



## Forest Fires in Portugal in 2005 – An Overview

### Introduction

In 2005 Portugal suffered a very heavy blow from forest fires that covered an area of the order of 300,000 hectares (ha) of forest and shrub land making this the second worst year of our history after the very recent year of 2003 in which more than 430,000 ha hectares were burned. These facts raise a series of questions about what is happening, about its causes and about the future. In spite of the complexity of the problem the author will attempt to give an overall perspective of the situation of forest fires in Portugal in 2005 and in the recent years.

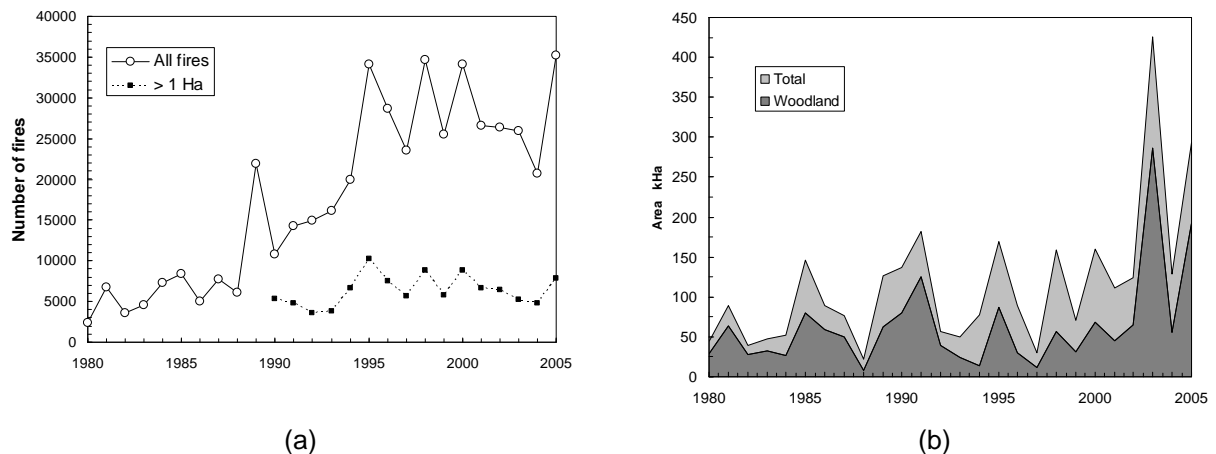
There are many factors that contribute to this level of destruction, some of them of structural nature, due to forest and fire management processes and other of conjuncture nature, due to climate and weather conditions. A brief analysis of both is presented.

As a consequence of these fires there is a general feeling that attitudes have to change and that more effective fuel management practices should be implemented in order to minimize the potential danger of fires and to induce a safer fire suppression effort.

### Some Numbers

Portugal has a surface of  $9 \times 10^6$  Ha that are mostly covered by forest and agricultural vegetation. Forested and agricultural lands are intermixed and the human presence is felt throughout the entire space. The forested area covers  $5.3 \times 10^6$  ha of the territory of which 63% are composed by woodland and 37% is non cultivated land that is covered by grass, shrubs and other light vegetation that is very prone to fire. In the period from October to April there is an average precipitation of around 700 mm that supports the growth of large amounts of herbaceous and small shrubs. These compose the fine fuels that are available to support forest fires during the summer season. On the other hand from May to October there is usually a deficit in rainfall associated to warm and dry conditions during summer; therefore it is normal to have a large number of fires and a considerably large burned area in each year.

In Figure 1 the number of fires (a) and the burned area (b) during the past years are shown. As can be seen the total number of fires has increased during the past decade with an average of the order of 25,000 fires per year during the recent years. If we consider only those fires that actually burned more than one Ha these numbers – also shown in Figure 1a – are much lower and remain fairly constant on the order of seven thousand. Practically all fires that are considered in these statistics had the intervention of the fire brigade forces. They manage to suppress the large majority of the fires at their beginning and keep them small. As they correspond to a heavy load and a dispersion of fire fighting forces they must be considered in this analysis as well although they do not contribute much to the total burned area.



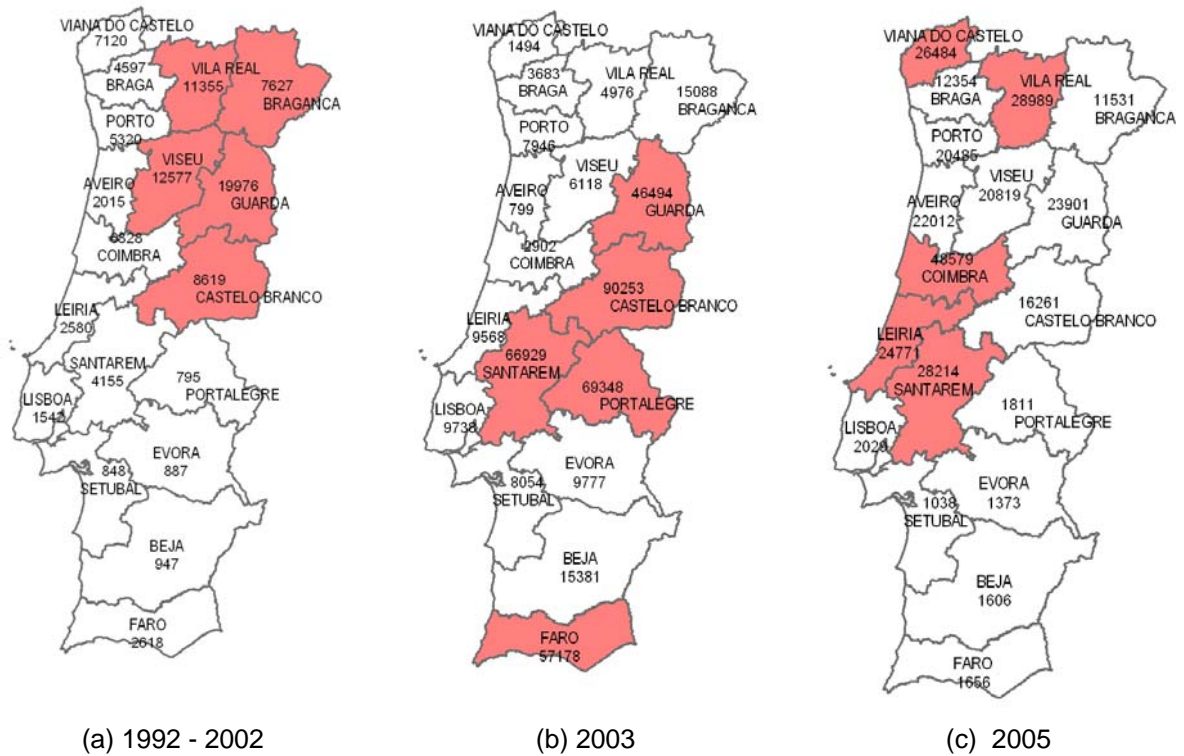
**Figure 1.** Number of fires (a) and burned area (b) in Portugal in each year from 1980 to 2005.

In spite of its large inter-annual variation the burned area has increased during the past decades, with an average of the order of 100,000 ha burned each year. As was said above, the years of 2003 and 2005 were exceptionally bad. The dark shaded area in Figure 1b corresponds to the area of woodland – tree covered land – that was burned in each year. Although most fires do not consume completely the trees the impact of fires on plantations is quite relevant. Most of the trees are killed by the fire and have to be removed from the land.

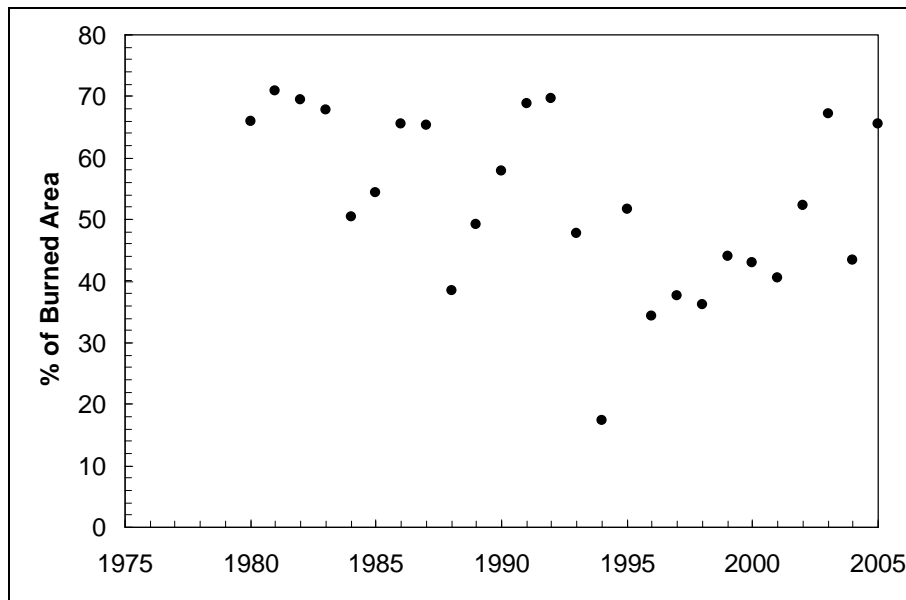
In Figure 2 the 18 administrative districts of Portugal are shown with an indication of the average values of the burned area in the previous decade from 1992 to 2002 (a), in 2003 (b) and in 2005 (c). The five districts with larger area burned in each period are shaded. Historically the districts of the interior North and Centre of Portugal are those that had the largest burned areas in the past, but the years of 2003 and 2005 were also singular in this respect as some districts that did not have such a serious problem in the past had it in these last years. This fact demonstrated also that the entire Country is susceptible to suffer from serious forest fires.

As was mentioned a matter of concern is the relatively large percentage of forested land that is affected by forest fires. As can be seen in Figure 3 there was a tendency in the period between 1980 and 1998 for this percentage to decrease from around 70% to 40%, but in the recent years the contribution of forested lands to the area burned in each year has increased to around 60% of the total. Having in mind that the areas burned in 2003 and in 2005 were very large this means that Portugal is losing an important share of its wooded lands due to fires.

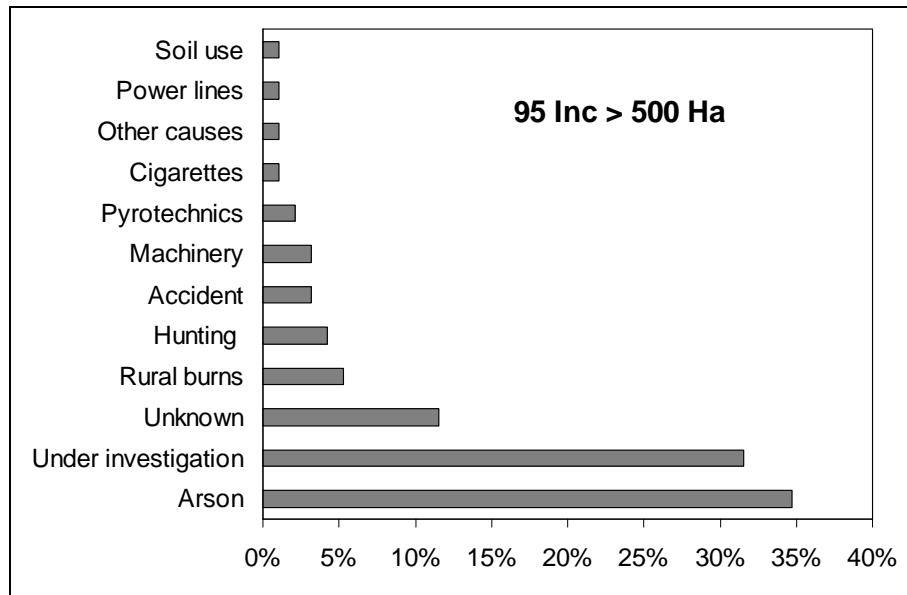
More than 90% of the fires in Portugal are caused by human activity. There is a systematic investigation of the causes of fires in Portugal. At least all fires larger than 100 hectares are investigated by the authorities. It is generally accepted that around 20 to 30% of the fires are caused by arson. In 2005 more than 100 persons were accused for arson by the authorities. The analysis of the causes of 95 of the major fires (>500 ha) in 2005 provided the results that are shown in Figure 4. As can be seen in this sample arson appears as around 35% of the causes and accidents in general – including cigarettes, machinery, rural burns, etc. - contributed to 20% of these fires.



**Figure 2.** The five Districts of Portugal with higher values of burned area (ha) per year in three different periods of time (Data from DGRF, 2005).



**Figure 3.** Percentage of forested land burned in each year in relation to the total burned surface in the period from 1980 to 2005.



**Figure 4.** Causes of 95 fires larger than 500 ha that occurred in Portugal in 2005.

### **Climate and Meteorology**

As was mentioned above climatic conditions have a very important role on fire occurrence and fire spread conditions. The last three years of 2003, 2004 and 2005 were not common both in terms of precipitation and temperature in most parts of Portugal. In Figure 5 the accumulated precipitation since previous September that is registered in Coimbra in these years is shown in comparison to the normal values for the period 1960-1990. It is realized that other parts of the country had different precipitation patterns, some of them were better and other were worse, but it is found that the weather conditions in Coimbra are quite representative of the situation in most relevant forested areas of Portugal. As can be seen in that figure the year of 2003 had an excessive amount of rainfall during Winter and Spring that produced a large amount of fine vegetation. Then the Summer of 2003 was very dry and the burned area in Portugal was an absolute maximum. During some days of August of 2003 extensive dry thunderstorms caused a large number of fire ignitions many of them simultaneously in the same region. As a result many large fires started to burn under control in the Centre and interior of the Country, even in regions that had not been much affected by fires in the past, like the districts of Santarém and Portalegre. On 2 August 2003, an area of the order of 100,000 ha was burned in a single day. This value is practically the same of the average area burned in a whole year! This was certainly the worst day in the recorded history of forest fires in Portugal. Six persons lost their lives in different fire related accidents in this day (Viegas, 2004).

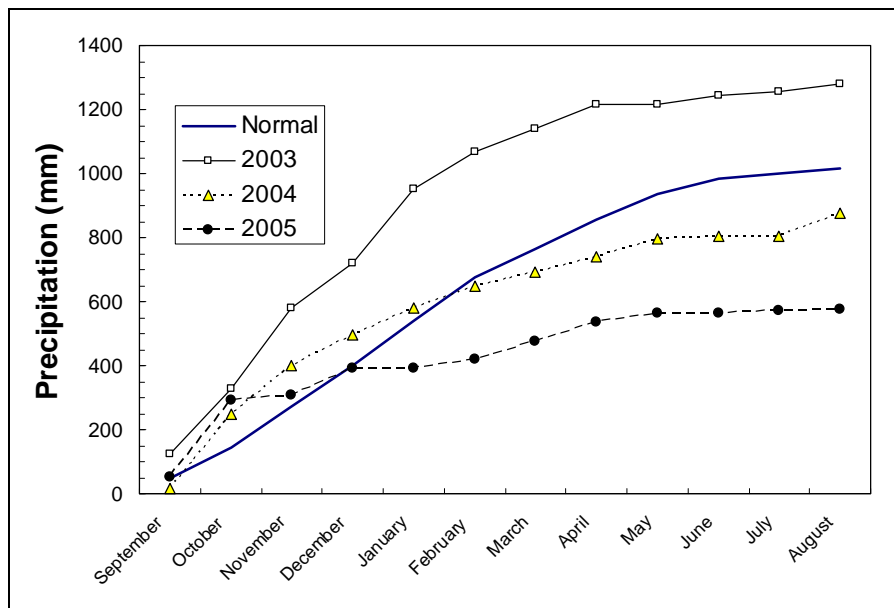
The year of 2004 was relatively normal although the summer months were relatively dry until mid August. As a result the burned area was as in the average years. The year of 2005 was one of extreme drought with practically no rainfall since December until mid October in most of the country.

The occurrence of extreme fire conditions in the last years can be associated to the global warming of the atmosphere that is predicted in all climate change scenario. As a matter of fact it has been observed that the fire season extends for much more days and that periods of very high air temperature are more frequent and felt in wider areas of the territory than in the previous decades. If this process continues we can only expect that the problem of forest fires may increase in the future.

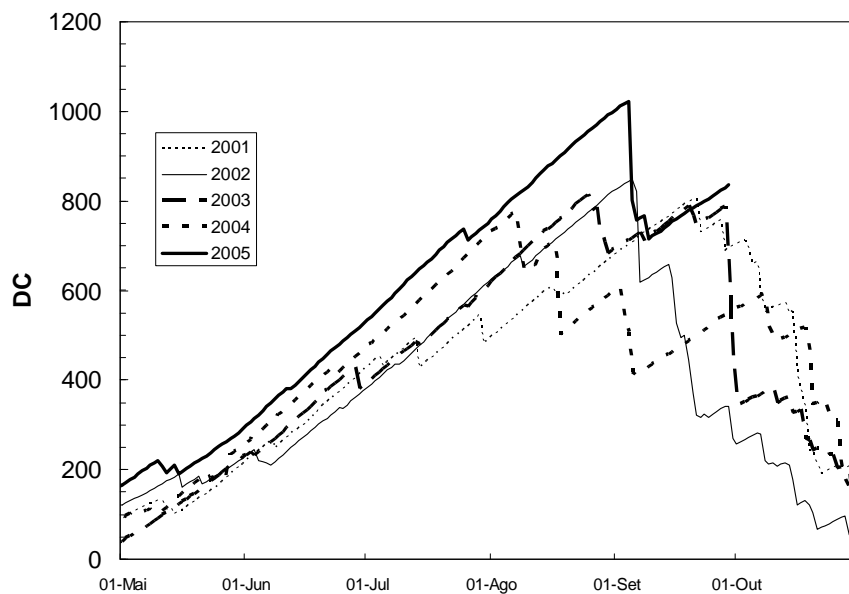
The joint effect of precipitation and temperature is reflected in the Drought Code (DC) that is a sub-index of the Canadian Fire Weather Index System (cf. Van Wagner, 1987) that is used in Portugal and in many other countries of the World. The daily value of DC is a measure of the soil water content and it gives a good indication of the severity of the fire season. High values of DC correspond to high levels of dryness. Precipitation events cause a drop on the values of DC and therefore reduce the potential danger of fire occurrence and spread. The daily values of DC for the past years in Coimbra are shown in Figure 6. The average value of DC for the period from 1993 to 2002 is shown for comparison. As can be seen in that figure the years of 2003, 2004 and 2005 came in a succession,

each of them worse than the previous one. As was said before in 2004 there was rainfall in mid August and therefore the fire season was not as bad as it had started but in 2005 the DC was the highest that was recorded in the period from 1988 to present.

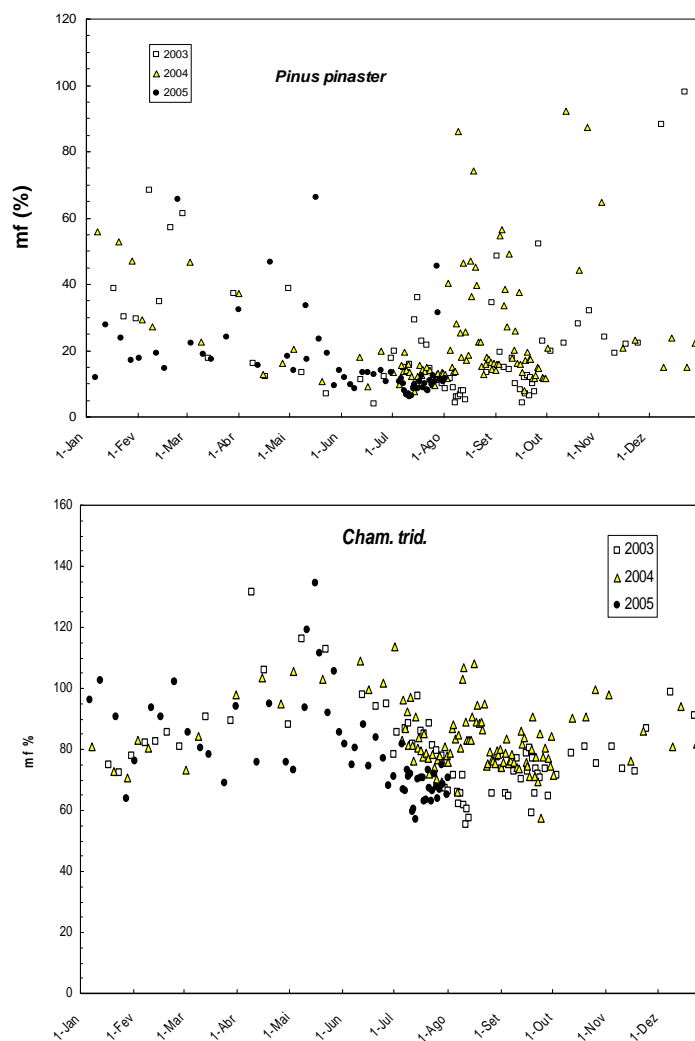
As a consequence of the meteorological conditions of 2005 the vegetation had a very low moisture content value  $m_f$ . Measurements carried out by the author and his co-workers confirm this as it is shown in figure 7, where moisture content  $m_f$  (dry basis) of dead *Pinus pinaster* needles and leaves of standing *Chamaespartium tridentatum* are shown. We know from past experience that values of  $m_f < 10\%$  for dead pine needles correspond to high risk of fire ignition and spread. In 2005 we had plenty of days in these conditions and even with  $m_f$  as low as 3 or 4%. Under these conditions fires are very easy to ignite and the probability of having many spot fires is very high. The values of  $m_f$  for shrub vegetation in the summer of 2005 were also much lower than it is usual, with values in the range of 40 to 50% that correspond to very intense fires.



**Figure 5.** Accumulated precipitation in Coimbra since September for the years of 2003, 2004 and 2005 compared with normal values.



**Figure 6.** Drought Code values for Coimbra during the last five years.



**Figure 7.** Moisture content of (a) dead needles of *Pinus pinaster* and (b) leaves of *Chamaespartium tridentatum* sampled at Lousã (Portugal).

## Fire Management

The climatic and meteorological parameters show that in 2005 there were very bad conditions for fire occurrence in Portugal but these factors alone do not justify the very large burned area that we had and the dangerous situations that were faced by many persons that live in forested areas. In the opinion of the author large areas of the forest are not managed in anticipation of such bad conditions. There are huge extensions without fire breaks or other discontinuities that might allow fire suppression in safer conditions. In the conditions that we had in 2005 it was observed that the fire could jump even wide open areas but in many situations the firefighters managed to stop the raging fires using counter fires (tactical fires).

The structure of the rural property in Portugal, including forest properties, is one of many very small properties that are owned by a large number of persons. As many of these properties are not sustainable technically and economically their management is very limited. It is very difficult to make plans that may cover wide areas of the territory as many particular interests are involved. These are some difficulties that are felt in order to overcome the general problem of forest fires in Portugal for decades.

Unlike their counterparts in other regions of the world – namely in Central and Northern Europe – farmers and foresters in Portugal have to struggle every year to manage fuel growth in order to reduce fuel loads that can facilitate fire ignition and propagation. It is very difficult and costly to open and maintain efficient fire breaks even for normal fire conditions and it is almost impossible to assure that

the forest is fire safe under the circumstances that we had in Portugal during 2003 and 2005. In spite of this it is felt that a better management of rural and forest areas, involving fuel management programs, could contribute to reduce the overall problem quite significantly.

In Portugal there is an extensive mixture between rural and urban areas that create an interface with the forest that is very difficult to manage and consequently to defend. In many cases this interface is not properly managed and the fire would come across single houses, villages or even towns spreading danger and destruction. Many houses and supporting structures were lost this year.

During the night of 21 August 2005 a fire that started at 20 km from Coimbra reached the city in few hours, encircled and even entered through some its main streets, see Figure 8. Fortunately there were no victims during this fire but that was not the case for the fire season of 2005.

In the whole 20 persons lost their lives in different accidents related to forest fires in 2005. This number includes 12 fire fighters. One of the most shocking accidents was the one that occurred on the 28<sup>th</sup> February, in which four professional fire fighters of the Coimbra Fire Brigade lost their lives. This accident occurred in an unusual winter fire with very cold, dry weather associated to very strong winds. This group of fire fighters was surprised by a sudden fire eruption in a small canyon where they had stopped their truck, see Figure 9 (Rodrigues et al., 2005).



**Figure 8.** View of the forest fire that encircled Coimbra on the night of 21 August 2005. Photo: Diário de Coimbra.





**Figure 9.** View of the accident with a vehicle of the Fire Brigade of Coimbra in which four fire fighters lost their lives. Photo: Diário de Coimbra.

Given the limitations of its resources to fight fires in the extreme conditions of 2005 Portugal requested and got the help from many other countries, including Germany, that sent some aerial means to support our fire fighters during the worst days of this fire season.

### **Consequences**

After the fire season heavy rainfall in the mountain areas that burned in the past months is creating bad problems with loss of soil, erosion and floods.

The repeated and apparently ever increasing incidence of forest fires is producing some loss of confidence on forest owners and managers who see a very low probability of achieving some profit from their investments in the forest. Timber price fluctuations compound to make the situation difficult for those who depend on the forest. For all these reasons forest fires are considered as a major threat and conditioning factor to the sustainability of the entire forestry system in Portugal.

It is felt that the coordination between the various institutions that deal with fire management must be improved both at national and local levels. In spite of the successive changes that were introduced in the system during the past five years another attempt is being made this year in order to improve this coordination and to promote a better efficiency of the entire fire prevention and suppression system.

### **Conclusions**

Portugal suffered very badly from forest fires in 2005 that was the second worst year of its history. The climatic conditions were not favourable for the valiant personnel that tried to fight the fires. This fact added to the lack of adequate fire prevention measures throughout the territory and near the houses caused the loss of lives, houses and of important forest land. There is a feeling of hope that the Country will join its resources, organize and manage them in a better way to avoid the repetition of the extensive destruction of the past.

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