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

Fantina Tedim
University of Porto, Portugal
Charles Darwin University, Australia
Pedrógão Grande wildfire: Portuguese society in incredulous and shock state

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of fatalities</th>
<th>Civilians</th>
<th>Firefighters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td></td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>1985</td>
<td></td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>1986</td>
<td></td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td>65</td>
<td>1</td>
</tr>
</tbody>
</table>

The previous **worst single wildfire events** in Portugal

<table>
<thead>
<tr>
<th>Year</th>
<th>Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>21</td>
</tr>
<tr>
<td>2005</td>
<td>22</td>
</tr>
<tr>
<td>2012</td>
<td>13</td>
</tr>
<tr>
<td>2017</td>
<td>112</td>
</tr>
</tbody>
</table>

The previous **worst years** in terms of fatalities
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
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

<table>
<thead>
<tr>
<th>Time interval, burned area during the interval</th>
<th>Environmental conditions</th>
<th>Fire behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>17th June 14:30-16:00 25 ha</td>
<td>Very low fuel moisture (~4%) Low wind velocity with an increase of velocity</td>
<td>ROS - 0.47 km/h FLI – 2500 – 7000 kW/m</td>
</tr>
<tr>
<td>17th June 16:00 – 18:00 390.79 ha</td>
<td>Fuel moisture increasing. Velocity of wind increase, high convective instability</td>
<td>ROS – 1.2 Km/h FLI – 6,000 – 18,000 kW/m Spotting activity</td>
</tr>
<tr>
<td>17th June 18:00 – 19:00 794.88 ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17th June 19:00 – 20:00 2588.65 ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17th June 20:00 – 21:00 4458.57 ha</td>
<td>Downburst 20:10 Possible Downburst 20:30 High spotting activity</td>
<td></td>
</tr>
</tbody>
</table>

Source: CTI, 2017

Source: ADAI/LAETA, 2017

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**Situation at 18h**

2nd ignition

1st ignition -
<table>
<thead>
<tr>
<th>Time interval, burned area during the interval</th>
<th>Environmental conditions</th>
<th>Fire behavior</th>
</tr>
</thead>
</table>
| 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 – 60,000 kW/m |

Source: Escola Tecnológica de Pedrógão Grande; Adai-LAETA, 2017
<table>
<thead>
<tr>
<th>Time interval, burned area during the interval</th>
<th>Environmental conditions</th>
<th>Fire behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>17th June 20:00 – 21:00 4458.57 ha</td>
<td>Downburst 20:10</td>
<td>ROS: 5.3 km/h</td>
</tr>
<tr>
<td></td>
<td>Possible Downburst 20:30</td>
<td>For 10 minutes 15.3 km</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High spotting activity</td>
</tr>
<tr>
<td>17th-18th June 21:00 – 03:00 5,316 ha</td>
<td>Lower temperature and higher humidity</td>
<td>ROS – 1.2 km/h</td>
</tr>
<tr>
<td>18th June 3:00-8:00 1,818.62 ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18th June 8:00 – 13:00 1,733.13 ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18th June 13:00 – 15:00 1,443 há</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18th June 15:00 – 17:00 3,369 ha</td>
<td></td>
<td>ROS: 3.8 km/h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FLI: 40,000 kW/m</td>
</tr>
<tr>
<td>Fire Category</td>
<td>FRP* (kWm⁻²)</td>
<td>ROS (m/min)</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Normal Fires</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>&lt;500</td>
<td>&lt;5</td>
</tr>
<tr>
<td>2</td>
<td>500–2000</td>
<td>&lt;15</td>
</tr>
<tr>
<td>3</td>
<td>2000–4000</td>
<td>&lt;20</td>
</tr>
<tr>
<td>4</td>
<td>4000–10,000</td>
<td>&lt;30</td>
</tr>
<tr>
<td>Extreme Wildfire Events</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>10,000–30,000</td>
<td>&lt;150</td>
</tr>
<tr>
<td>6</td>
<td>30,000–100,000</td>
<td>&lt;300</td>
</tr>
<tr>
<td>7</td>
<td>&gt;100,000</td>
<td>&gt;300</td>
</tr>
</tbody>
</table>

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 and 27th); 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)

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)

Drought Code (DC)

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

<table>
<thead>
<tr>
<th>Forecast (24h)</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>40</td>
</tr>
<tr>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td>38</td>
<td>36</td>
</tr>
<tr>
<td>26</td>
<td>49</td>
</tr>
</tbody>
</table>

Source: Adai/LAETA, 2017

Fire danger classes in EFFIS

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

Moisture content of *Pinus pinaster* duff

Moisture content of *Eucalyptus globulus* green leaves

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 were 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
58 people died between 20h05m and 20h15m

Source: CTI, 2017
AGE

Inside the car | Close the car (<50m) | far from the car (>50m) | N/A
--- | --- | --- | ---
7 | 2 | 1 | 1

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

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

Source: Adai/LAETA, 2017
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 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


Thank you for your attention!

ftedim@letras.up.pt