Wildfires in Portugal Geospatial Analysis

Project Proposal

by Helder Reis- 2019

Table of Contents

Background Information....1
Research Question....2
Potential Data Sources....3
Analysis Methods....4
Expected Results....4

Background Information

Wildfires are a big problem in many parts of the world, including Southern Europe.

According to a recently released WWF Report "*Portugal is by far the Mediterranean country that has suffered the most due to forest fires: in the last 30 years, it has faced more fire incidents with more hectares burned. 35% of the region's fire incidents and 39% of the area affected each year occur in Portugal. An average of 3% of Portugal's forests burn each year.*"

2017 was especially tragic in Portugal, where besides the great amount of burned forest there were over 100 casualties - 62 in one night alone .

While there are a number of reports on the burned area, the question of everyones mind is "why" - **why are there so many wildfires in Portugal?**

The question is raised not only in Portugal but also in international media and the fore-mentioned WWF report.

As with most complicated issues there doesn't seem to be one but a mix of potential causes:

- **Climate Change**: temperatures have been raising, rainfall has been declining. One of the most visible effects is that the fire season is no longer limited to July and August but goes from June to October. Also the fire patterns are altered, with the low humidity in the air, very strong winds, a very dry vegetation causing fires with unseen virulence.
- **Rural Abandonment and Depopulation:** the strong depopulation and ageing of the population (Portugal ranks 3rd in the Countries With The Elderly Population In The World report), especially of the rural areas in the interior and mountains has caused agricultural abandonment and the consequential change in vegetation, replacing cultivated and herding areas with shrubs.

- **Forest Ownership and Management:** around 85% of the woodland in Portugal is privately owned and highly fragmented, with privately owned plots averaging only five hectares (12.7 acres). This factor along with the rural abandonment makes it difficult to have an effective forest management and causes the unclean forests to be full of fuel for the fire and an obstacle for the emergency teams. Lately the Government has been trying to push the landowners to clean their part (imposing fines if they don't) and ultimately pushing it on local councils, which has not been a peaceful subject.
- **Forest Type:** the composition of the forest in the last decades has changed from the native oak, chestnut and olive trees to the more rapidly growing and lucrative pine and eucalyptus trees - the last one is highly inflammable and has such a high consumption of ground water that it can dry up water sources such as rivers and springs. Since it supplies the paper industry, eucalyptus is planted in high density (up to 70k tress/hectare when the recommended density is 3k/hectare) and extensive areas, being blamed by many for the current situation.
- **Emergency Response:** Portugal has years of experience but seems short on equipment and finances. While the need for professional firefighters has been on the table for years, most of the firefighters are volunteers, relying on old vehicles and almost all of the firefighting aircrafts are rented to private companies or sent by other countries as part of the European Firefighting Fleet - these are specially important given the hilly terrain that is virtually inaccessible by land vehicles. This year 158 fire lookouts were added to the existing 72 but early detection is still an issue, with many fires having spread beyond control by the time the fight starts.
- **Criminal Activity and Negligence:** it's hard to prove the role of criminal activity tied to speculation with prices of land and wood, especially since 54% (European average is 28%) of the wildfires in Portugal are due to unknown causes. The Government has been intervening in the prices of burned wood to avoid speculation and many suspect of "criminal hand". Negligence is attributed to 26% of fires due to people using fire for clearing of fields, burning of debris and recreation (barbecues, camp fires, fire stoves, etc.). In any event, an estimated 99% of wildfires are due to human causes.

Research Question

Hence, the question and scope for this project can be refined, from "Why are there so many wildfires in Portugal?" to **"Can we find a correlation between these factors and the wildfires in Portugal?".**

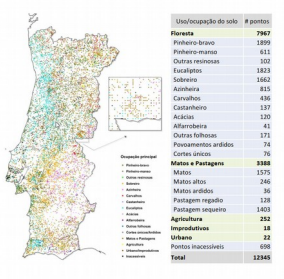
Potential Data Sources

During the initial investigation I found some potential data sources related to some of the identified factors:

- **Climate Change:**
  - PORDATA has information on temperature and rainfall
  - The European Environment Agency has a 424 page report on "Climate change, impacts and vulnerability in Europe"
- **Rural Abandonment and Depopulation:**
  - Also on PORDATA Census information is available
- **Forest Ownership:**
  - There is a map on the Proportion of forest land in private ownership, the underlying data is from the European Forest Institute **but at this point there doesn't seem to be enough data available to pursue an analysis on this**.
- **Forest Type:**
  - The Portuguese Nature and Forest Institute has published a preliminary 2019 report that includes a map with the distribution of tree types in the country (page 8). I'll see if I can have access to the underlying data, if not I will try to manually recreate it.
- **Emergency Response:**
  - The location of the firefighters is available from the Civil Protection, including the coordinates. **I couldn't find data on the human resources, vehicles and aircraft.**
  - On the IGEO site there is a map of fire lookouts and a visibility map but both are from 2002. I will try to get in contact with them to see if I can get updated locations, if not I'll work with those.
- **Criminal Activity and Negligence:**
  - Unfortunately I haven't found any publicly available data on this, **so I won't be able to pursue an analysis on this.**
- **Satellite Data:**
  - To calculate the Normalized Burn Ratio (NBR) data from Sentinel-2 and Landsat will be used.
- **Digital Elevation Model (DEM):**
  - A DEM is available at the Copernicus site.

Analysis Methods

- To start with, we need to **calculate the NBR** using the shortwave-infrared and near-infrared portions of the satellite data. We will calculate the NBR at the end of each year, going back probably 5 years (or more, if a particular analysis requires it). Besides a national total, data might also need to be aggregated by districts since the census and firefighters data is also district based.
- We need an historical evolution of the **average temperature** per year and district, and eventually a national averaged one. Using a graphic we will compare the average temperature with the NBR to find a correlation between higher temperatures and burned areas. The same will be done for the **rainfall**.
- We will calculate the **historic population density** per district and compare it with the NBR to see if there is a correlation between depopulation and wildfires.
- If we can't get data on **the soil occupation** (types of trees) I will try to use the existing image overlapped on a map and an unsupervised classification to recreate it. Given the image is a collection of different coloured points on a map this could work. We will then group it using a Proximity analysis and overlap it with the NBR to see if we find a correlation between certain types of trees and the location of burned areas.



Uso/ocupação do solo	# pontos
Floresta	**7967**
Pinheiro-bravo	1899
Pinheiro-manso	611
Outras resinosas	102
Eucaliptos	1823
Sobreiro	1662
Azinheira	815
Carvalhos	436
Castanheiro	137
Acácias	120
Alfarrobeira	41
Outras folhosas	171
Povoamentos ardidos	74
Cortes únicos	76
Matos e Pastagens	**3388**
Matos	1575
Matos altos	246
Matos ardidos	36
Pastagem regadio	128
Pastagem sequeiro	1403
Agricultura	**252**
Improdutivos	**18**
Urbano	**22**
Pontos inacessíveis	698
Total	**12345**

- Since the location of firefighters is not on a list, I might have to collect a **list of the fire departments** using a web scraper written in Python. Once we have the locations, create a Proximity buffer to see if there are areas without a fire department in less than 50 km and overlap it with the NBR map.
- Similarly we can either use the existing or an updated **fire lookout location** map to create a visibility map using the DEM and find blind spots. Contrasting these with the NBR map might not be useful since we have no guarantee the fire originated there.

Expected Results

We expected to find at least some **positive correlation between burned area and years with high temperatures and negative correlation with low rainfall**. In years were these 2 factors are combined we expect to see a strong correlation.

We also expect to see **a negative correlation between population density and wildfires**, although this issue is more complicated than that. Obviously urban areas have less forest and hence less wildfires. Our hypothesis is that **areas where the population density has declined over the years have seen an increase in wildfires**.

We expect to see a **higher NBR in areas occupied by eucalyptus**, followed by the ones by pines and lastly by autochthonous trees such as oaks.

We expect to see some areas apparently not covered by firefighters, but without information on the number of the human resources, vehicles and a road analysis, as well as where and how many aircraft there are, **this analysis is not likely to be conclusive and could well be a project on its own.**

We expect to see some blind spots not covered by fire lookouts, but without info where the fires actually started and given human surveillance is being replaced by drones, **this information might not be relevant**.

If I'm running out of time during the project **I might drop the analysis related to the emergency response** (firefighters and fire lookouts), since the data is insufficient for a meaningful analysis and the focus of the project is why wildfires break out in the first place.

Thank you for reading,

Helder