



# Determination of forest fire causes in Portugal (1996-2010)

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Arson fires  
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## Abstract

The main goal of this study is to analyse the most important causes affecting fire ignitions in Portugal mainland, between 1996 and 2010. The forest fire database was provided by the Portuguese Government Forest Services (National Forest Authority, AFN), that group the causes in six main categories (negligent usage of fire, accidental, structural causes, incendiary, natural and unknown). The analysis of the causes of the forest fires ignitions shows that the greatest part was not investigated (84%), whilst the knowledge of cause only occurred in 8% of fires. At national level, the results show that incendiary and the negligent usage of the fire are the most important motivations behind forest fires, with almost 40% of the identified causes. At regional scale, fires caused by negligence seems to be more common in the north due to traditional agricultural practices such as pasture renewal, the burning of agricultural and forest debris and hunting practices. In the Alentejo, accidental causes mainly associated with crop harvesting machinery, were the primary reason for the outbreak of forest fires.

## Palabras clave

Causas de ignición  
Incendios provocados  
Incendios forestales  
Uso negligente del fuego  
Portugal

## Resumen

El objetivo principal de este estudio es analizar las causas más importantes que afectan a las igniciones de incendios forestales en Portugal continental, entre 1996 y 2010. La base de datos de incendios fue proporcionada por los Servicios Forestales del Gobierno portugués (Autoridad Forestal Nacional, AFN), que agrupa las causas en seis categorías principales (uso negligente del fuego, accidentales, causas estructurales, incendiarismo, natural y desconocido). El análisis de las causas de ignición de los incendios forestales muestra que su mayor parte no ha sido investigada (84%), mientras que el conocimiento de la causa concreta sólo ocurrió en el 8% de los incendios. A nivel nacional, los resultados muestran que el incendiarismo y el uso negligente del fuego son las motivaciones más importantes, con casi el 40% de las causas identificadas. A escala regional, los incendios causados por negligencia parecen ser la causa más común en el norte del país, debido a las prácticas agrícolas tradicionales, como la renovación de los pastizales, la quema de residuos agrícolas y forestales y, aún, a las prácticas de caza. En la región de Alentejo, en el sur, las causas accidentales, asociadas a las cosechas con maquinaria de recolección, fueron la razón principal para la ocurrencia de incendios forestales.

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## 1 INTRODUCTION

Portugal's number of ignitions and burnt area has increased significantly in recent decades, as in other Mediterranean countries. This rising trend distinguishes, however, Portugal from other southern Member States with the highest number of ignitions and burnt areas, particularly in the central and northern regions. Forest fires therefore constitute one of the most relevant environmental problems (Moreno, 1989; Nunes, 2012) and are frequently considered the major cause of soil degradation and desertification (Rubio, 1987).

At the regional level, the ignition and spread of forest fires result from a complex interaction among ignition causes, weather, topography, and land cover (Rothermel, 1983). During the last decades, the Portuguese forest fire authorities have made great efforts to improve the investigation of the causes of fires ignition, which is integral to a better understanding of patterns of fire occurrence and improved fire prevention measures (Nunes, 2012). Despite these efforts, a substantial percentage of fires still have unknown causes. Accurate origin and cause determination is an essential first step in a successful fire investigation, and successful fire investigations are necessary in preventing unwanted wildfires.

## 2 OBJECTIVES

The main goal of this study is to analyse the most important causes affecting fire ignitions in Portugal. In fact, forest fires occur because of anthropological or natural causes, although the majority of fires around the world are caused by human activity. In addition, a temporal and a spatial pattern of human and natural causes behind wildfire ignitions, at district level, will be discussed.

## 3 METHODS

### 3.1 STUDY AREA

The study area consists of the whole of mainland Portugal (surface area 89,015 km<sup>2</sup>) and is located in the Iberian Peninsula (Figure 1), in the extreme southwest of continental Europe.

The physical environment varies enormously between northern and southern Portugal. This variation is largely explained by the different physiographic characteristics.



Figure 1. Location of the study area.

### 3.2 FOREST FIRE CAUSES CLASSIFICATION

The forest fire database was provided by the Portuguese Government Forest Services (National Forest Authority, AFN). The Forest Services (National Forest Authority) were responsible for the forest fires causes investigation and statistical information until 2006. Forest Services made a codification of the forest fires causes in categories and their respective causes to make uniform the work by the forest fires causes investigators in the field, during the 90s and later in 2000. In 2007, the Forest Service with the collaboration of the Criminal Police and the National Guard, trained agents of the National Guard - Nature and Environment Protection Service, on the Forest Fire investigation process.

The current classification of the forest fires causes is made under a three level structure, which leads to a three-digit code for each fire ignition cause. The higher level (first digit) groups the cause classification in six main categories: 1 – Negligent usage of fire; 2 – Accidental; 3 – Structural causes; 4 – Incendiary; 5 – Natural; 6 – Unknown. The second level (second digit) divides the high categories into smaller groups, identifying common behaviours/activities and the third level (third digit) corresponds to each cause of forest fire ignition.

Only attested causes, with fully confirmed evidences, are recorded. That explains the high percentage of “unknown” causes. The “unknown” causes include fires having a

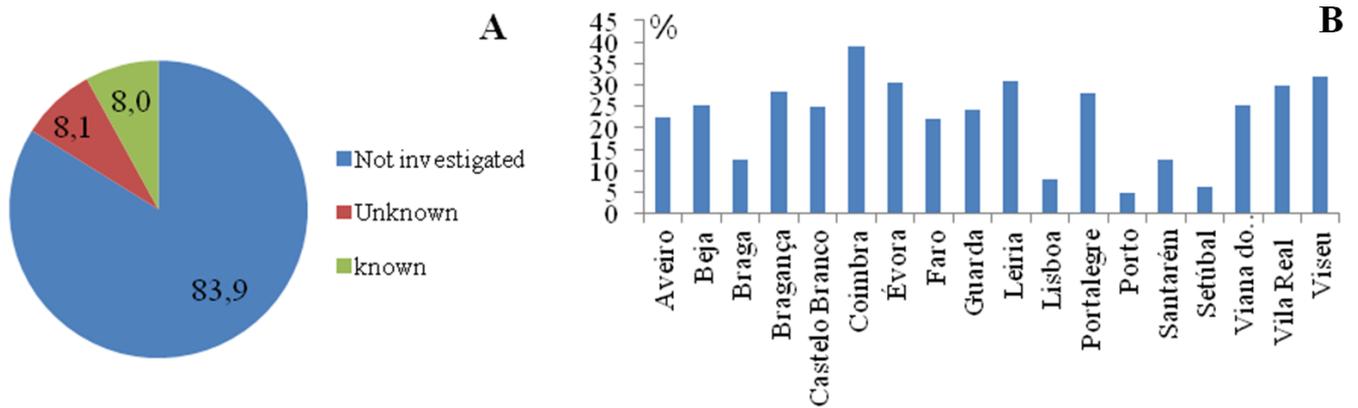


Figure 2. A - Percentage of forest fires not investigated and investigated with unknown and known cause (1996-2010); B - Percentage of investigated causes, 1996-2010.

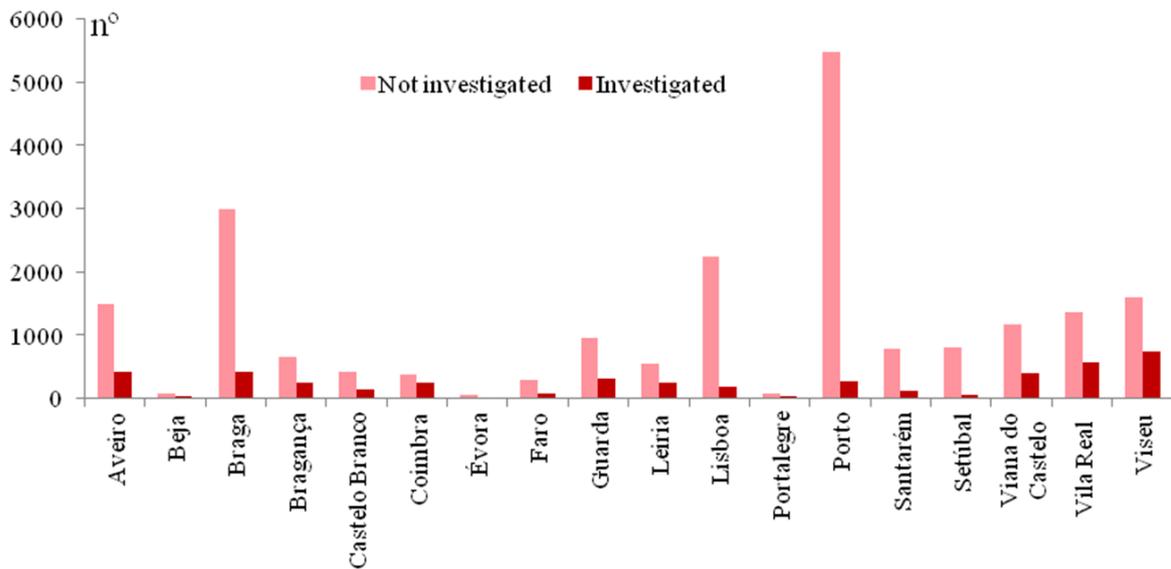


Figure 3. Number of ignitions investigated and not investigated (1996-2010).

supposed cause, which in any case is 100% sure.

In order to make the causes comparable, (before and after 2000) a reclassification of fire causes was made for the first period, according to the current classification. For the entire period, re-ignition was included as an additional cause, since the initial ones had been investigated.

Simple statistical calculations for causes of forest fire ignition in Portugal were carried out in order to gain a better understanding of the main characteristics and dynamics of regional and temporal distribution.

#### 4 RESULTS AND DISCUSSION

Over the period analyzed, the number of forest fires exceeded 387900 ignitions, which means an average of 25864 forest fires per year. The maximum number of annual forest fires occurred in 2005, 1998 and 2000 totaling more than 34000 cases.

Information about the causes of the forest fires ignitions (Figure 2A) shows that the greatest part was not investigated (84%), whilst truly known causes account for only occurred 8% of cases. The percentage of “unknown”

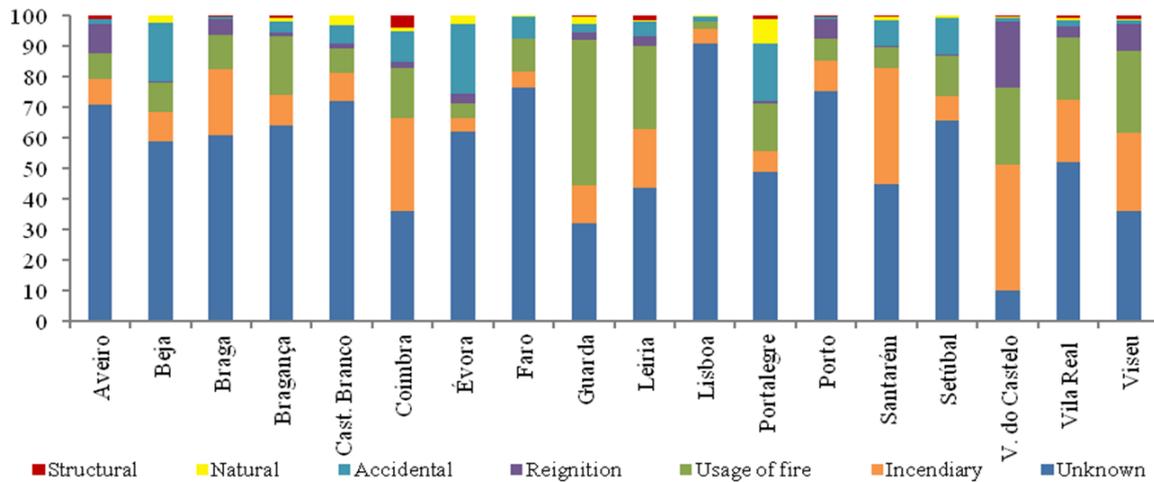


Figure 4. Main categories of causes of forest fires in the districts of Portugal mainland (1996-2010).

causes (8%) means that an investigation was carried out but the driving force behind the ignition of the fires was not specified.

As we can observe (Figure 2B), with the new organization, after 2006 the number of fires investigated has increased but with a larger uncertainty, so that the problem of knowledge the causes is not solved yet (Savazzi et al., 2010). Moreover, from the fire investigation activity performed by trained forest rangers, there is a significant difference among the higher number of investigations in the most densely forested areas (such as Viana do Castelo, Vila Real, Viseu and Coimbra), as compared to the other areas, especially the urban and peri-urban municipalities (mainly Porto, Lisboa and Braga) (Figure3).

Incendiary and the negligent usage of the fire emerge as the most important motivations behind forest fires, with almost 40% out of the identified causes (Table 1). Here, *incendiary* refers to irresponsible acts, such as children game or pyromania, whereas responsible motivations include diversionary maneuvers, fire lighting for pleasure, conflicts between neighbors, revenge, vandalism and other deliberate actions.

In the negligent usage of fire are included actions like garbage burning, vegetation burning (clearing of agricultural and forest areas, burning remnants or agricultural waste, renewing pastures, improving access to hunting and fishing areas...), fireworks, bonfires and apiculture. Reignition represents around 6% of fire causes, whilst accidental occurrences (with transports and communications or machinery) correspond to 3% of the

identified causes. Natural events like lightning represent an ignition factor but the number of naturally occurring fires is relatively small compared to the events caused by people (0.8%).

Figure 4 shows the 18 administrative districts of Portugal with the classification of the investigated fires per main category, from 1996 to 2010. In terms of unknown causes, the greatest percentages were registered in the districts of Lisboa (90%), Faro (76%), Porto (75%) and Castelo Branco (72%) whereas the lowest values were recorded in Viana do Castelo (10%), Guarda (32%), Coimbra (36%) and Viseu (36%). The causes related with incendiaries account for more than 1/3 of the defined causes in Viana do Castelo, Santarém and Coimbra, whilst the inadequate usage of fire were the most frequent cause in Leiria (47%). In Vila Real, Viana do Castelo and Viseu the negligent usage of fire explains between 20 and 27% of the known causes,

Table 1. Main categories of causes for Portugal mainland (1996-2010).

Main categories of causes	Number of ignitions	Percentage of total (%)
Unknown	34,638	50.7
Incendiary	13,277	19.4
Usage of fire	12,992	19.0
Reignition (with initial cause investigated)	4,243	6.2
Accidental	2,060	3.0
Natural	550	0.8
Structural	538	0.8
Total	68,298	100.0

respectively, over the period under analysis. Fires caused by negligence seem to be more common in the north due to traditional agricultural practices such as pasture renewal, the burning of agricultural and forest debris and hunting (Nunes, 2012). In the Alentejo districts (Portalegre, Faro and Beja) accidental causes, mainly associated with crop harvesting machinery, were the primary reason for the outbreak of forest fires.

## 5 CONCLUSIONS

As a final remark, we can consider that one of the problems related to the forest fires causes investigation derives from the lack of representation of the investigated fires to the total amount of forest fires, as well as the great percentage of unknown causes, although an investigation was carried out, the driving force behind the ignition of the fires could not be specified. In addition, these findings clearly indicate that Portuguese forest fire management strategies need to be thoroughly reviewed as they have failed to reduce the number of cases and, therefore, the damage caused by forest fires.

An exhaustive review of Portuguese forest fire management strategies must therefore start with a recognition of the holistic factors that lead to the break out of fires and must, above all, abandon the obsession with the propagation and extinction tasks, paying more attention to the real problem, namely, the large number of ignitions and the increase in flammable biomass, especially in the regions with steeper slopes.

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