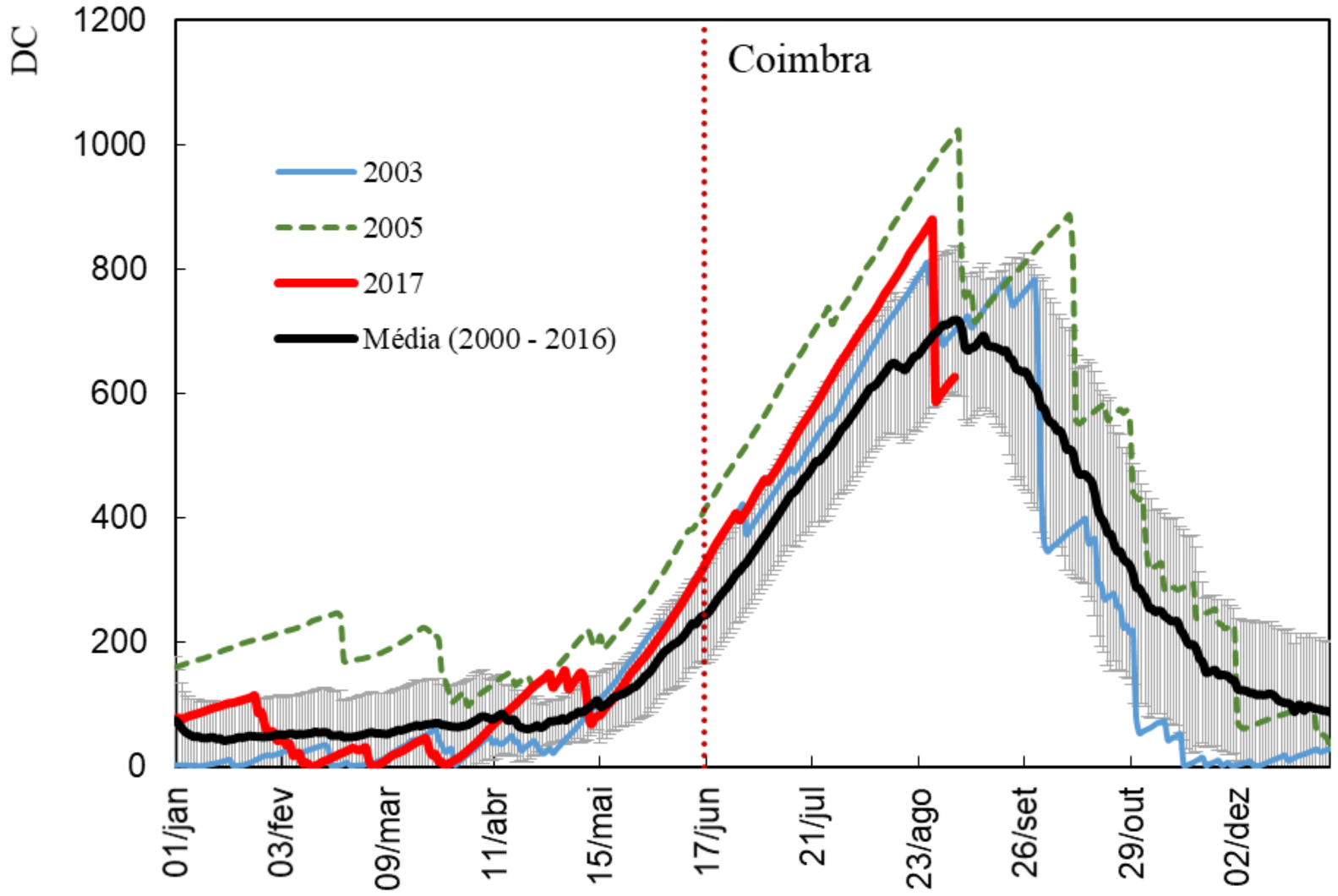


Days of the year

Source:Adai/LAETA, 2017

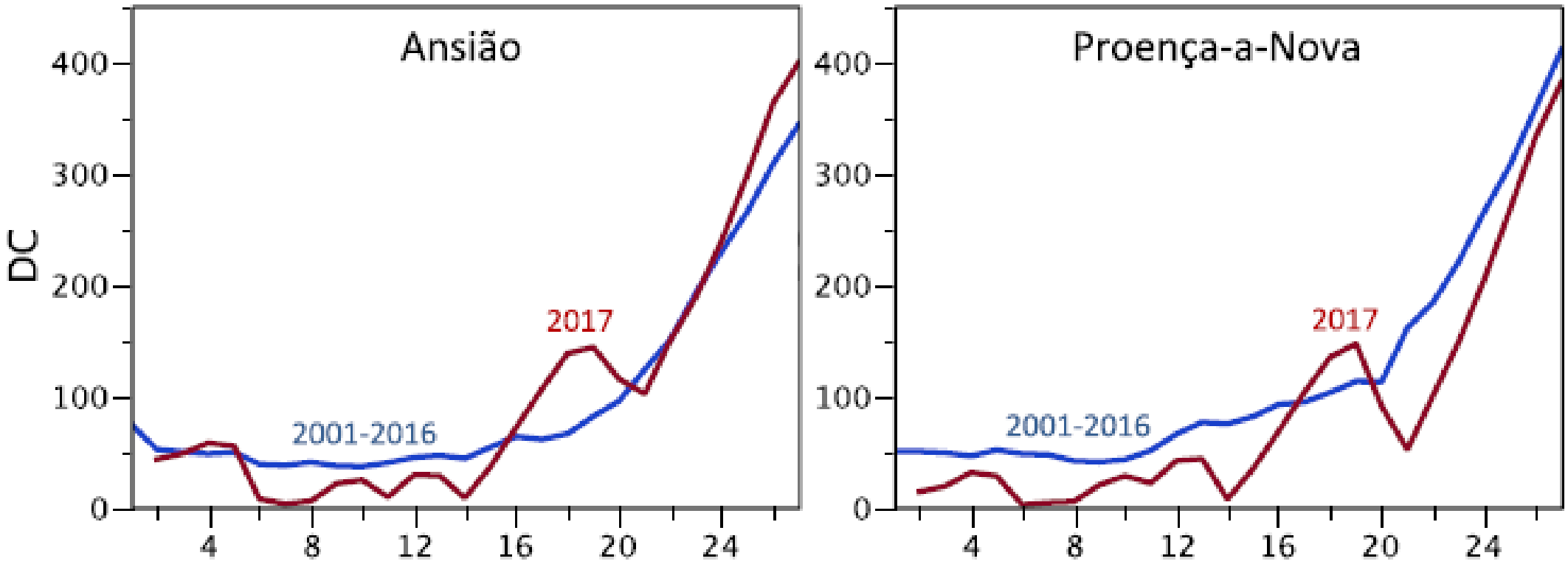
1. Climatic and weather conditions

Evolution of DC of Coimbra, 2017 (Data IPMA)



Source: ADAI/LAETA, 2017

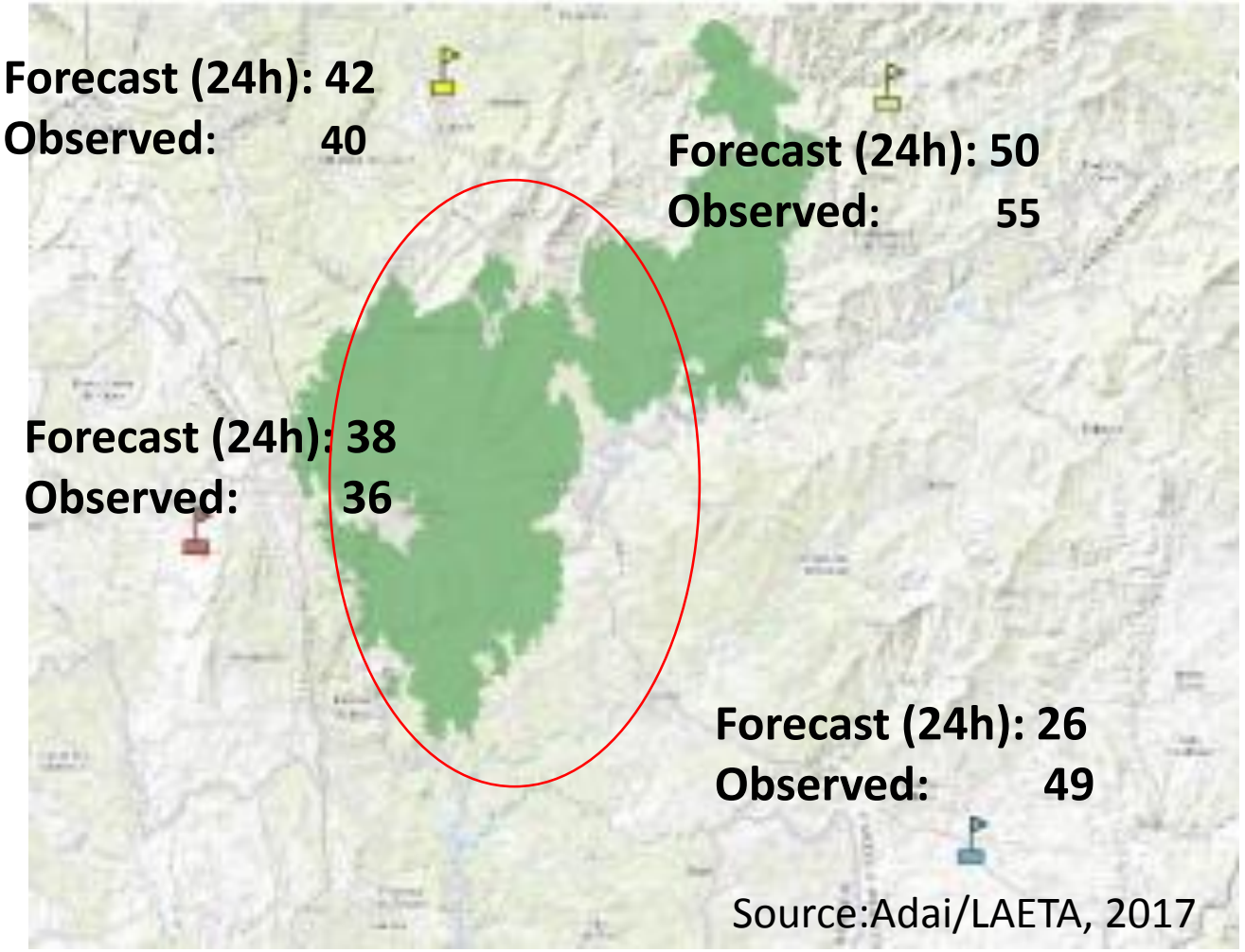
1. Climatic and weather conditions



Source:Adai/LAETA, 2017

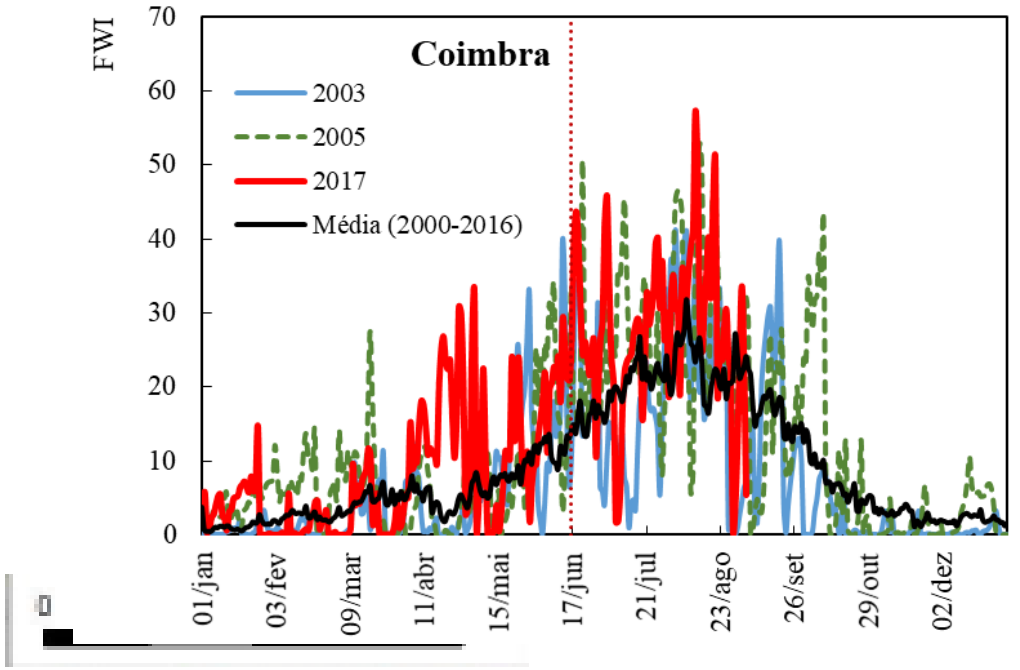
1. Climatic and weather conditions

FWI: forecast *vs* observed values



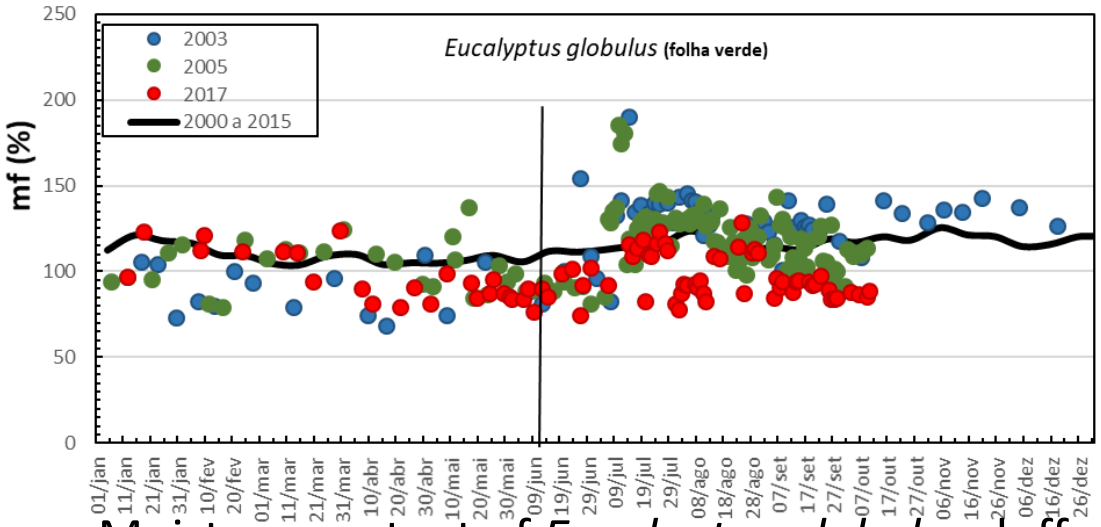
Fire danger classes in EFFIS

FWI range	Fire danger level (and approximate expected fire behavior)
<5.2	Very low. Fire spread unlikely, no control problems
5.2 – 11.2	Low. Surface fires can be controlled with hand tools
11.2 -21.3	Moderate. Vigorous surface fires
21.3 – 38.0	High. Intermittent crowning in forests
38.0 – 50.0	Very high. Onset of "blow ups". In EU 75% of large fires (burned area > 500 ha) occurred when FWI > 38
> 50.0	Extreme. Conflagrations. Most catastrophic events (burned area> 5000 ha) are in this class

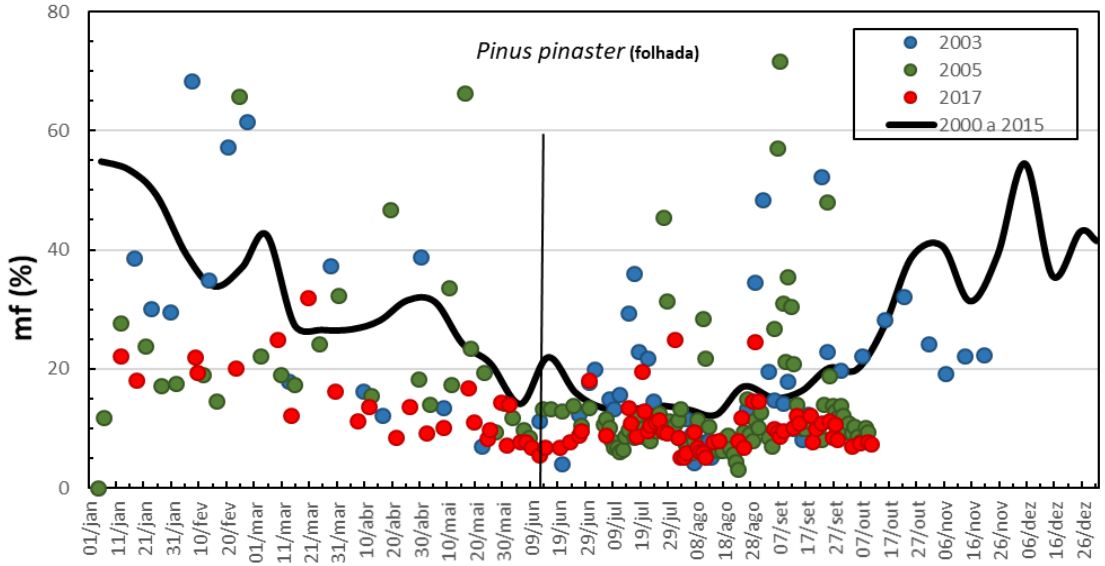


1. Climatic and weather conditions

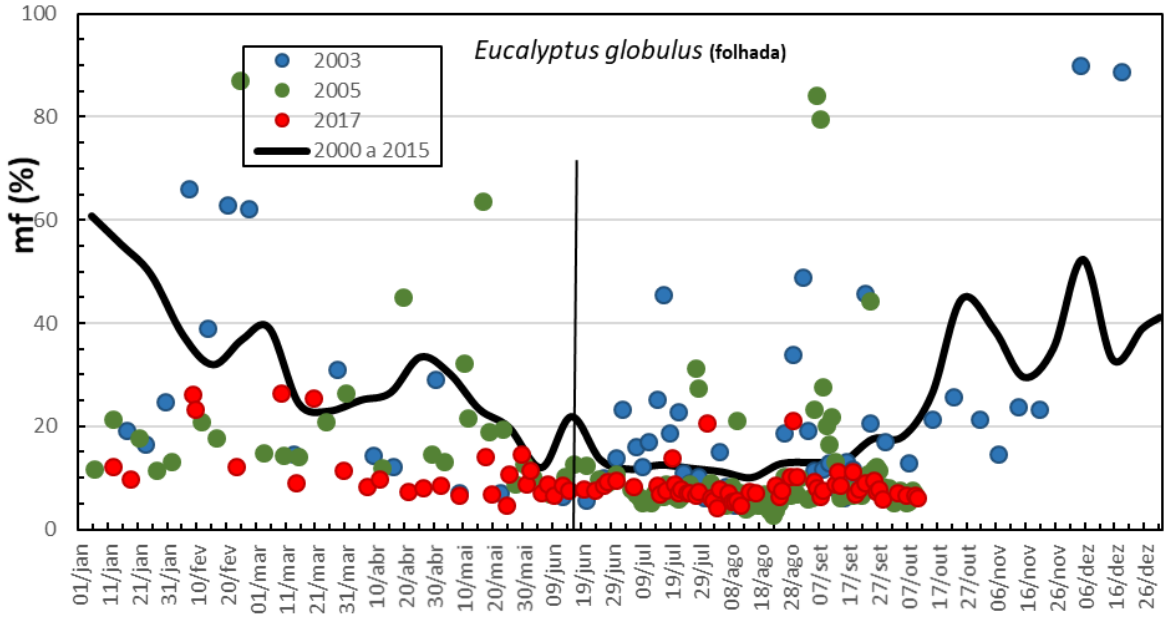
Moisture content of *Eucaluptus globulus* green leaves



Moisture content of *Pinus pinaster* duff



Moisture content of *Eucalyptus globulus* duff



Source: ADAI/LAETA, 2017

2. Landscape

- The dominant land use is forest (>50%); mainly plantations of Eucalyptus and Pinus pinaster with high continuity in a rough relief

- Broadleaves and deciduous forest patches are very small and residual, appearing mainly on river banks and close to agricultural areas. and villages

- The second dominant land use is shrubs but with the decrease of husbandry there is high level of fuel load

- Agricultural area is residual (represents < 10%)

3. Wildfire management

- The wrong perception of the potential of this fire to turn into an extreme wildfire explains the reduced resources attributed to this fire notwithstanding the extreme weather conditions
- Some resources affected to Pedrogão Grande fire never arrived there or arrived but quickly were redirected to other fires
- Given the date of the Pedrógão Grande, fire preceding the start of the critical period, the available firefighting resources were still limited
- Collapse of the communication system (SIRESP)
- High pressure of politicians and media over the operational forces that where acting in an unusual and extremely difficult scenario
- The presence of politicians in the operational decision room diverted the attention of the command and control chain
- Misevaluation, failures and errors in the command and control chain

4. Social dynamics

Depopulation of rural areas

In last 60 years, rural population decreased at least 50%

Population ageing

Lack of working force

Abandonment of agriculture

Decrease of grazing and forestry activities

Increase of fuel load

4. Social dynamics

Dense network of small settlements in rough relief

very low number of inhabitants (20 and 100 inhabitants)

In some settlements only elderly people live, without capacity to maintain agricultural and forestry activities

The extent of the agriculture buffer involving the villages decreases

The abandonment of agricultural fields facilitates the fire spread and its entrance into the villages

Poor budgets do not allow prevention measures and a convenient houses maintenance

Social marginalization

Poor safety and difficult evacuation of people in case of a fire

4. Social dynamics

Presence of residents from urban areas unaware of fire risk

Former residents that after leaving the active life return to their village of origin.
They lost the knowledge about wildfire

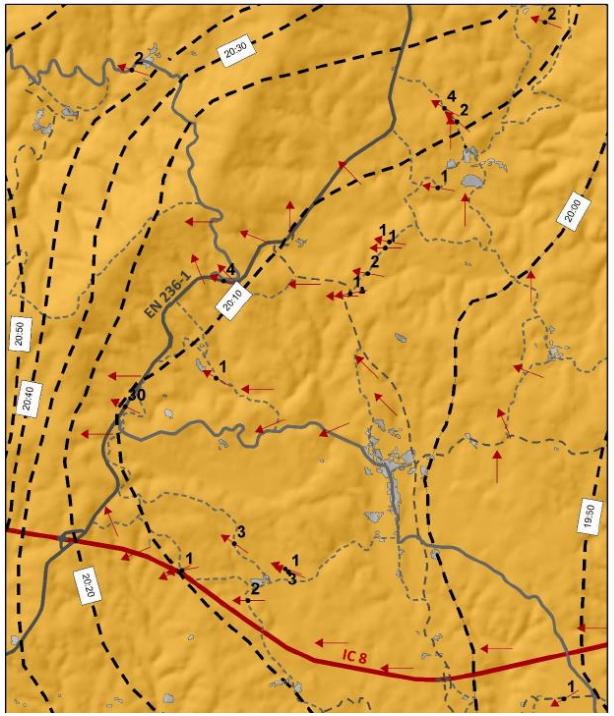
Tourists unaware of fire risk

Lack of preparedness

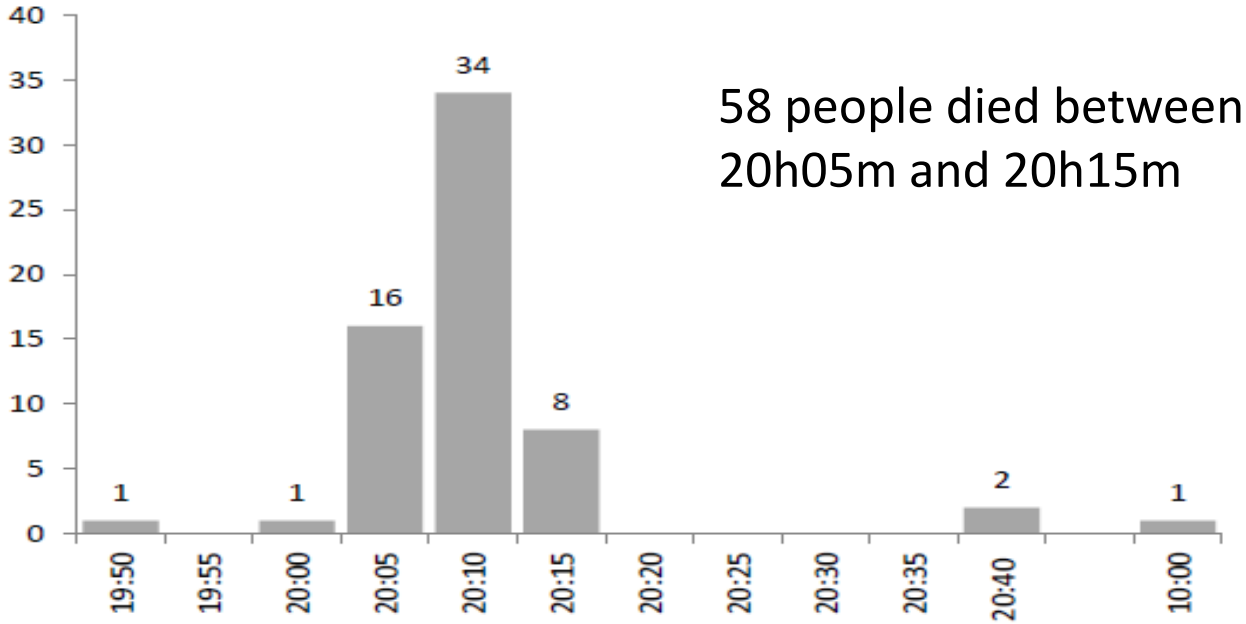
Increased vulnerability

High level of losses and damage

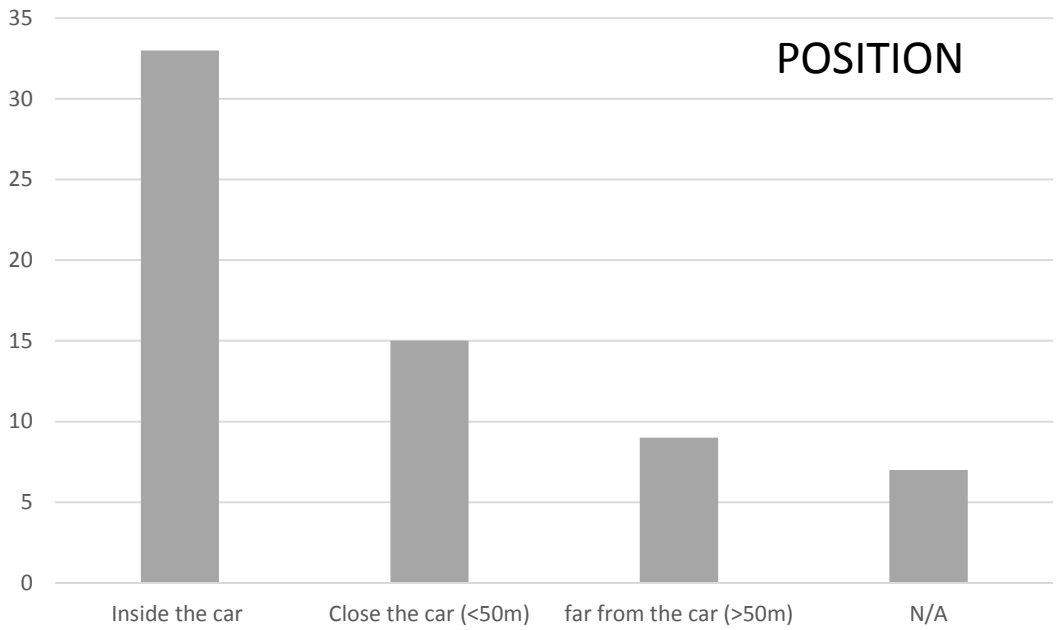
3. The social impacts of PG wildfire

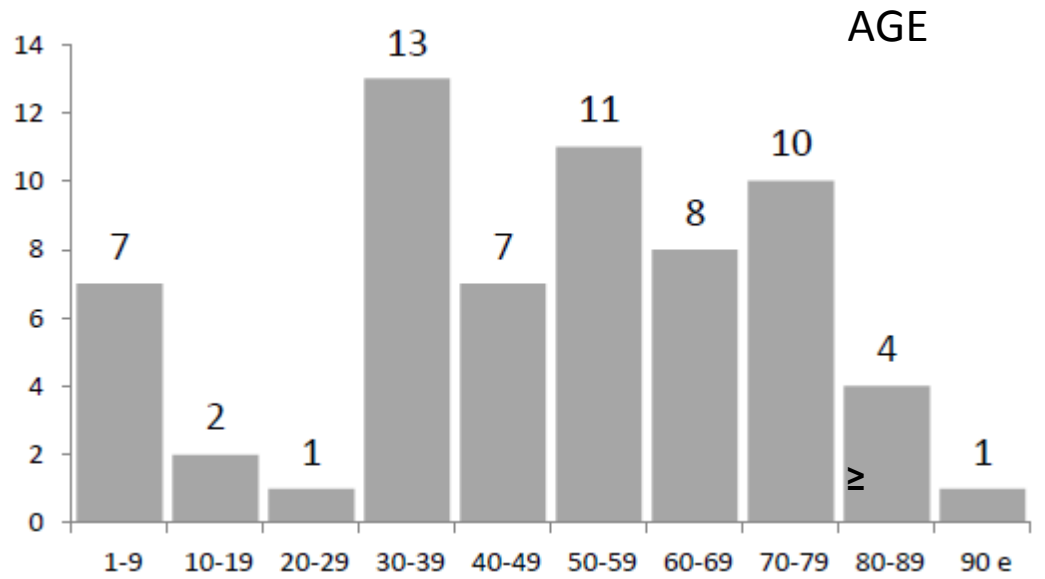


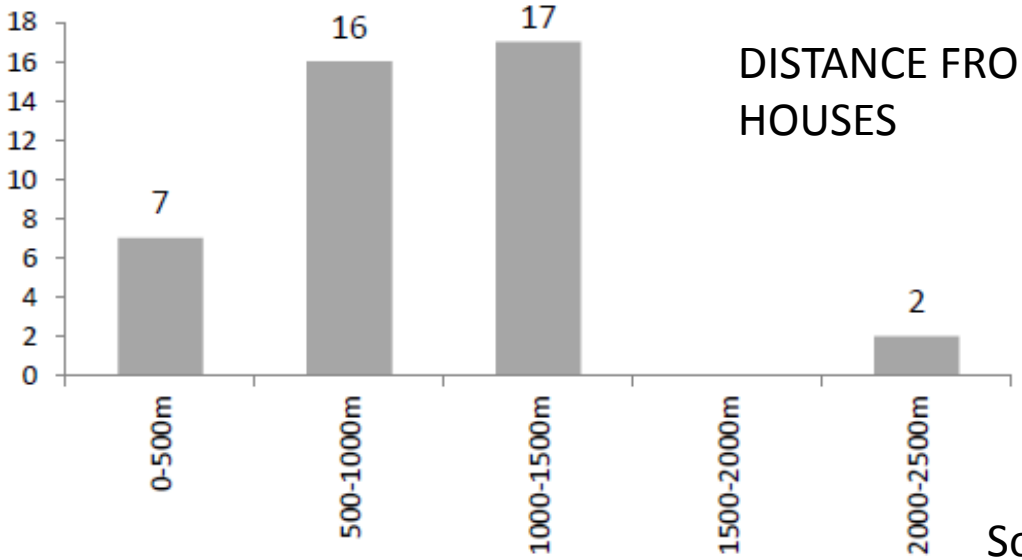
Source: CTI, 2017



58 people died between 20h05m and 20h15m

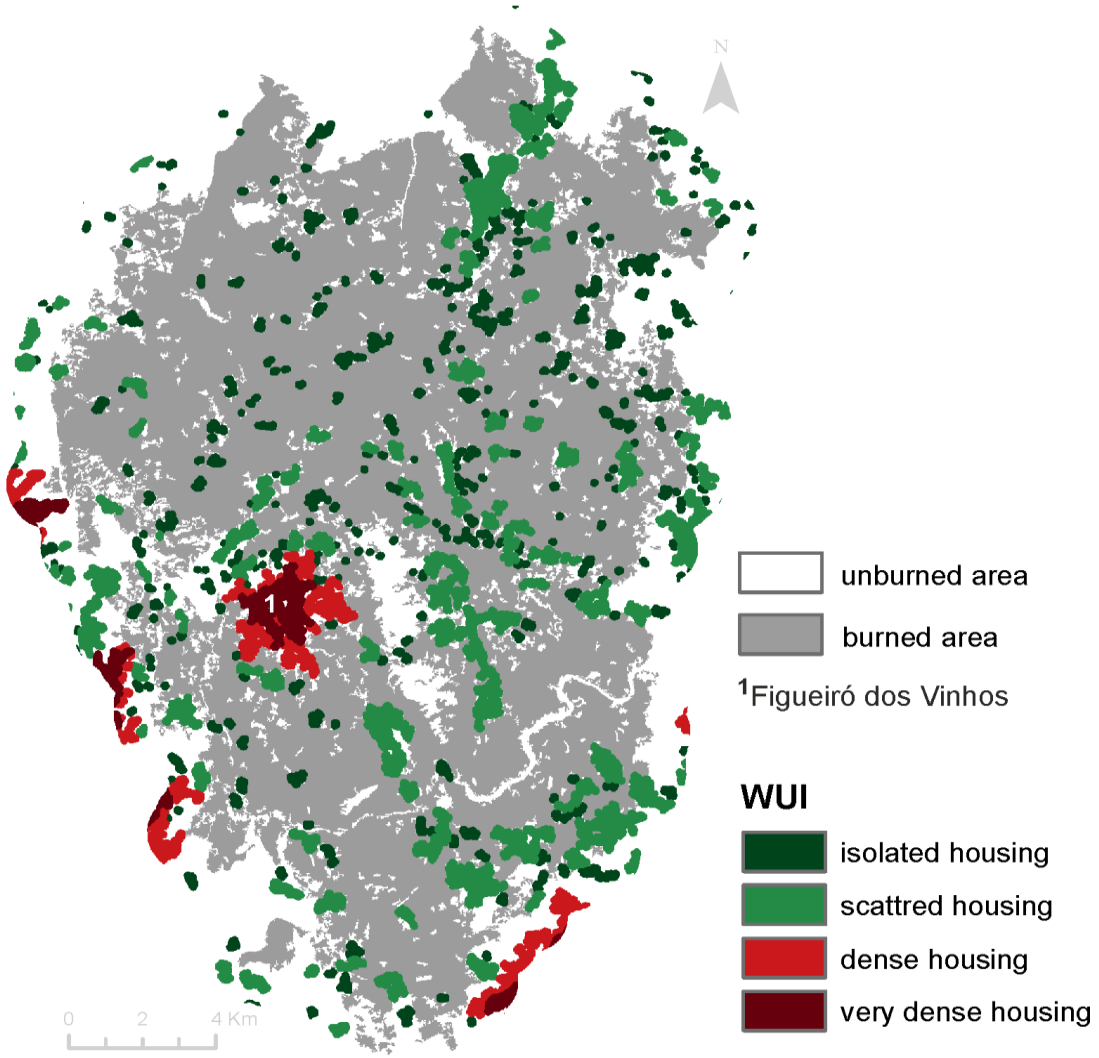






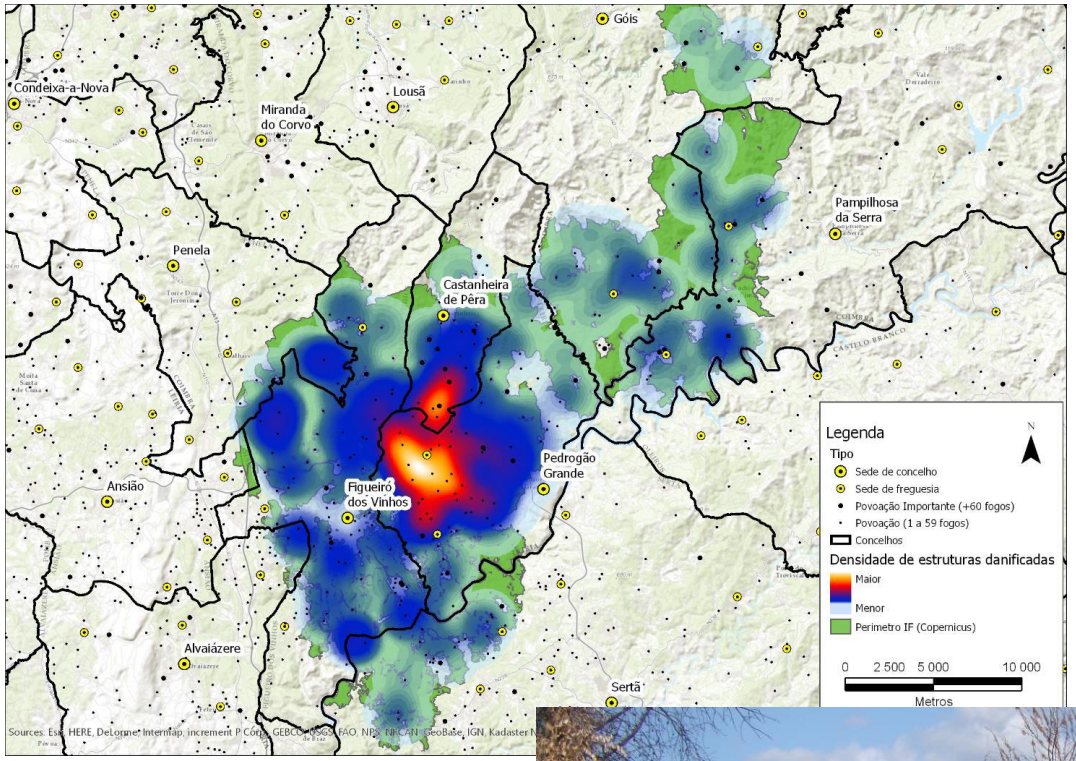
Source: CTI, 2017

- Extent of the WUI - 3,832.94 ha
  - Burned area - 2,126.0 ha
  - Unburned area - 1,706.9 ha



Source: Tedim, Royé, Bouillon, Correia, Leone, 2018

1043 structures affected



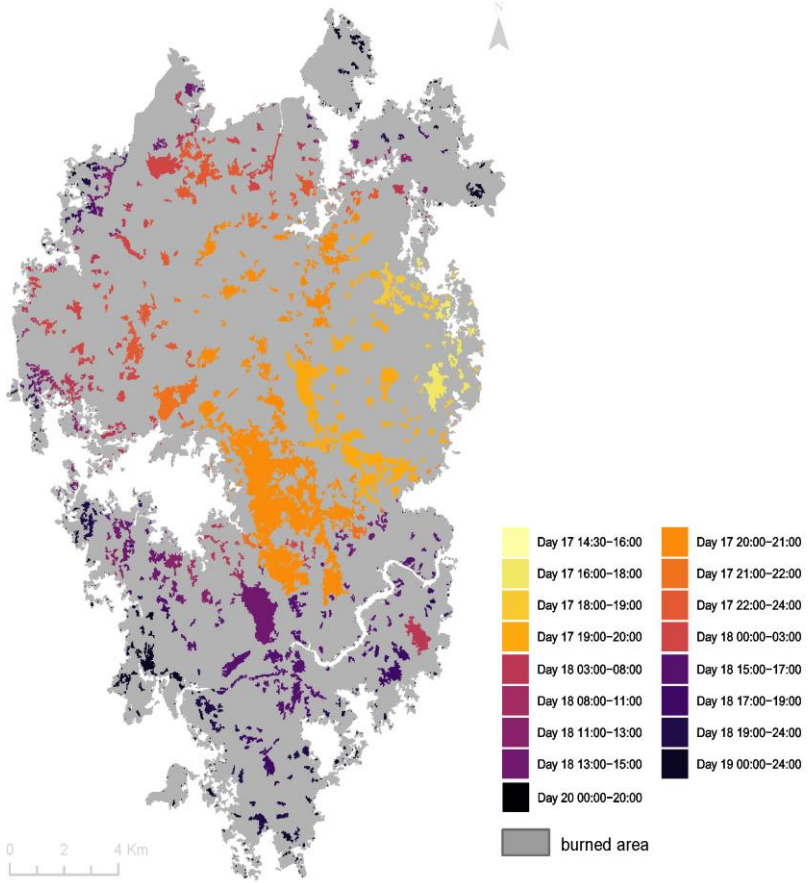
Source:Adai/LAETA, 2017

Number of permanent houses - 139
Number of second houses – 124
Factories/comercial - 16
Buildings related with agricultural activity - 497
Abandonned houses – 190
Other structures - 77

WUI within Pedrógão Grande wildfire perimeter: survivors

- Inside stone or brick houses
- Water tanks for irrigation or laundry

WUI within Pedrógão Grande wildfire perimeter: survivors



Unburned áreas (UPs) 2039 occupying 3850 ha

Vegetation UPs WUI UPs Mix UPs

Source: Tedim, Royé, Bouillon, Correia, Leone, 2018

4. Why PG wildfire turned into a disaster?

EVIDENCE: What scared people was the noise, the "balls of fire" everywhere, the heat. Even people that faced a fire before had never seen such extreme manifestations of fire behavior (Adai/Laeta, 2017)

DIRECT CONDITIONS

- **Lack of wildfire risk awareness**

  . Understand what is fire hazard and the different categories of wildfires in order to understand what to do

  . Identify the prevention and mitigation measures

- **Lack of people physical and psychological preparedness**

  . Understand the different dimensions of individual and community preparedness

- **Lack of adequate crisis communication**

  . Adequate and accurate information to support the definition of wildfire management

- **Lack of prevention measures: fuel management and defensible space,**

INDIRECT CONDITIONS

- **Wrong wildfire management paradigm and policies**

  . The narrow sighted vision of the wildfire problems with the adoption of a paradigm of "war against fire" ignoring the limits of suppression activities

  . The recurrent opinion that wildfires are a civil protection issue instead of understanding that they are mainly the result of a land management and development issues, so requiring different strategies and measures to contain the problem

  . Wildfire policies defined in response to events and determined by political cycles (electoral periods)

  . The lack of continuity of wildfire management policies supported by a sound evaluation process

  . The top-down "one fits-all model" of wildfire management policy, relying on mandatory measures from central government agencies

  . No consideration of the social context where wildfires occur

  . Weakness in wildfire management governance model

  . The tools used are the conventional ones (i.e. legislation and regulations) ignoring the traditional knowledge of the inhabitants

INDIRECT CONDITIONS

- **A wrong wildfire management paradigm and policies (continuation)**

  . Lack of collaborative work between central fire agencies, municipal governments and local communities

  . The loss of the technical knowledge developed for decades by the Forest Service and the minimization of the its role and competences

  . The restrictive legislation of the use of fire as a management tool

- **Difficulty in transferring scientific knowledge to enhance wildfire management policies and practices**

- **Marginalization of rural areas**

  . Unwise spatial planning focus on urban areas

  . Lack of continuity and soundness of rural development policies

  . Unwise policy of afforestation based on continuous cover of exotic and highly flammable species

5. Final remarks

Pedrógão Grande was an extreme wildfire event (EWE) because it was a pyro-convective phenomenon overwhelming capacity of control (fireline intensity currently assumed ≥ 10,000 kWm−1; rate of spread >50 m/min), exhibiting spotting distance > 1 km, and erratic and unpredictable fire behavior and spread.

But the disaster could have been avoided

A WILDFIRE DISASTER IS NOT AN ECOLOGICAL INEVITABILITY

BUT

ALWAYS A SOCIAL CONSTRUCTION

References

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Thank you for your attention!

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