EUROPEAN PARLIAMENT

STUDY

Policy Department
Economic and Scientific Policy

FOREST FIRES:

causes and contributing factors in Europe

IP/A/ENVI/ST/2007-15

PE 401.003

This study was requested by the European Parliament's Committee on the Environment, Public Health and Food Safety.

Only published in English.

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Manuscript completed in February 2008.

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FOREST FIRES: CAUSES AND CONTRIBUTING FACTORS TO FOREST FIRE EVENTS IN EUROPE

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EXECUTIVE SUMMARY

Forest fires are the most important threat to forest and wooded area in Southern Europe. Reports of forest fires in France, Greece, Italy, Portugal and Spain show that in these areas more than 450,000 ha burned on average each year between 2000 and 2006. In 2007 the phenomenon got even worse, especially in the south-eastern countries (Greece and Italy in particular), and the total area burned was about 500,000 ha.

Fires have caused extensive damage in recent years, leading to loss of human lives, affecting human health, burning properties, infrastructures and business and causing extensive environmental damage in forest and agriculture areas. Many argue that fires also contribute to global warming through the emission of CO_2.

The present study aims to provide a critical analysis of the causes that lead to the most relevant recent forest fires events in the EU, focusing in particular on Southern European countries. In particular, the study assesses to what extent forest fires have been influenced by forest management, extreme weather events and climate change, territorial planning/development regulations regarding the use of forests or burned areas, and inadequacy of response and lack of material capacity. To do so, two case studies were developed, one the Portuguese forest fires of 2003 and 2005, and one on the Greek fires of 2007.

Forest fires: the case of Portugal

The fire regime in Portugal has become worse along time, with 2003 and 2005 been the most recent worst years – leading respectively to the destruction of about 425,000 and 340,000 hectares.

The causes of forest fires in Portugal have been attributed to the depopulation of the interior of the country (leading to an increase of unattended shrublands) associated with the increase of fire prone species (especially pine and eucalyptus), and lack of forest management due to the small average holding size. Weather conditions, i.e. hot and dry summers, have also contributed to the spreading of forest fires, and could potentially become worse due to the effects of climate change. Fires ignition has also been frequently attributed to human responsibilities, e.g. negligent use of fire.

Among the main initiatives to counteract forest fires, it was recommended to diversify the forest composition (e.g. re-introducing broadleaves trees), act on rural depopulation (e.g. through agri-environmental measures), improve forest management, integrate forest policy with other policies and coordinate with private stakeholders, aggregate existing properties (e.g. through joint management or forest owners' associations) and adopt others ancillary measures – like prescribed fires – which could reduce fire risk.

Some measures have been already implemented, although their effect was not always perceived, either because they will bring result only in the medium-long term, or because they were not sufficient. As a matter of fact, the combination of weather conditions and of measure taken resulted in a substantially smaller area burnt in 2006 and 2007. Further efforts may be required in the future, especially in light of the likely increasing risks of fire related to climate change.

Forest fires: case of Greece

Since 1998, forest fire management in Greece has been characterised by emphasis on fire suppression, which lies in the hands of the Greek Fire Service. The Forest Service, which is responsible for forest fire prevention, has been weakened in its competence and structure and is poorly funded. In total, however, since 1998, costs for forest fire management have greatly increased, with the highest part of funding being absorbed in the acquisition of modern fire suppression equipment. Investments in water-bombing aircrafts and other fire suppression equipment and personnel are not bringing the desired results on the ground, since the burned forest areas have increased. The forest fire events in summer 2007 were of immense extent and had a great toll on human life, infrastructure and ecosystems.

In this context, the need for substantial changes becomes apparent. The accumulation of dry biomass due to the lack of appropriate fire-preventive forest management makes fire control extremely difficult under adverse weather conditions. The lack of substantial fire prevention measures and policies leads to the eruption of many destructive fires. The uncontrolled development of fire-unprotected interface zones between forest and urban areas is a large problem for fire-fighting forces and highly increases damages to homes and infrastructure.

To prevent the extreme spreading of forest fire events in the future, political choices should not remain focused only on the acquisition of further fire-suppression equipment and personnel. A shift of emphasis to the substantial upgrading of the entire organisation of forest fire management is needed, with more emphasis on forest fire prevention and forest ecosystem protection.

Lessons learnt: the most common causes of forest fires

The causes of fire are various, but as a matter of fact the Mediterranean basin is marked by a strong prevalence of human induced fires. In some cases they are initiated voluntarily, e.g. for criminal reasons. In many others they are related to agricultural and forestry activities, e.g. fires for agricultural cleaning that go out of control. Other factors then come in to play in the spreading of fire, which make fire more difficult to contain and fight. These are often related to.

Forest management: Rural depopulation, often related to a widespread transfer of population from the countryside to the cities due to improved economic conditions, is leading to an increased abandonment of arable lands. As farmland is abandoned, wild and invasive flammable species establish, providing fuel to forest fires. Furthermore, in many cases the shrinking of profitable markets for Mediterranean forest products discourages the investment in forests and forest management, also leading to less control over fuel material and reduced local monitoring. Small forest properties, typical of certain Mediterranean countries, also provide little incentive to invest on forest management, given the small scale of return from forestry activities. Sometimes lack of coordination between institutional structures responsible for forest fires can also lead to ineffective forest management.

Extreme weather or climate change: Southern Europe is usually characterised by hot and dry summers, associated to high levels of fire hazard. Strong summer winds in addition can make fire spread at high speed. Furthermore, research on climate change indicates that increased fire hazard is likely to arise from global warming.

Territorial planning and development regulations: In general, inappropriate forest land use planning that does not take into consideration the environmental characteristics of the area (e.g. monocultures of fire prone tree species) can contribute to forest fires, both in Mediterranean and in broader Europe. Lack of territorial planning is also a problem, e.g. the uncontrolled construction of urban areas near the forests. In addition the possibility that burned areas can be reclassified as building areas, either for the absence of appropriate legislation or for lack of clarity in territorial plans and registers, can intensify the risk of arson.

Inadequacy of response or lack of capacity: A number of countries suffering from forest fires seem to lack a reliable fire monitoring and forecasting system that would allow an early response to fire. Furthermore, a response that is not suited to the type of event and territory can be ineffective – i.e. the right tools have to be used. Aerial means for instance are useful, but should be complemented by sufficient crews on the ground. The use of hand tools may be required in some cases, while in others the use of fire-for-fire control methods (such as backfire and burning-out) may be more efficient. In addition, insufficient training of fire fighters and public authorities, as well as the insufficient financial resources, has proved problematic in some countries. Lack of cooperation between the authorities responsible for forest fires and forest management can also lead to an insufficient response to forest fires. Lack of citizens' response in managing, monitoring, preventing fires is also detrimental.

Other causes: In addition, forest fires can be involuntarily set by livestock farmers, when fires which are lit for maintaining pastureland get out of control. In general, carelessness has been identified as one of the main causes for forest fires in a number of countries. A significant proportion of forest fires is also caused by arson, due to economic motives and personal gain.

What can be done: recommendations for policy makers

In general policy-makers and citizens should not just take decisions when severe fire events occur. Decisions on planning and prevention are always required. Investments in fire prevention can be more effective than investment in fire fight. Public awareness campaigns, monitoring and early warning systems are also crucial.

Political commitment is essential, especially with regard to the provision of adequate budget, the adoption of proactive rather than reactive responses, the amendment of conflicting policies and legislations and the definition of clear responsibilities for fire management.

The collection of data on forest fires is improving, but should be encouraged further, especially in light of a harmonisation of terminology and definitions, and the development of a common format for regional databases on fire across countries.

Collaboration between countries, within and between regions (e.g. on fire suppression, training and information exchange) is generally increasing, and should be pursued further.

1 INTRODUCTION AND BACKGROUND

The study aims to provide a critical analysis, on the basis of existing data, of the causes that led to the most relevant recent forest fires events in the EU, focusing in particular on Southern European countries. In particular, the study assesses to what extent forest fires have been influenced by forest management, extreme weather events and climate change, territorial planning or development regulations relating to the use of forests or burned areas, and inadequacy of response and lack of capacity.

To do so, two case studies were developed, one on the Portugal forest fires of 2003 and 2005 and one on the Greek fires of 2007. The case studies portray the major environmental, economic and social impacts of major forest fires in these countries, highlighting the causes of those events. Some general conclusions were drawn and recommendations made on how to reduce the fire risk. The case studies build on the existing literature and portray also experts' opinions, providing a picture of the views more seriously considered among professionals in this field.

The study is also complemented by information on 2007 forest fire events that spread in other South-East European countries, which are summarised in Annex 3. Additional literature research was also conducted in order to further understand the recent forest fire phenomena.

On the basis of this analysis, and on the lessons learned from Portugal and Greece, the report presents an overview of the main causes of forest fires and proposes some general conclusions and recommendations on how to tackle the increasingly serious problem of fires in European forests.

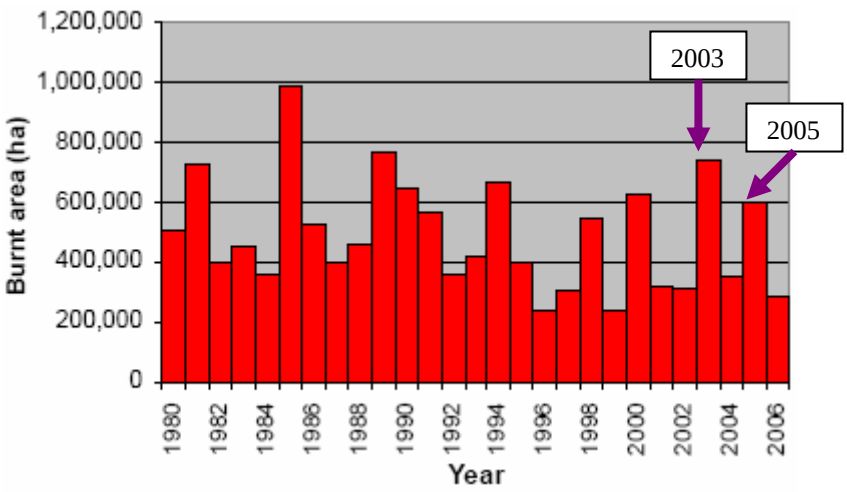
Chapter 2 presents some facts and figures about forest fires in Southern Europe, providing some insights on forest fires' environmental, economic and social damage from the case studies on Greece and Portugal. Chapter 3 presents an overview of forest fire causes, building on the existing literature and on the lessons from the case studies. Chapter 4 provides concluding remarks and proposes a range of recommendations to address the causes of forest fires in order to reduce fire hazards and damage. Annex 1 includes the Portuguese case study, while the Greek case study is contained in Annex 2. Annex 3 presents a summary table of insights on the major forest fire events of 2007 in the most severely hit South-East European countries. In annex 4 a summary table contains some data and statistics on recent forest fires.

2 FACTS ABOUT FOREST FIRES IN SOUTHERN EUROPE

The Mediterranean forests are dominated by open canopy pine forests on the coasts of Spain, France, Italy and Greece with oak forests along the mid-mountain ranges (FAO, 2006). The mosaic of forest types hosts approximately 25,000 vascular plant species that are important not only because they represent 10% of the world's flowering plants, but also because more than half of these species (an estimated 13,000) are found nowhere else in the world (WWF, 2004). The dominant pine and oak species are fire-adapted species – they depend in part on fire to regenerate – however, the frequency and severity of the fires in the Mediterranean is one of the leading causes of forest degradation (EEA, 2007). Since 1960, the burnt area in Europe has quadrupled, and forests are not able to regenerate at this rate of fire return (WWF, 2004).

Figures 1 and 2 below show the total burnt area and the number of fires per year in five Southern Member States (Portugal, Spain, France, Italy, and Greece) since 1980. The statistics vary considerably from one year to the next, indicating how much the burnt area depends on seasonal meteorological conditions. Fire frequency followed an increasing trend during the 1990s, but since 2001 the number of fires has remained more or less stable. This may possibly be due to public information campaigns and to the improvements in the prevention and fire-fighting capacities of these countries (EC, 2007). Between 2000 and 2006 more than 450,000 ha on average burned in the five countries each year[1]. 2003 and 2005 have been the worst two years in terms of total area burnt in the past decade, revealing an increase in forest fires of large dimensions.

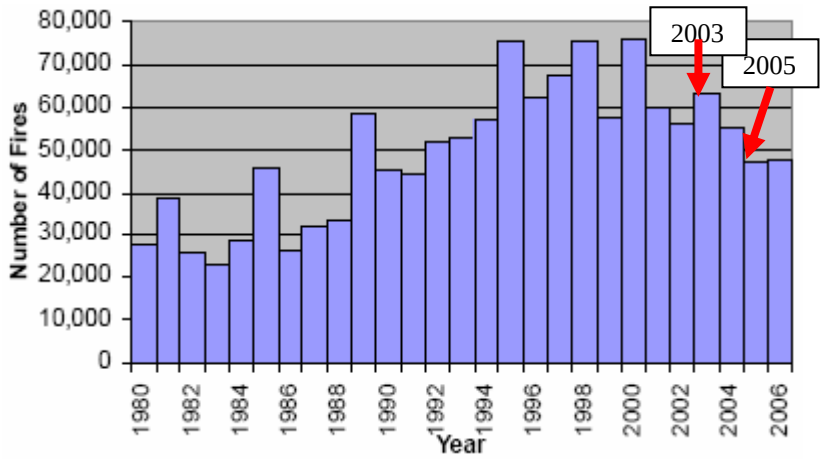
Figure 1 Burnt area in the Southern Member States



Source: EC, 2007

[1] http://effis.jrc.it/documents/2007/EFFIS_Newsletter_3_2007_small.pdf

Figure 2 Number of fires in the Southern Member States



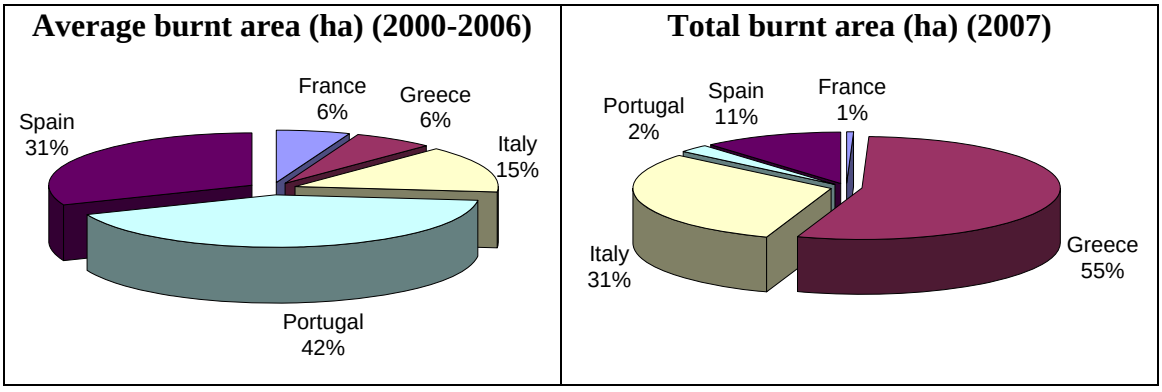
Source: EC, 2007

Data shows that in summer 2007, especially in the second half of July, quite severe fire weather conditions occurred in South-Eastern Europe, with consequent very high fire danger levels and peaks of fire activity. Bulgaria, Croatia, Greece, and Italy experienced one of the worst recorded months of July in terms of forest fires. Southern Italy and Greece were again under high fire danger conditions during the second half of August, reaching extreme fire weather conditions that resulted in highly catastrophic events towards the end of the month. South-Western Europe instead experimented more moderate fire danger conditions if compared to recent years (e.g. 2003 and 2005), although some periods of very high risk - mainly in the south of the Iberian Peninsula and in Canary Islands - contributed to the development of some very large fires[2].

An overview of the most relevant forest fire episodes of 2007 is provided in Annex 3. Data on the size of the area burnt in South-East European countries are provided in Annex 4.

Figure 3 below clearly shows how, throughout the period 2000-2006, the Member State most severely affected by forest fires was Portugal, followed by Spain and Italy. In 2007 instead the situation was almost reversed, with the South-Western Member States recording a relatively smaller area burnt, while Italy and, in particular, Greece saw vast areas burned by forest fires. In 2007 about 500,000 ha burned across these five EU countries.

Figure 3 Average burnt area in 2000-2006 and 2007 burnt area



Source: Elaboration from EFFIS data[3]

[2] http://effis.jrc.it/documents/2007/EFFIS_Newsletter_3_2007_small.pdf
[3] http://effis.jrc.it/documents/2007/EFFIS_Newsletter_3_2007_small.pdf

2.1 The impacts of forest fires: insights from case studies

Forests fires have a number of environmental, economic and social impacts. They destroy the forest itself, as well as agricultural land and human settlements, leading to significant damage. Biodiversity can be severely affected. For instance, it was estimated that, due to the fires of 2007, more than 106,000 ha of land in Natura 2000 sites burned in Cyprus, France, Greece, Italy, Portugal and Spain – corresponding to 21.3% of the burnt area in these countries[4]. Fires can also affect important economic activities, like forestry or tourism. In some cases they lead to loss of human lives.

Some examples of environmental, economic and social damage are provided below, based on the experience gained from some of the worst forest fire episodes which occurred in Southern Europe in recent years – namely in Portugal in 2003 and 2005, and in Greece in 2007.

Environmental damage. Between 2002 and 2006, every year in Portugal on average 200,000 hectares burned and 1.6 million tonnes of carbon were emitted due to forest fires (DGRF, 2007). The fires of 2003 have been the worst in the past 27 years in terms of burnt area, and led to the destruction of about 425,000 hectares, causing the loss of 8.6% of the total Portuguese forest[5]. In 2005, the second worst year for forest fires, about 340,000 hectares were destroyed. Furthermore, fires also lead to soil deterioration, causing large soil losses during rainfall and deterioration of downstream water quality. It is also expected that, if current frequencies of wildfires persist or increase, there will be some major consequences for soils (e.g. decreased fertility) and for run-off (e.g. increased likelihood of floods) (Pereira et al, 2004).

In Greece it was estimated that, in total, 97,518 ha of natural vegetation cover were burned by fires in 2007 (WWF, 2007). 30,132 ha were located in Natura 2000 sites (WWF, 2007). Seven important Sites of Community Importance were affected, as well as certain species of ecological importance (eg the golden jackal). Furthermore, a significant part of the National Park of Mount Parnitha and of the Parnitha true-fir forest was destroyed – with substantial damage for biodiversity, as true-fir forests are not adapted to fire events and will require great human effort to be regenerated. The forest fire in Parnitha also caused damage to the populations of several protected birds, mammals (especially deer), and other vertebrates and invertebrates (WWF, 2007b). Forest fires and forest destruction are also expected to affect the local climate, leading to a rise of average temperatures, extension of the summer period, and reduction of rainfall – accompanied by increased rain intensity.

Economic damage. The Portuguese forest fires in 2002-2006 led to significant losses of timber and non-timber products, recreational activities, and carbon sinks, and reduced protection of agricultural soil, aquifers and biodiversity. These losses were estimated to amount to more than € 300 million per year on average (DGRF, 2007), with peaks in 2003 (€600 million for DGRF - €1 billion according to the European Commission) and in 2003 (€500 million according to DGRF). In 2003 it was also estimated that more than 2,000 buildings were affected by fire (EC, 2004), as well as 2,000 km of electrical cables and, in some areas, the telephone network.

[4] http://effis.jrc.it/documents/2007/EFFIS_Newsletter_3_2007_small.pdf

[5] The total size of the Portuguese forest is estimated to be 3.3 million ha – based on the 1995 National Forest Inventory, 3rd Revision,1999

The catastrophic 2007 fires in Greece caused extensive damage to entire villages, thousands of houses, livestock, the road network, telecommunications, electricity infrastructure and irrigation networks. Tourism is also expected to be affected significantly in the future, due to the damage caused by the fires. In addition, about 78,000 ha of agricultural land (mainly olive groves) were burnt on the Peloponnese (WWF, 2007). The extensive damage to olive trees and livestock are bound to change the agricultural production balance on a national level and will require extensive compensation for agricultural damage. The final cost of the fires is likely to be very high, and could range between €3 to 5 billion, i.e. 1.4% to 2.4% of the country's GDP (Xanthopoulos, 2007).

Social damage. In Portugal 21 people died in the forest fires of 2003, and 18 died in the fire of 2005. In addition, in both years more than one thousand people were reported as in need of medical assistance due to smoke intoxication, burn, wounds and other fire related problems. The damage to buildings due to forest fires caused almost 200 homeless (EC, 2004).

In Greece, the fires of the summer of 2007 caused the death of 76 people (Xanthopoulos, 2007) and left thousands of people homeless and unemployed (WWF, 2007). In addition, it is thought that these events will have serious short- and long-term impacts on health (e.g. from the toxic smog remaining over cities, large quantities of dioxin emissions[6], pollution of drinking water from ashes etc). The quality of life of inhabitants in fire-affected areas will also be undermined by damage to the landscape – like disturbances of the soil and water balance, floods and land- and mud-slides caused by the destruction of the vegetation cover (WWF, 2007).

[6] Newspaper 'Kathimerini', online edition of 14/10/2007. Expert interviews with Mr. Nikolaou, Vice-president of the Union of Chemists of Central and Western Macedonia, and Ms. Nikolopoulou-Stamati, Professor of Athens Medical School (in Greek).

3 ASSESSMENT OF CAUSES

The Mediterranean basin is marked by a prevalence of human induced fires, i.e. about 95% of fires (FAO, 2007). Fires can be set voluntarily or involuntarily. In some cases they are initiated for criminal reasons, in many others they are related to agricultural and forestry activities (e.g fires for agricultural clearing that go out of control). Other factors then come into play in the spreading of fire, which make it more difficult to contain and fight. Paradoxically, the fundamental cause of forest fires is linked to increased standards of living among the local population. Economic changes in Western Europe in fact have led to transfers of population from the countryside to the cities, a slowing down of demographic growth, abandonment of arable land and disinterest in the forest as a resource (Alexandrian et al, 1999). This in turn resulted in an increase of unmanaged shrubs and biomass – hence fuel – which increases the risk of fires. These factors are also exacerbated by climate conditions, as Southern Europe is usually characterised by hot and dry summers, associated with high levels of fire hazard. Furthermore, research on climate change indicates that increased fire hazard is likely to arise from global warming (FAO, 2007).

The causes and factors contributing to the high incidence of forest fires recorded in recent years are described below, and grouped in 4 categories: forest management, extreme weather events or climate change, territorial planning and development regulations, and inadequacy of response or lack of capacity. Additional factors are mentioned as 'other elements'. It should be noted that these different categories of causes are in reality interlinked, hence in some cases the attribution of certain factors to a specific category was not always easy.

3.1 Forest management

One of the main causes of forest fires, especially the spread of fire, is biomass accumulation both on the forest floor and in abandoned pastures (FAO, 2005). Lack of forest management, especially lack of fuel management, is a leading factor in forest fires in the Mediterranean basin (FAO, 2007).

As shown in the Greek and Portuguese case studies, forests are often not well managed. This problem is primarily due to the rural to urban migration shift that began in the 1960s, the lack of a market for forest products and of resources for fire prevention. In addition, there are problems related to the institutional structure of national forest agencies. The key issues related to the link between forest management and fires are described in more detail below.

Rural – Urban Shift. Rural depopulation and land abandonment is a widespread problem across Europe. As farmland is abandoned, wild and invasive flammable species establish, thereby providing fuel for forest fires. At the same time, people are not there to maintain firebreaks and road networks, making it difficult or impossible to stop the spread of fire.

In addition, farmers and shepherds who remain in the rural areas often practice traditional farming methods, including the use of fire as a tool to maintain pasture.[7] These intentional fires often spread out of control, and there are not enough people to contain the fire. This is the case in Portugal, where the abandonment of cultivation has led to the conversion to extensive animal husbandry, and hence to an increased number of fires started by shepherds to maintain the ecosystems in the early succession stage of grassland.

[7] 4th International Wildland Fire Conference, 2007. Regional Session C: Europe, Southeast Europe, Mediterranean North Africa and Caucasus. *Regional Fire Assessment. Conclusions and Recommendations.* http://www.fire.uni-freiburg.de/sevilla-2007/Session-C-Europe-Report-en.pdf

Also, as shown in the Greek case study, the migration of people means that fewer people are collecting firewood for fuel, thereby causing additional biomass to build up on the forest floor.

Furthermore, policies have shifted emphasis from forest products to nature conservation and recreation. In some places, this policy shift has resulted in a decrease in logging and timber removal, thereby adding additional biomass build-up.[8]

Lack of market. There is a lack of a traditional economic market for Mediterranean forest products, which discourages investment in forest management due to lack of profit or any financial incentive.[9] As shown in the Greek case study, management of low elevation pine forests was supported by a Greek subsidy for resin, but this was discontinued in the 1980s when Greece joined the EU. In Portugal, fire-prone shrub land was historically controlled in part by using the shrubs for animal bedding, but today this is not economically viable due to increased labour costs (Pereira et al., 2004).

Land use change related to ownership patterns. In Portugal, the division of forest property into a large quantity of small holdings, especially in the north, contributes to a larger number of fires. Small forest owners have often little incentive to invest in fire prevention measures, given the small scale of return from their activities.

Another related problem is the perverse economic incentive to clear forests for development. For example, Greek law prohibits development on land classified as forest, but because there is no forest or land register it is nearly impossible to prove that burnt land was previously forest. Thus, arson is often suspected in the transition zones between forests and urban areas in order to allow profitable development.

National forest institutional structure. The institutional structure of national forest agencies is context-driven and varies from country to country. In Greece, there are two agencies responsible for forest fires. Historically, the Greek Forest Service was responsible for all aspects of forest fires, but in 1998 the responsibility for fire suppression was transferred to the Greek Fire Service. The severity of the 2007 forest fires is partly attributed to the fact that, as a result of institutional restructuring, funds for prevention have systematically been cut over time, rendering the forests more susceptible to fire.

Also in Portugal there used to be a low degree of coordination, as financial incentives to forestry used to be managed by the Ministry of Agriculture, while fire fighting depended on the Ministry for Internal Affairs. Since 2003 though there has been a significant effort by the Portuguese government to reform forest management. They established a forest fund to implement forest management and fire prevention projects, and have focused on construction and improvement of firebreaks and water reservoirs. In addition, they have developed afforestation programmes that aim to plant diverse broadleaf tree species rather than more vulnerable species such as maritime pine and eucalyptus, as was promoted in the past. The effect of many of these policies though could only be seen in the long run. As a matter of fact, they have not been able to prevent the forest fire episodes of 2005.

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8 Working Group on Forest Fire Prevention, 2005. Conclusions of the Expert Working Group 'Forest Fire Prevention'. Available at: http://www.ctfc.es/confeinfor/articles/PAPER%20PINAUDEAU_english.pdf

9 Wildfire 2007, 4th International Wildland Fire Conference, 2007. Regional Session C: Europe, Southeast Europe, Mediterranean North Africa and Caucasus. *Regional Fire Assessment. Conclusions and Recommendations*. http://www.fire.uni-freiburg.de/sevilla-2007/Session-C-Europe-Report-en.pdf

3.2 Extreme weather events or climate change

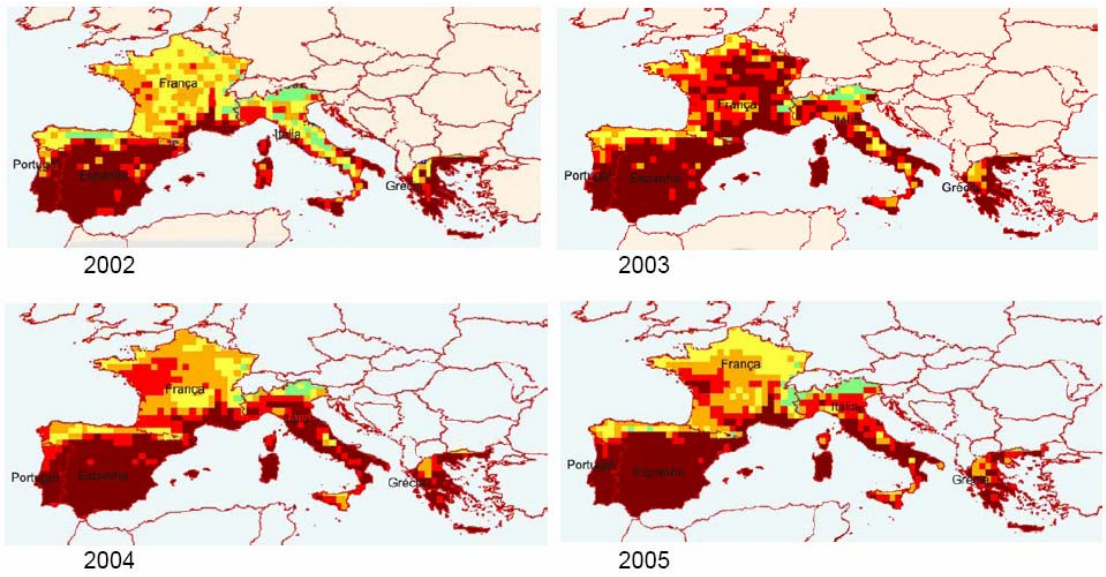
Weather conditions are rarely the cause of fire ignition, but rather have a catalytic effect, as fires propagate more easily in a hot and dry environment. Climate conditions hence are important factors affecting forest fire, especially in Southern Europe, where the climate is characterised by prolonged summers with no rain and average temperatures above 30ºC. In addition, climate change dynamics are expected to make these climate conditions increasingly more extreme, and the risk of forest fire could rise further in the future. Climate change is hence considered to be among the main factors playing a significant role in fire regimes in the Mediterranean basin in the twenty first century (FAO, 2007).

Climatic conditions typically leading to increased fire risk in South-Eastern Europe are described below.

Heat and drought. Mediterranean countries are usually characterised by hot and dry weather during the summer time. This climate decreases the water content in plants, leading to an increase of the inflammability of the vegetation. Furthermore, in some countries, like Portugal, cool and rainy winters provide soil moisture allowing good vegetation growth, hence increasing the mass of potential burning material. Other countries may instead experience dry winters, like Greece, making resinous pine forests even more flammable.

In general, the fire risk related to meteorological conditions in Southern European countries is very high, as can be seen in figure 4 below. For instance the summer of 2003 in Portugal was characterised by very high temperatures and low humidity, which led to the worst forest fires ever recorded in the country. Also the extended Greek forest fires of 2007 took place in a summer with three continuous heat waves, with temperature peaks above 39°C and low humidity.

Figure 4: Fire risk in southern EU countries (2002-2005)



Source: European Forest Fire Information System/ European Forest Fire Risk Forecasting System

Wind. Wind is another climatic factor influencing fire hazard. The inland summer winds are characterised by high speed and low humidity, and are highly desiccating (FAO, 2007). The dry, cold wind of Mediterranean winters can also increase fire danger. The Greek forest fires of 2007 spread at high speed also due to strong winds (up to 50-70 km/h).

Lightning. 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 (FAO, 2007). More common in Canada and in the Russian Federation, lightning is less frequent in South-East Europe, and in some cases fires started by lightning are extinguished by rain. Nevertheless, lightning can contribute to forest fires. For instance, the serious fires in Portugal in 2003 were also associated with a strong lightning activity at the beginning of August.

Climate change. Predictions of climate warming in the Mediterranean areas indicate an increase in air temperature and a decrease in summer rainfall, suggesting a future increment in water deficit. This in turn may lead to an increase in ignition probability and fire propagation during the summer period.

3.3 Territorial planning and development regulations

Territorial planning and development regulations can also play a significant role in increasing the risk of forest fires. The main issues related to planning and development are described below.

Poor forest land use planning. In general, inappropriate forest land use planning that does not take into consideration the environmental characteristics of the area, e.g. aspects related to the natural occurrence of fire and inflammability of vegetation, has been recognised as a key contributing factor to forest fires both in the Mediterranean and in broader Europe (e.g. Bulgaria - EC, 2005). In a number of cases, e.g. in Portugal, the forestry related land use planning has favoured the spread of monocultures such as pine and imported eucalyptus. These species are significantly more fire-prone than the fire resistant native oak forests; thus the decision to support monocultures has led to a higher frequency of forest fires in several areas – especially in the north of Portugal. Furthermore, on several occasions these land use decisions increasing the risk of fire have been supported by national and EU funds for rural and regional development[10].

Lack of territorial planning and control. In a number of cases a specific lack of territorial planning and control has been identified as one of the important underlying causes of forest fires in the Mediterranean region. This is the case, for example, in Greece, which has experienced a rather uncontrolled construction boom around important urban areas and in rural areas of recreational value since 1970s. This has further led to the development of extended interface zones between forests and urban areas. The territorial planning in these highly sought-after areas has been very poor, partly due to the lack of a complete land register and the often unclear ownership regime at national level. This has resulted in huge private interests in trespassing and building illegally in forest areas. Furthermore, the absence of appropriate territorial plans and land registers is such that burnt forest areas can easily be reclassified and released for development. This factor has been held responsible for the increased occurrence of arson in Greece. In addition, people living in these interface zones have a limited knowledge of forest fires, thus the hazard of fires due to negligence is high.

[10] WWF and IUCN briefing on forest fires in the Mediterranean (2003) http://www.iucn.org/places/medoffice/documentos/Background_med_forest_fires.pdf

Given the characteristics above, the urban – forest interface areas are considered to be very vulnerable to forest fire. In addition, the possible damage to estates in these areas is very high and the conditions for fire-fighting are difficult.

3.4 Inadequacy of response or lack of capacity

Inadequacy of response or lack of capacity is recognised as an important reason behind countries' and/or regions' failure to respond to forest fires. The evidence from the Greek and Portuguese case studies also strongly supports this conclusion. The factors related to response/capacity issues affecting the risk of forest fires are described below.

Insufficient prevention. Insufficient monitoring and lack of appropriate schemes for fire prevention and management are often identified as an underlying cause of fire related natural hazards (e.g. in Greece and Bulgaria). A number of countries suffering from forest fires seem to lack a reliable fire monitoring and forecasting system that would allow an early response in the event of fire. This includes also a systematic monitoring to prevent the re-start of already suppressed fires. For example, in Greece there is a lack of fire-observation towers in use, and guarding and monitoring of forests for fires is limited. Additionally, the relevant authorities have no access to satellite pictures that could enable firemen to quickly find the exact location of blazes. Furthermore, the lack of statistics on forest fires and their causes can also be a major obstacle to the formulation of effective forest fire prevention strategies.

Unsuitable response. In some countries, like in Greece, initial attack from the air has become the basic principle of the national fire service operational procedure. However, in a number of cases, relying only on aerial means might be an inadequate approach. This was, for example, the case in Greece in 2007, when the large number of rapidly spreading parallel fire events exceeded the capacity of the aerial fire fighting fleet. In addition, the Greek ground forces today almost exclusively rely on water to extinguish fires. Use of hand tools is limited (e.g. bulldozers to open ways of access for land fire-fighting vehicles), and there is no provision for use of fire-for-fire control methods such as backfire or even burning-out. As a result, effectiveness of fire suppression missions in areas with few roads (such as high elevation forests) is very low.

Lack of knowledge, resources and funding. In several countries the lack of knowledge, resources and funding has been recognised as a factor contributing to the inadequate response to forest fires. For example, Bulgaria has identified limited and outdated fire fighting equipment as one of their main problems in responding to forest fires (EC, 2005). In Portugal the lack of professional training of volunteer fire fighters in the local fire departments (legally responsible for extinguishing forest fires) has been seen as a significant hindrance to the country's capacity to respond to forest fires. In Greece it is considered that the current public authority responsible of forest fire suppression, namely the National Fire Service, does not have an adequate level of information about extinguishing forest fires (e.g. the behaviour of forest fires, different types of forest vegetation, road networks, forest paths and forest management). As a consequence, the Service faces significant problems in controlling forest fires, indicating that training in urban fire-fighting does not provide sufficient background for efficient forest fire control and management. This seems to demonstrate that good technical equipment, sufficient personnel and fire-fighting training are not enough on their own to guarantee sufficient response in the event of fire.

In general it has been noted that the overall focus for forest fire funding has historically been mostly on fire suppression, although there are movements toward greater funding for prevention as shown in the Portuguese case study (e.g. see section on land use above). Currently, the EU does not have a specific regulation for forest fire prevention[11]. However, the EU Structural and Cohesion Funds provide a number of opportunities for funding of prevention and management of natural hazards, e.g. forest fires.

Lack of cooperation and coordination. Failures in the governance of forest fire management can also significantly reduce the national and/or regional capacity to counter forest fires. In this context, the poor regulatory basis has been identified as one of the reasons hindering coordination between the different state and local authorities dealing with forest fires issues (eg in Bulgaria - EC, 2005). For example, the case study from Greece clearly shows that the lack of cooperation, both between and within the responsible organisations, can result in serious negative effects. It has also been considered that the protection of Mediterranean forests from fire should be closely linked to their day-to-day management and this should be reflected when making decisions on forest fire related governance.

Lack of response from citizens. The Greek case study also flagged up that sometimes the inaction of citizens when confronted with fire can also be considered as a part of the country's inadequate response to forest fires. In the Greek case, people neglected taking basic safety measures (e.g. clearing their fields and groves from undergrowth) despite of the warning on approaching fires. The reasons behind this lack of response are manifold, however the limited cooperation between citizens and the current authority responsible for managing forest fires is seen as one of the underlying factors. In the past, rural people were eager to assist the Forest Service, i.e. the previous authority responsible for action on forest fire, in fire suppression missions. Also, their dependence on forest resources was greater - and thus their interest in protecting forests. Following considerable rural depopulation, the Forest Service was forced to acquire fire-fighting vehicles and hire seasonal fire-fighters. However, this led partly to inaction in the remaining countryside population during fire events. When water-bombing aircrafts were acquired, the inaction of citizens increased even more (Xanthopoulos, 1998). It is seen that the rural population gradually lost knowledge and interest in forest fire-fighting altogether.

3.5 Other causes

Forest fires can be involuntarily set by livestock farmers, when fires which are lit for maintaining pastureland get out of control. In Greece for instance the problem of fires due to grazing on forest land worsened in the 1990s because of misplaced EU subsidies for livestock, and was aggravated by the lack of cooperation between different State services responsible for livestock and for forests (Xanthopoulos, 1998; 1996).

In general, carelessness has been identified as one of the main causes for forest fires in a number of countries, e.g. Greece, Poland and Bulgaria (EU, 2005). For example, it has been estimated that in Poland the human factor is the main cause of fires, as only about 1 per cent of fires are due to natural causes (Ubysz and Szczygieł, 2006). In addition to carelessness, a significant proportion of forest fires through out Europe has been caused by arson. This has been the case, for example, in Greece and Poland (EU, 2005). In a number of cases economic motives and personal gain have been the reasons behind arson. In Greece arson has been used to free forest areas for development activities whereas in Poland the prospect of temporary job opportunities has motivated people to deliberately cause fires.

[11] Working Group on Forest Fire Prevention, 2005. *Conclusions of the Expert Working Group 'Forest Fire Prevention'.* Available at: http://www.ctfc.es/confeinfor/articles/PAPER%20PINAUDEAU_english.pdf

4 CONCLUSIONS AND RECOMMENDATIONS

Forest fires are the most important threat to forests and wooded areas in Southern Europe. Reports of forest fires in France, Greece, Italy, Portugal and Spain show that, in these areas, between 2000 and 2006, more than 450,000 ha burned on average each year. In 2007 the phenomenon got even worse, especially in the South-Eastern countries (Greece and Italy in particular), and the total area burned was about 500,000 ha. Fires have caused extensive damage in recent years, leading to loss of human lives, affecting human health, burning properties, infrastructure and businesses and causing extensive environmental damage in forest and agricultural areas. Forest fires can also contribute to global warming through the emission of CO_2 (FAO, 2007).

The causes of fire are manifold, but as a matter of fact people are overwhelmingly reported to be the main causes of ignition – often as a consequence of agricultural clearing, or due to criminal acts. The hot and dry weather which characterises Southern European countries is also a factor of high fire risk – which could potentially worsen due to the effect of global warming.

Several initiatives should be taken (and some have already been taken) to reduce the impact on forest fires of forest management, land planning, administrative capacity, and other forest related factors. Some recommendations, based on the existing literature and on the examples provided in the case studies on Greece and Portugal, are provided below.

Recommendations: Forest management

Improvement in forest management, especially with respect to fire prevention techniques, has the potential to limit the spread of forest fire both as the fire moves through the forest as well as in assisting fire-fighters (i.e. through enhanced firebreaks, road networks and reservoirs). Forest management practices are considered relatively easy to control. Therefore, many scientists and increasingly policy-makers are recommending that funding be increased for fire prevention and not only fire suppression. At the same time, there is a need for more landowner-specific information on which species should be planted and guidance on biomass removal. There is no overarching EU policy specific to fire prevention. A policy should be in place to encourage forest owners to share the responsibility through collective organisation with proper technical guidance, so that both small and large forest owners contribute to the reduction of fire risk.

Forest management should include methods specifically designed for forest fire prevention, including biomass reduction, prescribed burning and afforestation. There is for instance an opportunity to incorporate fuel management methods into traditional silviculture practices in order to prevent the spread of forest fire (FAO, 2007).

Methods to reduce biomass include mechanical and manual removal of shrubby species and tree thinning to prevent the spread of fire across the ground and up to the tree canopy. The use of herbicides should be highly restricted. Where economically viable, biomass could be used as fuel. Also, mechanical removal of biomass could be combined with clearing road and firebreak networks.

Prescribed burning is a tool to reduce biomass accumulation and is important for fire-dependent species (e.g. pine). It consists of using fire in a planned and supervised way in a predefined zone, without endangering adjacent areas. Prescribed fires require trained labour as well as equipment. The practice is increasing in certain areas of Europe (e.g. Spain) (Molina, 2007). Prescribed burning is particularly effective when combined with livestock grazing. However, farmers and shepherds that use fire need to be trained and supported to ensure the fire is effectively controlled. While it is important to consider that prescribed burning negatively affects air quality, the severity of catastrophic wildfire is much greater.

Afforestation can contribute to or prevent forest fire depending on the type and diversity of species. In determining which species to plant, it is important to consider that species respond differently to fire. Ultimately, a mosaic of different forest types should cover the landscape, which can help to naturally control the fire by varying the flammability of species. In this context, monocultures should be avoided, although this is not often mentioned in the general literature.

Recommendations: Territorial planning

It is clear that poor forest land use planning and the lack of territorial planning and control can significantly contribute to the intensity and frequency of forest fires. Consequently, development of adequate policies and plans that assess fire risk in land-use planning and encourage the participation of all the stakeholders (e.g. public administration, local authorities, land users, land owners) in fire prevention are of high importance. These policies should, for example, take into consideration improving the links between forest and territorial planning tools to ensure their compatibility and enforce their joint use[12]. Additionally, the forest land use policies should integrate the natural risk of fire in all the aspects related to management and conservation of forest resources.

In practice, for example, shifting away from monocultures and providing support to mixed forests with native fire resistant species has been considered to improve the 'natural' fire prevention in the Mediterranean area. In addition to fire prevention, the overall value of these forests (i.e. the range of ecosystem services they provide) has often been underestimated. Consequently, support to more fire resistant land use in forests can also have a broader positive socio-economic impact in an area.

Recommendations: Inadequacy of response or lack of capacity

National and/or regional plans for forest fire prevention and management should be developed and/or reviewed. These plans should appropriately reflect the needs on the ground and they should ensure linkages between fire prevention and management activities and plans and polices for land use and territorial planning. In addition, they should have a specific focus on preventive actions.

Adequate resources and funding for fire prevention and fire-fighting activities should be secured.

When required, the knowledge and awareness of stakeholders on forest fire prevention and management should be improved, including that of competent authorities and the general public.

[12] International Conference on prevention on strategies of fires in Southern Europe (2005) – the book of abstracts. 186 pp. http://www.ctfc.es/confeinfor/htmlangles/articles.html

Coordination and cooperation between different stakeholders, including the involvement of the general public, should be enhanced.

Forest fire governance should be reviewed and, when appropriate, reorganised so that it best reflects the needs of a country/region and efficiently uses the skills of different authorities.

Concluding Remarks

As a general remark, it should be noted that policy makers and citizens should not just react when severe fire events occur. Planning and prevention are always required. Investments in fire prevention can be very effective, as well as public awareness campaigns, monitoring and early warning systems (FAO, 2007).

Political commitment is essential, especially with regard to the provision of adequate budgets, the adoption of proactive rather than reactive responses, the amendment of conflicting policies and legislation and the definition of clear responsibilities for fire management.

The collection of data on forest fires is improving, and should be further encouraged, especially with a view to harmonisation of terminology and definitions, and the development of a common format for regional fire databases across countries.

Collaboration between countries, within and between regions (e.g. on fire suppression, training and information exchange) is generally increasing, and should be further pursued (FAO, 2007).

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ANNEX 1 – CASE STUDY: PORTUGAL

1 FOREST FIRES EVENTS

Portugal is one of the countries most hit by forest fires in the EU. Between 1980 and 2004 more than 2.7 million hectares burned in Portugal due to forest fires, ie about 22% of the burnt area in Southern Europe (EC, 2005)[13].

The fire regime in Portugal has become worse over time. Recently, 2003 (a global heat wave year) and 2005 (a very hot and dry year) have been the worst years for forest fires. This analysis will focus on these two periods in particular to identify and understand the main causes of forest fires, and their impacts on the environment and on society.

1.1 Environmental Damage

On average, during the period 1997-2006, more than 162,000 hectares burned yearly in Portugal due to forest fires. The phenomenon got worse in recent years, and the average burnt area increased to 200,000 hectares per year during the period 2002-2006. In the same period about 1.6 million tonnes of carbon were emitted every year (DGRF, 2007).

Furthermore, forest fires also lead to soil deterioration, causing large soil losses during rainfall and deterioration of downstream water quality. It is also expected that, if current frequencies of wildfires persist or increase, there will be some major consequences for soils and for run-off. Physical and chemical soil erosion increases with decreasing soil thickness, leading to decreased soil fertility and carbon sequestration capacity. Surface run-off can also increase the likelihood of floods (Pereira et al, 2004).

The forests fires of 2003 were the worst in the past 27 years in terms of total area burnt, and led to the destruction of about 425,000 hectares. 67 percent of this area was covered by forest, hence the 2003 fires were responsible for the loss of 8.6 percent of the total Portuguese forest area[14].

The fires of 2005 were also among the most disruptive, second only to the 2003 episodes. About 340,000 hectares were destroyed. In both years, these areas corresponded to about 57 percent of the burnt area in Southern Europe (EC, 2006).

[13] This including Portugal, Spain, France, Italy and Greece.

[14] 3.3 million ha of forest – based on the 1995 National Forest Inventory, 3rd Revision,1999

Table 1: Number of occurrences and area burned in Portugal - 1997-2007

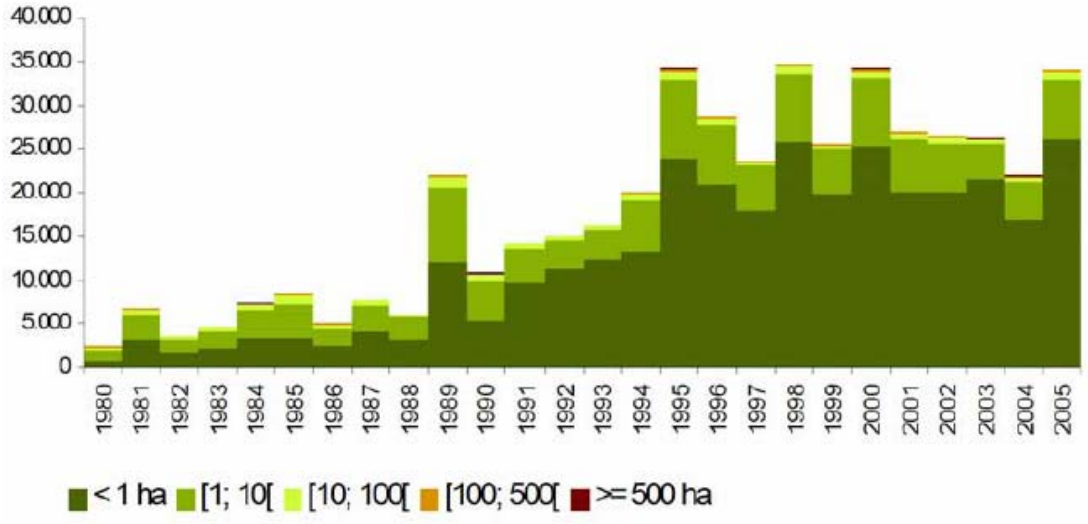
	Number of occurrences		Burnt area (ha)
Year	**Forest fires >1ha**	**Forest Fires <1ha**	**Total**
1997	5,637	17,860	30,535
1998	8,834	25,842	158,369
1999	5,782	19,695	70,613
2000	8,802	25,307	159,604
2001	6,869	20,073	112,166
2002	6,492	20,000	124,410
2003	5,309	20,886	**425,726**
2004	5,020	16,950	129,539
2005	8,179	27,519	**338,262**
2006	3,455	16,466	75,509
2007*	1,567	8,828	16,605
Average 1997-2006	**6,438**	**21,060**	**162,473**

**from 1 January to 30 September 2007*

Source: adapted from DGFR 2007

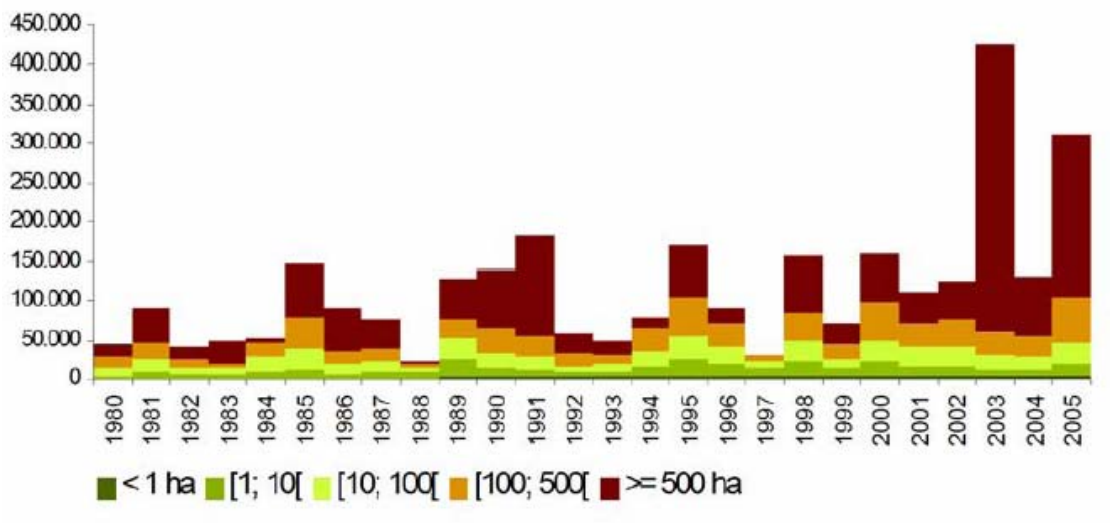
The number of occurrences has increased substantially since 1990, as shown in Figure 5. Figure 6 shows the total burnt area, highlighting the peaks in 2003 and 2005. It is possible to conclude that the increase in the number of occurrences did not correspond to an equal increase in the extent of the burnt area, indicating an increase of the number of small fires (up to 10 ha). This may reveal an improved effectiveness of fire-fighting. For instance, during the worst two years, 2005 recorded the highest number of fire ignitions (about 35,700 ha), but the burnt area was smaller than in 2003 (when the ignitions were 'only' 26,200 ha). Nevertheless it should also be noted that fires of large dimensions (above 100 ha) are responsible for most of the burnt area in the two years considered.

Figure 5: Number of occurrences



Source: DGFR 2006

Figure 6: Size of burnt area (hectares)



Source: DGFR 2006

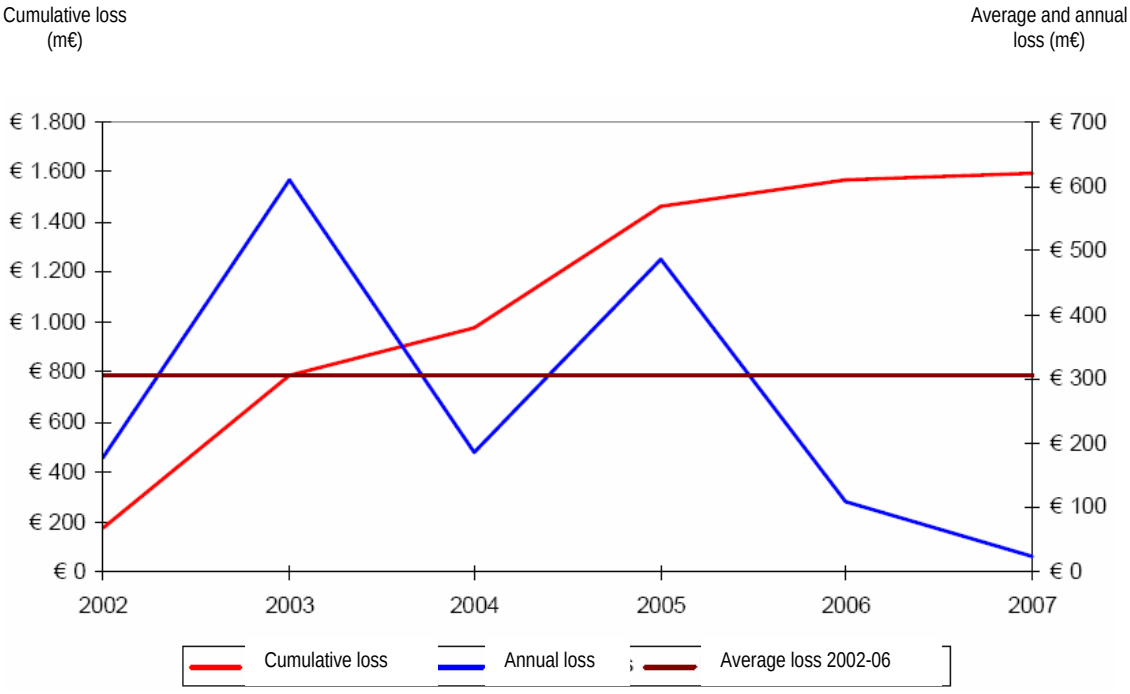
1.2 Economic damage

The average value lost by the Portuguese forest because of forest fires in 2002-2006 has been estimated to amount to more than € 300 million per year (DGRF, 2007). This includes the value of timber and non-timber products lost, of damage to recreational activities and carbon sinks, and to the protection of agricultural soils and aquifers and biodiversity protection. As can be seen in figure 7 below, the worst annual losses have been registered in 2003 and 2005 - respectively about €600 million and €500 million.

The European Commission estimated that in 2003 economic damage was even higher, reaching about €1 billion. It was estimated that more than 2,000 buildings were affected (EC, 2004). More than 2,000 km of electrical cables were destroyed, leaving half a million people without electricity. Telephone networks were also destroyed in some areas, leaving more than 10,000 homes without communication.

Estimates by the Portuguese Catholic University (Mendes, 2004) provide a gross figure for the overall externality cost of forest fires. This include forest fire prevention costs (ie more than €3 million covered by pulp and paper companies, €11 million by the Portuguese government and €3 millions by EU funding), fire-fighting costs (about €36 million -including government expenses, pulp and paper company investments and the opportunity costs of the time spent by volunteer fighters), losses in timber products (about € 38 million) and the cost of restoring burnt forest (€ 45 million). In 2001, these amounted to more than €136 million.

Figure 7: Annual and cumulative loss (mEUR) due to forest fires



Source: adapted from DGRF 2007

1.3 Social Damage

Forest fires in Portugal cause loss of human lives, both among firemen and civilians. The biggest forest fires are those responsible for the largest number of fatalities.

21 people died in the forest fires of 2003, while more than one thousand people were reported to be in need of medical assistance due to smoke intoxication, burns, wounds and other fire related problems. The damage to buildings due to forest fires caused almost 200 homeless (EC, 2004).

In 2005, 18 cases of death were registered. More than a thousand people were also injured (EC, 2004).

2 ASSESSMENT OF THE CAUSES

In Portugal it has been observed that the majority of forest fires are initiated by intentional acts and negligence (DGRF, 2007). In addition to the reasons for the actual ignition, other factors contribute to the spreading of fires, like climate conditions, vegetation characteristics, population distribution, etc. An important factor affecting fire hazards in Portugal is the lack of management due to rural abandonment, which has led to a significant increase of vegetation fuel loads on the ground. Fires are also affected by climate conditions. In Portugal, summers tend to be hot and dry, and most of the plant species in forests and scrublands have a relatively high degree of inflammability. Hence the Portuguese forests are under a high natural risk of damage by fire, especially in summertime. It is also thought that climate change could be a real challenge for the Portuguese forests (Santos et al, 2002), as predictions show that summers are getting drier and hotter (Costa et al, 2007).

Furthermore, forest composition has been changing in the past centuries, witnessing an increase of monocultures of fire-prone species - namely maritime pine and eucalyptus – due to private and public investments (Pereira et al, 2004; Mendes, 2004). Together with land abandonment and depopulation of rural areas, this has worsened the problem of forest fire.

These factors contributing to forest fires in Portugal are described in more detail in the chapters that follow.

2.1 Forest management

One of the most important reasons for fire increase in Portugal is due to **changes in land use.** Agricultural land has been progressively abandoned since the mid 1950s, especially in the interior regions, leading to shrub encroachment. Increased labour costs have also made the cutting of shrubs for animal bedding uneconomical, hence eliminating one of the control factors (Pereira et al, 2004). Shrubs can evolve into more fire-resistant oak forest only if fire frequency is kept at a low level. This though can prove to be difficult given the low level of management of abandoned land. Abandonment in fact leads to having less people occupying and tending the landscape – hence leaving new forests or shrublands unattended - and to decreased landscape compartmentalisation. All these factors create the conditions for the development of frequent and severe fire cycles, especially when large and continuous areas of shrubland are created (Pereira et al, 2004). Furthermore, the abandonment of crop cultivation has led to conversion to extensive animal husbandry. In many interior regions this entails burning by shepherds to maintain the ecosystem in the early succession stage of grassland. This has also been an important factor increasing fire ignitions (Pereira et al, 2004).

In addition, the rapid decline in resin tapping since mid 1980s deprived the forests most vulnerable to forest fires (pine forests) from the regular presence of resin tappers, who were active in overseeing the forests against the risk of fire and worked to reduce the amount of inflammable materials in the forests.

Fire risk is also influenced by the **forest ownership structure**, especially in the north and centre. Most forests and other wooded land in Portugal (about 93.4% - Mendes, 2004) are privately owned and managed. Forest property though is divided among a large number of smallholders, which make a standardized and effective prevention planning against wildfires difficult. Recently created ZIFs (Zonas de Intervenção Florestal) – associations of forest owners leading to common management units – may contribute to planning against wildfires[15]. The average size of private forest properties ranges between 2 ha in the north of Portugal to 30 ha in the centre, and up to 100 ha in the south (Costa et al, 2007).

[15] N. Berrahmouni - WWF

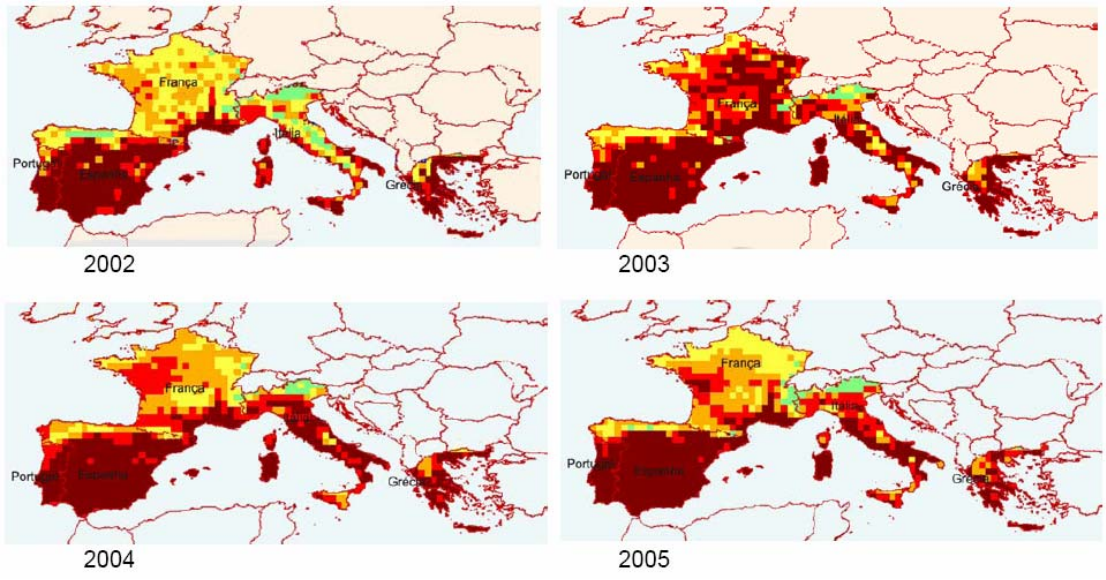
In addition, forest owners often have little incentive to invest in a resource that is at high risk due to fire and yields little return given the small scale of their activities (Pereira et al, 2004). This leads in turn to poor forest management, and hence limited capacity to prevent and fight forest fires. This also partially explains the high frequency of fires in the northern regions, characterised by a large population density in forest land and a small average dimension of forest properties (EC, 2004).

2.2 Extreme weather events or climate change

Most of Southern Portugal is characterised by a Mediterranean climate of cool and rainy winters and dry hot summers. The rainy winters provide soil moisture which, along with warm spring temperatures, leads to high primary productivity of forests. The dry hot summers negatively affect the water content of plants, leading to increased inflammability of the vegetation (Costa et al, 2007).

These two factors make the Portuguese forests particularly vulnerable to forest fires, especially in the summer season. A weak but significant relation exists between **climate variables** (such as precipitation and temperature in the summer season) and the area burnt in the northern regions, while for the southern regions no significant relation could be detected (EC, 2004). The fire risk related to meteorological conditions in Portugal, as well as in other Southern European countries, is very high, as can be seen in the figure below. Meteorological risk has increased in recent years, especially in 2005.

Figure 8: Fire risk in southern EU countries, including Portugal (2002-2005)



Source: European Forest Fire Information System/ European Forest Fire Risk Forecasting System

Predictions of **climate warming** in the Mediterranean area indicate an increase in air temperature and a decrease in summer rainfall, suggesting a future increment in water deficit. This in turn may lead to an increase in ignition probability and fire propagation during summer. Portugal's ecosystems and agriculture are considered particularly vulnerable to climate change (Santos et al. 2002), also because of the increased fire risk.

For instance, the summer of 2003, the worst period of forest fires in Portugal, was characterised by very high temperatures and low humidity, associated with a strong lightning activity at the beginning of August. In 2005 Portugal also experienced a pronounced period of intensive drought, with rain levels mostly below usual averages. These climate conditions led to a very high drought of forest fuels, and hence to an increased risk of fire ignition and propagation. These extreme situations led to the highest number of fire ignitions since 1980 (EC, 2006)[16]. July and August, with temperature exceeding the 30-year monthly average in some of the inland southern regions, were the most difficult months for fire suppression activities. 81 percent of the total burnt area occurred in these two months.

2.3 Territorial planning and development regulations

An important factor held responsible for the high fire risk in the Portuguese forest is the **plant species and vegetation pattern**. The fire resistant native oak–forests have been gradually replaced by monocultures of pine and imported eucalyptus, which are significantly more fire-prone (Mendes, 2004). In the 1960s eucalyptus (*Eucalyptus globulus*) – an alien species from Tasmania – took off to supply wood for pulp mills, replacing part of the pine forests damaged by fires, especially in the northern and central regions. The spread of eucalyptus was due to direct investment of the pulp and paper companies and non-industrial private forest owners, and to national afforestation programmes and incentives. Currently it represents about 21% of the Portuguese forest (DGRF, 2007b). Pine (mainly *Pinus pinaster*) is not an alien species – or it was at least introduced in Portugal long time ago, as there are traces of it since the Neolithic period. Nevertheless its presence in the Portuguese forest increased substantially in the last century. Initially growing in coastal areas – wetter and hence at lower risk of fire – pine has increasingly been planted in continental areas, promoted, directly or indirectly, by public policies and reforestation programmes. Pines now cover about 23% of the Portuguese forested area (DGRF, 2007b), especially in the north of the country. Pine was chosen because it is a pioneer species, e.g. fitting sites which are poor and non-forested, and has a relatively high survival rate. Nevertheless, it is more fire prone than other native species, like oak, and hence is more vulnerable to forest fires (Mendes, 2004). In addition, more recently, a decrease in demand of inflammable forest sub-products (e.g. fuelwood, resin etc) and higher labour costs are leading to increased depopulation and reduced forest management, further increasing the vulnerability of pine forests. These types of afforestation both increased the risk of inflammability, given the characteristics of eucalyptus and pine – which are both highly fire-prone – and the monospecific composition of the stands (Mendes, 2004). Oaks, especially evergreen species (cork oak), which are significantly more fire resistant, are mainly concentrated in the south of the region. This is another factor that explains the higher frequency of forest fires in the north, rather than in the south of Portugal.

[16] This is the first year of forest fire data collection.

Investigation of forest fire causes conducted by the DGRF[17] in the period 2000-2005 revealed that more than 35% of occurrences were due to **intentional causes**. About 27% were caused by negligent use of fire (e.g. burning of grasslands, picnicking, cigarettes, etc), 8% by accidental events (e.g. the operation of farm or forestry machinery, vehicles) and 2% by natural causes. About 28% of forest fires could not be attributed to a precise cause. Some ignition sources reflect the land use in some districts. For example, in some north eastern districts (Vila Real, Bragança and Guarda) fires originated by the renewal of pastures represent a significant percentage of the ignition sources. Ignition from recreation activities – especially due to hunting accidents – are instead more frequent in the northern districts, were hunting is a common activity. Data in 2007 follow a similar pattern – although the number of events with unknown causes is higher. In general it can be observed that the majority of forest fires whose causes can be identified are initiated by human activities, especially due to intentional acts and negligence.

This also explains why the number of forest fires in Portugal is positively related to **population density**. Between 2001 and 2005 the majority of fire ignitions were concentrated in the northern and central littoral area, in the most populated municipalities, and were intentionally caused. 85% of the ignitions occurred at less than 500m from urban areas, and 98% were within a distance of 2 km.

Ignitions were also often very close to the main roads (Catry et al, 2007). High population density though seems to play a double role. On the one hand it leads to a higher number of fires, as many fires are human-caused. On the other hand the probability of early fire detection is higher in high population density districts, and can lead to a quicker response of fire-fighters – hence to a reduction of the average area affected by each fire event (Costa et al, 2007).

2.4 Inadequacy of response or lack of capacity

The Forest Service Agency has been complaining for a long time of the **lack of professional training of volunteer fire-fighters** in local fire departments, to whom the responsibility for extinguishing forest fires has been entrusted by law. For this reason the Forest Service was in favour of developing a network of professional fighters of forest fires, under their supervision, for the operation of preventive silvicultural works outside the fire season, and detection and first intervention during the summertime. Forest fire-fighting though remained a domain of local fire departments and the supervising Ministry of Internal Affair.

[17] DGRF, Direcção-Geral dos Recursos Florestais, Directorate General for Forest Resources

3 RECOMMENDATIONS AND CONCLUSIONS

Lessons learned and initiatives taken in the past

After the forest fires of 2003 the awareness among the population and public decision makers about the economic, social and environmental importance of forests increased substantially. The Portuguese government began a **reform of forestry management**, which encompassed mandatory forest management (with the Government being given the legal capacity to manage forests which are not managed by their owners) and the creation of an **investment fund for forests**. The forest fund is financed by a tax on fossil fuels (reflecting the contribution of forests to the fixation of carbon dioxide released by these) and by the income generated by the government-managed forests (Pereira et al, 2004). In addition, a Secretary of State for Forestry was appointed within the Ministry of Agriculture, new financial incentives were provided to private forest management, and the profile of command-and-control instruments for private forestry was enhanced.

Increased forest management has also been achieved by **aggregating existing properties** and through **joint management** of several plots – through the financing of the investment fund and fiscal support. Some forestry projects are also aimed at replacing shrubby areas.

Among the infrastructures funded by the Portuguese authorities to tackle the problem of forest fires, there are the construction and improvement of **divisional forest roads** for fire prevention, of **fire breaks** and **water reservoirs**.

Responses to land abandonment at various levels have also been taken into consideration, e.g. some **agri-environmental measures** at EU level, national fire responses measures (eg in 2003, see above) and the **acquisition of farms** by the League for the Protection of nature (LPN) for biodiversity protection at local level (Pereira et al, 2004).

The recent developments in the use of **prescribed fire** were followed with a renewed interest in Portugal in the actual fight against wildfires. In 2006 DGRF created 3-4 groups of specialists in the analysis of fire behaviour with the capacity to assess the possibilities to use suppression fire, and the skills to actually perform such operations. The Portuguese elements in the groups had sufficient expertise in the operational use of prescribed fire during winter, and assistance from the GRAF[18] in Catalonia and the Plan Nacional de Manejo del Fuego in Argentina was of great interest. Some of the major wildfires in Portugal during the summer of 2006 saw interventions by these groups. The success of the work encouraged the creation of 6-7 groups of specialists , during 2007. They received further training, and the continued assistance of the above mentioned Catalonian and Argentinean organisations as well as the French organisation Espaces Méditerranéens. In 2007 these groups covered the whole country and were asked by the Civil Protection to assist in most of the large fires. Typically when fires started during the night and aerial attack was not possible the groups performed the analysis and the possible interventions with great success[19]. These new initiatives, besides weather conditions, are thought to explain to a large extent the success of fire-fighting during the 2006 and 2007 seasons.

[18] GRAF, Grup de Recolzament a Actuacions Forestals, Forest Actions Support Group

[19] Reports and videos of their operations were done under the EU research project FIRE PARADOX aiming at a new approach to integrated fire management.

In addition, Portuguese specialists also explored the possibility of using these new approaches in Greece. It was concluded that cooperation and training were needed at EU level in order to develop these new possibilities that were already used in the past and that can be extremely effective (in terms of costs and of effectiveness) if correctly performed. Plans to further develop this approach are underway.

As the problem of forest fires got worse, and environmental awareness rose, the government projects supporting afforestation based on monospecific plantations got more and more criticism (Mendes, 2004). Recent Portuguese programmes[20] tackling forest fires aim to contribute to the **diversification of tree species composition towards broadleaf species**, as they are less vulnerable to fire than maritime pine and eucalyptus (Mendes, 2004). These are thought to contribute to the reduction of forest fires in the long run. The major effects of these programmes though are hardly visible in the short period, as it can take some time for the new species to grow. In addition, these programs are thought not to be able to solve the problem alone, and other problems may offset their effect. This is the case for instance of rural abandonment, with the corresponding abandonment of farming and the increase of scrublands in those places where afforestation of abandoned land did not happen (Mendes, 2004).

Forestry-related programmes and funding in Portugal have generated a demand for technical advice by the non industrial private forest owners. A growing number of **forest owners' associations** appeared since the 1990s, especially in the northern and central regions where small-scale forestry is more salient. The existence and sustainability of these associations is thought to be an important factor contributing to the effectiveness of forestry policy and to sustainable forest management (Mendes, 2004).

WWF through its cork oak landscapes programme is active in three priority landscapes (including Southern Portugal) to develop **models for good practices** in protection, management and restoration based on a multi-purpose management approach. This will aim at conserving all uses, values and services, deriving socio-economic benefit from all values, engaging communities, developing partnerships and promoting certification[21].

Recommendations for the future

Protection against the risk of forest fires should have been a high priority in Portuguese forest policy since the 1960s, when the rural exodus was on the rise. Nevertheless this did not happen. It is believed that in Portugal there has been a **weak integration of forest policy and rural development policy**. As a matter of fact forest fire risk tended to increase in areas where rural exodus was worse, so that some of the new plantations and stands improved with the support of forest programmes were destroyed by fire (Mendes, 2004).

It is thought that the **degree of coordination of political strength of public and private stakeholders has been weak** in the 1980s and 1990s, and did not favour the position of forest policy in the ranking of public policy priorities. Such coordination would have been helpful, among others, in the area of prevention, detection and extinction of forest fires. For instance, financial incentives to forestry depended on the Ministry of Agriculture, while forest fire extinction depended on the Ministry of Internal Affairs (Mendes, 2004).

[20] PAF, PDF and Reg. 2080/92 (1987-99)
[21] N. Berrahmouni, WWF

It was noted that private owners of pine and eucalyptus forests benefiting from public initiatives for fire protection and combat should contribute to the costs of these measures. Although some big companies/owners may have some private fire prevention programmes in effect, small owners do not. **Policy**, it has been suggested, **should take private benefits into account** (Interview with H. M. Pereira).

It is thought that one of the more appropriate ways to deal with fire risk is through prevention, because once a fire starts it spreads very quickly, making fighting largely ineffective (except for the protection of human life and houses). **Fire prevention** is believed to be mainly a matter of **forest management**, e.g. through preventive silvicultural works reducing the accumulation of combustible material. With rural emigration these works are increasingly expensive for private forest owners. Therefore forest policy should promote forms of **collective organisation of private forest owners** to carry out these works with some economies of scale and proper technical guidance, providing the owners with some co-funding to cover part of the costs. In 1999 some financial assistance was provided to forest owners' associations to create brigades to carry out fire surveillance and preventive silvicultural works. The management and funding of this initiative in the past though has not been very effective.

Fire protection and fighting is usually done for production forests, but it has been suggested that **scrublands too should be protected** – as scrubs increase the risk of fire. The **support for pastoral/agricultural activities** for instance was considered to be important, as these activities decrease the amount of fuel (e.g. shrubs) and hence the risk of forest fires. Some measures supported by subsidies for Natura 2000 areas are under development.[22]

WWF has also suggested providing new incentives for people to manage and preserve the land, like schemes of payments for environmental services (e.g. biodiversity, carbon sequestration, hydrological cycle). Innovative ways of generating income from rural and forest areas, it was noted, may create incentives for landowners to preserve the land and invest against wildfires[23].

Restoration programmes can also play a role. The Forest Landscape Restoration (FLR) approach, for instance, developed by IUCN and WWF, helps to manage tree-planting, and also searches for the best ways to re-establish the forest functionality within a landscape. Interventions include for example the rehabilitation and management of degraded forests (including enrichment planting), the promotion of natural regeneration, ecological restoration (including the establishment of corridors between protected areas), and the development of income-generating activities based on sustainable use of natural resources. Within its cork oak landscapes programme, WWF with its partners such as ADPM (Associação de Defesa do Património de Mértola) applied this approach in 200 ha of land in Southern Portugal and guidelines have been developed.

It has been noted that one of the cheapest measures for fire protection is to **plant oak tree species**. Their ecosystem services are often underestimated, as well as their economic value. Evergreen oak in fact is a valuable resource for the cork industry. Furthermore, deciduous oaks growing in the north of the country are currently mainly used as firewood, but could more profitably be used for timber.

[22] Interview with H. M. Pereira
[23] N. Berrahmouni, WWF

Recent studies have also proved that oak could be useful as construction material. Nevertheless, oak is less attractive due to its slow growth (i.e. first cork extraction is done at 30 years after planting). Many of the owners of oak forests are old, and may not see the profit of new plantations. It was noted that it will be important to raise people's awareness of the value of oak, especially of the economic potential of timber from deciduous oaks[24].

Prescribed fires (or burns) are also considered effective tools for fire prevention. This approach, also tested in some US national parks, consists of starting controlled fires, usually during winter, creating discontinuity in forests or burning shrubs – ie reducing the possibility of big forest fires spreading. Prescribed fires would be relatively easy to do in oak forests, less so in eucalyptus and pine forests – given their high fire proneness and hence the difficulty to keep them under control[25].

Summary of the issues and core messages

The fire regime in Portugal has become worse over time, with 2003 and 2005 the most recent worst years – leading respectively to the destruction of about 425,000 and 340,000 hectares. In both years, these areas amounted to almost 60% of the burnt area in Southern Europe.

The causes of forest fires have been attributed to the increase of fire prone species (especially pine and eucalyptus), associated with the depopulation of the interior of the country (leading to an increase of unattended shrublands) and lack of forest management due to the small average holding size. Weather conditions, i.e. hot and dry summers, have also contributed to the spread of forest fires, and could potentially become worse due to the effects of climate change. Fire ignition has also been frequently attributed to human responsibilities, e.g. negligent use of fire.

Among the main initiatives to counteract forest fires, it is recommended to diversify forest composition (e.g. re-introducing broadleaf trees), act on rural depopulation (e.g. through agri-environmental measures), improve forest management, integrate forest policy with other policies and coordinate with private stakeholders, aggregate existing properties (e.g. through joint management or forest owners' associations) and adopt other ancillary measures – like prescribed fires – which could reduce fire risk.

Some measures have already been implemented, although their effect has not always been perceived, either because they will bring results only in the medium or long term, or because they were not sufficient. As a matter of fact, the combination of weather conditions and of measures taken resulted in a substantially smaller burnt area in 2006 and 2007. Further efforts may be required in the future, especially in light of the likely increasing risks of fire related to climate change.

[24] Interview with H. M. Pereira
[25] Interview with H. M. Pereira

Acknowledgements

Many thanks to the experts who have been interviewed and/or have provided comments on the work for their time and very useful contributions, namely:

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ANNEX 2 – CASE STUDY: GREECE

1 FOREST FIRES EVENTS

In the summer of 2007, Greece was severely hit by forest fires. Three consecutive waves of heavy fires raged all across the country from the end of June to early September (see Box 1 for a brief chronological account of the fire events).

Box 1 Chronology of fires in Greece in the summer of 2007

In June and July 2007, forest fires affected parts of middle Greece (area of Agia on Mount Ossa, Mount Pelion in Magnesia), the island of Crete as well as the National Park of Mount Parnitha outside Athens. In total, hundreds of fire sites were reported across the country at the end of June. In July, occasional fires continued to erupt around the country, and in the second half of July many fires grew large (Xanthopoulos, 2007).

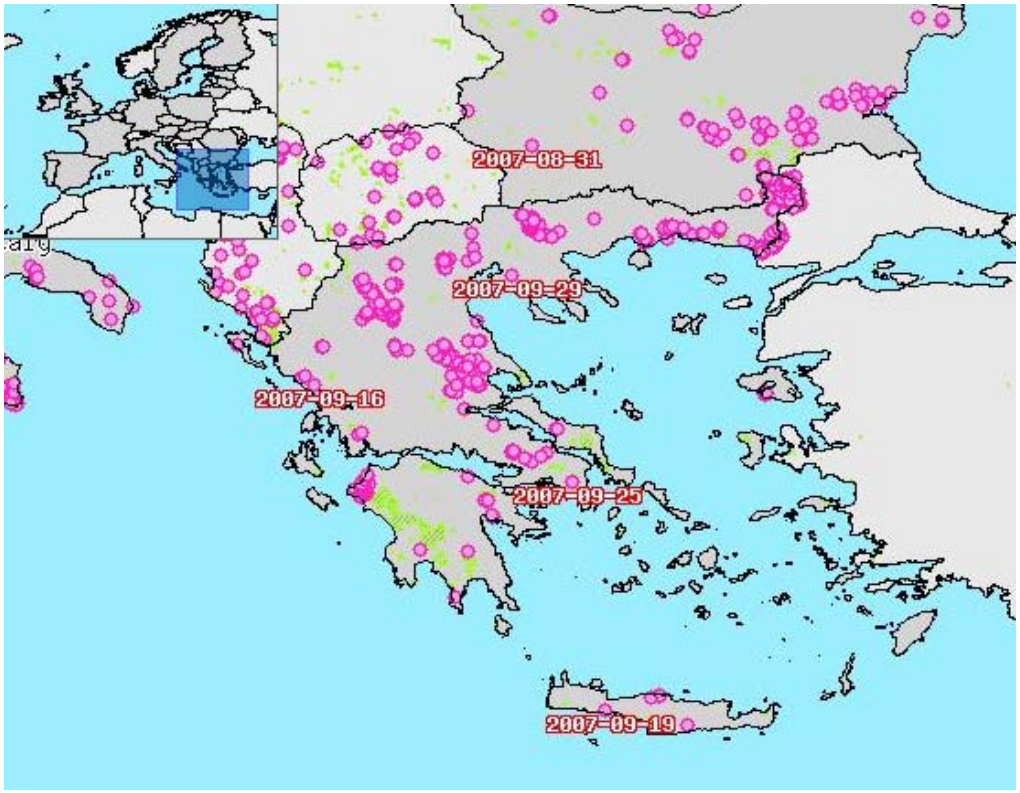
August proved to be the month most severely marked by forest fires. On 16 August, a fire started on the slope of Penteli mountain, at the north eastern boundary of the Athens basin. From 24 to 28 August, a series of fires started mainly on Peloponnese and the island of Evia, leading to the greatest forest fire disaster of this summer. Even the ancient Olympia site on Peloponnese was threatened by the blazes. The site and its museum were saved but all the forest around it burned down.

In total, more than 3,000 fires were recorded all over Greece, ravaging approximately 270,000 ha of forest, olive groves and farmland, according to data of the European Forest Fire Information System. The greatest forest area burned out within only three days in August 2007 in the large fires on Peloponnese and Evia. On the Peloponnese, 177,265.4 ha burned out, consisting of 55% forests and natural lands, 41.1% agricultural lands and 0.9% built-up areas (WWF, 2007). Figure 9 shows the location of the most important fire events in summer 2007.

The 2007 forest fires of Greece have now gone on record as the most catastrophic in the country's history and the most catastrophic of the last decades in Europe. The toll does not include only forests and agricultural lands, but also entire villages, infrastructure and a large toll on human life (WWF, 2007). These fire events have been cited in the press as the fourth worst disaster due to forest fires worldwide since 1871 and by far the deadliest for humans in recent years.[26]

[26] Newspaper 'Macedonia', online edition of 24/10/2007 (in Greek).

Figure 9 Map of forest fire events in Greece, summer 2007



Source: EFFIS Open Web Service, Rapid Damage Assessment.
Green areas represent 'burned areas' and red circles represent 'hot spot detection'.

The special characteristics of the 2007 forest fires, which distinguish them from past forest fires in Greece, can be summarised as follows:

- In summer 2007, the phenomenon of 'mega-fires', i.e. fires of very large size and extent, was recorded in Greece.[27]
- Although the number of fires recorded was not remarkable, the extent of the burnt area was very large compared to previous years.
- Many fire episodes occurred at the same time in several locations.
- There was frequent re-start of already suppressed fires.

The following paragraphs illustrate key environmental, economic and social impacts of these fires. In summary, the main short- and long-term impacts include: ecological disasters and impacts on the climate, threats to cultural monuments (e.g. ancient Olympia on Peloponnese), immense damage to real estate, agriculture and tourism (with implications for the national economy), a large toll on human life and health, and homelessness and unemployment as well as 'fire refugees'.

Chapter 2 of this Case study discusses the underlying causes of the fires while chapter 3 presents recommendations and key messages.

[27] Official joint statement of Greek Scientific Researchers on the '2007 Forest Fires'. Available online: http://www.arthro24.gr/pdf/paremvasi.pdf. Accessed: 10 December 2007 (in Greek).

1.1 Environmental Damage

Biodiversity impacts. The burnt areas of summer 2007, which lie within protected areas of the Natura 2000 network, amount to 30,132 ha (WWF, 2007). On the **Peloponnese**, WWF recorded impacts on seven important Sites of Community Importance, and significant impacts on the biotopes of certain species of special ecological importance: the golden jackal (70% of its population lived in these protected areas of the Peloponnese), 4 out of 5 species of endemic lizards, land turtles and other animals. The potential for recovery of these biotopes depends on the effective protection of these areas from any future change in land use. Apart from the environmental damage within protected areas, equally significant was the impact on the wider natural environment of the Peloponnese, due to the destruction of extensive tracts of natural vegetation, covered by Aleppo pine forests, low phryganic and maquis vegetation and grasslands. It is estimated that in total 97,518 ha of natural vegetation cover was totally burned (WWF, 2007).

Another great ecological damage of the 2007 forest fires occurred in the **National Park of Mount Parnitha** near Athens. A significant part of the nucleus of the National Park and of the Parnitha true-fir forest was burned. The destruction in much of the Parnitha National Park is irreversible in the mid-term. True-fir forests are not adapted to fire events. If burned, they have to be regenerated with human help, especially on Mount Parnitha where the true-fir forest grows at the limits of its climatic distribution zone. It shall take great efforts and costs to regenerate this forest[28]. The forest fire in Parnitha also caused damage to the populations of several protected birds, mammals (especially deer – the National Park of Parnitha hosted the most important population of *Cervus elaphus* in the country), other vertebrates and invertebrates (WWF, 2007b).

Climatic impacts. Forest fires will have impacts on the climate of the fire-afflicted areas in Greece. These impacts are expected to include a rise of average local temperatures, extension of the summer period, and a reduction of the volume and at the same time increased intensity of rainfall.

Especially in the urban area of Athens and surroundings, more intense heat waves are expected in the coming summer periods due to the destruction of the Parnitha National Park. Further, air quality will worsen, since burnt areas will be a continuous source of micro-particles.[29]

1.2 Economic damage

Following the catastrophic fires on the Peloponnese and Evia in August 2007, the Greek government declared a state of emergency and allocated about €300 million for emergency relief. However, the final cost of the fires is likely to be higher. Tourism and agriculture have been hard-hit and the regeneration of forests will take many years.[30] An independent estimate by the international assessment firm Standard & Poors evaluates the damage in the range of €3 to 5 billion, corresponding to 1.4% to 2.4% of the country's GDP (Xanthopoulos, 2007).

[28] Newspaper 'Ethnos', online edition of 13/12/07. Statements Mr. Amorgianiotis, Forester of Parnitha National Park, and Ms. Verdi, forest scientist of the Afforestation Directorate of Attica (in Greek).

[29] Newspaper 'Ta Nea', online edition of 17/8/2007. Expert interview with forester-environmentalist Mr. Chlykas (in Greek).

[30] Newspaper 'The Times', online edition of 29/8/2007.

Especially on the Peloponnese, the impacts of forest fires on the local economy are considered to be very high. The on-site inspections have recorded extensive damage to entire villages, to thousands of houses, to livestock, to the road network, and to telecommunications, electricity and irrigation networks.

The sector of tourism is also expected to be affected significantly. Tourism on the Peloponnese was almost exclusively based on the natural environment and the traditional human settlements as primary attractions for the thousands of foreign and Greek visitors. If unplanned development of the human settlements and encroachment on natural areas is not effectively prevented during the reconstruction phase, the region is expected to experience a degradation of its tourism potential (WWF, 2007).

As concerns the agricultural sector, it should be kept in mind that the Peloponnese hosted 35% of the country's livestock and 30% of the country's olive groves.

Indeed, the 78,043 ha of agricultural land burned on the Peloponnese were primarily olive groves. In the Prefecture of Ilia alone, 50% of the olive production potential was totally burned (WWF, 2007). Such damage should be seen in relation to the main source of income in this area. In this Prefecture, 50% of the employed people work in the primary sector. At the same time, this Prefecture has the lowest GDP/capita of all Prefectures struck by the August fires (approximately half of the national average GDP/capita).[31]

The extensive damage to olive trees and livestock is bound to change the agricultural production balance on a national level and will require extensive compensation for agricultural damage. Indeed, many farmers will have to live from European subsidies and national compensation for several years. For many, there will not be full compensation of damage and they will be called upon to decide whether to make a new start or abandon the countryside.

1.3 Social Damage

The fires of summer 2007 caused the death of 76 people (Xanthopoulos, 2007). The fires also left thousands of people homeless and unemployed (WWF, 2007).

Additionally, the 2007 forest fire events can have serious short- and long-term impacts on health. In addition to the immediate health impacts on citizens and firemen during the fire, there can be impacts from the toxic smog remaining over cities in the long-term. This smog can lead to an increased occurrence of diseases of the respiratory system and of the heart.[32] Additionally, large quantities of dioxins, with the ability to accumulate in animals and humans, were emitted during the large fire events.[33] Toxic pollutants in the ashes can also pollute groundwater. In many areas, the use of water from wells was prohibited until further investigation.

The quality of life of inhabitants in fire-affected areas will also be undermined by damage to the landscape. It is estimated that the destruction of the natural vegetation cover will be followed by a disturbance of the soil and water balance and, most likely, by floods, land- and mudslides (WWF, 2007).

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31 Data of the National Statistical Service and Ministry of National Economy, cited in Newspaper 'Kyriakatiki Eleftherotypia', edition of 2/9/2007 (in Greek).

32 Newspaper 'Ta Nea', edition of 23/8/2007. Expert interview with Prof. Siafakas, Professor of Pneumonology at the Medical School of the University of Crete (in Greek).

33 Newspaper 'Kathimerini', online edition of 14/10/2007. Expert interviews with Mr. Nikolaou, Vice-president of the Union of Chemists of Central and Western Macedonia, and Ms. Nikolopoulou-Stamati, Professor of Athens Medical School (in Greek).

2 ASSESSMENT OF THE CAUSES

This chapter discusses different causes or factors which contributed to the forest fire events in Greece in summer 2007. The assessment is mainly based on interviews with Greek scientific experts as well as on the information available in published articles and the press.

There is no question that the forest fire season of summer 2007 was a very difficult one in Greece. However, the circumstances cannot be considered unique and it would be overly simplistic to attribute the disaster to extreme weather conditions due to climate change (Xanthopoulos, 2007). Scientific experts emphasise that the main underlying causes lie in the lack of appropriate preventive forest management and of a fire prevention policy, the weakness of State mechanisms for effective forest fire suppression and the lack of organised hazard management plans in the event of so-called mega-fires. Above all, the perception that protection from forest fires is equivalent to forest fire suppression is to blame for the tragic fire events of 2007. The emphasis on these causes is not intended to underestimate the role of climatic factors (evident in prolonged periods of drought and heat waves) and/or criminal action (arson) linked to development ambitions. However, since neither the climate nor arsonists' intentions can be directly influenced, scientific experts see increased efforts in forest ecosystem protection as the key to more effective forest fire control in the future.[34]

2.1 Forest management

Forest management for forest fire prevention has unfortunately not actively been practiced in Greece in recent decades. This is mainly obvious from the accumulation of large amounts of dry biomass and other flammable material such as scattered litter in Greek forests. Biomass and other flammable material enormously increase the potential intensity of fires, as soon as these break out under favourable weather conditions.[35] There are multiple reasons for the accumulation of flammable biomass in Greek forests, which are summarised below.

Greek forests had not experienced large fire events in the last 5-6 years prior to 2007. Thus, much dry uncollected biomass could accumulate in the forests (Interview 1).

The collection of superfluous forest biomass by people is a practice that has been abandoned in Greece for several decades now. In the past (prior to 1970), people in the Greek countryside collected wood and forest undergrowth for heating and cooking purposes etc. People in fact had no alternative but to take fire-fighting (next to biomass collection) in their hands under the guidance of forest workers. The spreading of any fire was a direct danger to personal belongings, crops and the forest which was itself a source of income and employment for many citizens, as well as of wood and resin. Then, social changes due to migration away from the countryside led to a radical reduction of the rural population and increased the hazard of fires due to the accumulation of non-collected biomass in the abandoned countryside. Also the replacement of wood by other energy sources contributed to the accumulation of biomass (Xanthopoulos, 1998; Interview 2).

The abandonment of active fire-preventive forest management is most evident in Greek pine forests (Interview 1). Traditionally, forest management by the Forest Service (the State organisation competent for forest management) was centred around mountainous areas, mainly in Northern Greece, where productive forests grow.

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[34] Newspaper 'Kathimerini', online edition of 11/9/2007. Expert interview with forest scientist Mr. Eftychidis (in Greek);
Official joint statement of Greek Scientific Researchers on the '2007 Forest Fires'. Available online: http://www.arthro24.gr/pdf/paremvasi.pdf. Accessed: 10 December 2007 (in Greek).

[35] Ibid.

Low elevation pine forests were for the most part left out of scientific management as the funds needed for this task were never available. On the ground, there was a management scheme applied by resin collectors who cultivated the pine forests, securing their regeneration and protection. When Greece joined the EU in the 1980s, subsidies to resin producers were not among the policies of the EU. Thus, a lack of incentives and the emergence of other financially more attractive opportunities led to low-elevation pine forests being left practically unmanaged. As these forests and villages were gradually abandoned, the number of forest fires and the area burned annually started growing steeply since the end of the 1970s (Xanthopoulos, 2004). Pine forests are especially vulnerable to fire and thus in need of appropriate management for two reasons: First, they are highly flammable due to their nature. Pine-needles disintegrate slowly and create much and highly flammable biomass. Second, low-elevation pine forests are usually located close to the coastline, to urban centres and on islands. At these locations, land is of high value and forests frequently become the target of arson aiming at real estate development (see also section 2.3) (Interview 1).

A parallel development was the weakening of Greek forest management in general as a result of institutional restructuring in the late 1990s. In 1998, competence for forest fire suppression was transferred from the Forest Service to the Greek Fire Service. This transfer of competence was faced with resentment by Forest Service personnel. Much of their specialized knowledge and experience in fire-fighting seemed to be wasted. This was especially true for senior officers who had devoted a big part of their lives protecting forests with few means and State support. The Forest Service was also deprived of its central leadership and political strength, when the central General Secretariat for Forests and Natural Environment was turned into a (less strong) General Directorate in the Ministry of Agriculture. The Forest Service was broken down into a decentralised structure placed under the administrative mandate of the country's Regions. Funding to the Forest Service systematically decreased, although forest fire prevention still remained its responsibility (according to law). Examples are the lack of funds to maintain the network of forest roads, the abandonment of efforts to control biomass accumulation and in general the abandonment of active forest management in the less productive forests (Xanthopoulos, 2004). Funds allocated to fire prevention have in total been very limited compared to funds allocated to fire suppression. The fires of 2007 revealed the limited work being done on forest road and firebreak maintenance. The lack of firebreaks and the inability to clear forest roads on time for easy access to the fire locations made the rash spreading of fire easier and its suppression more difficult.[36]

The fire prevention mandate of the Forest Service not only suffers from lack of funding but also from lack of a clear objective since fire suppression was taken out of its hands. The Forest Service staff has grown old, since no new personnel has been hired for years. The motivation of the Service has also decreased; this Service was in the past quite effective in forest fire suppression with few funds, while now the Fire Service is given a much higher budget but is much less effective (Interview 2). Indeed, forest fire prevention nowadays also suffers from the missing fire management mentality within the Forest Service. As time goes by, the knowledge and experience of the Forest Service staff with respect to forest fires is being lost. This is negative both with regard to the perspective for better fire-aware forest management as well as with regard to the introduction of preventive fire-fighting techniques such as prescribed burning to control biomass and prevent large fires (Xanthopoulos, 2004).

[36] Newspaper 'To Vima'/monthly publication 'Vima Ideon', edition of September 2007. Expert opinion of Prof. Mylopoulos, Aristoteles University of Thessaloniki (in Greek).

2.2 Inadequacy of response or lack of capacity

The institutional changes described in the previous section (transfer of forest fire suppression competence from the Forest Service to the Fire Service in 1998) resulted in an overall shift of emphasis from forest fire prevention to fire suppression.

As concerns preparedness for adequate response to fire, this transfer of competence was considered, on the one hand, a positive step given the good technical equipment, the sufficient personnel and fire-fighting training of the Fire Service. On the other hand, the Fire Service had (and continues to have) very little knowledge of the behaviour of forest fires, different types of forest vegetation, road networks, forest paths and forest management in general. The Fire Service was not adequately prepared and trained for its new duties in fighting forest fires. The training and operational mode of the Fire Service in urban fire-fighting are principally focused on the protection of humans and infrastructure rather than forests. It also soon became evident that no provision had been made for adequate cooperation between the personnel of the Forest and Fire Services at all levels (Xanthopoulos, 2004).

Several experts argue that the decision to transfer forest fire suppression competence from the Forest Service to the Fire Service was mainly a political one and was not justified on the basis of objective criteria (Xanthopoulos, 1998; 2004; 2007b). Xanthopoulos (1998) emphasised that this decision followed the model of non-Mediterranean countries and was not appropriate for a country like Greece dominated by Mediterranean forest ecosystems. The protection of such forests from fire is inseparably linked to their day-to-day management.

The reservations of experts with respect to these organisational changes in forest fire suppression were confirmed in practice. Two catastrophic years in terms of forest fire damage (in 1998 and 2000) revealed the lack of preparedness and specific knowledge of the Fire Service on forest fires. The government, however, remained steady in its decision and rashly enhanced the Fire Service with more personnel and technical fire-fighting equipment (Xanthopoulos, 2007b). For this reason, the cost of forest fire-fighting in recent years in Greece has sky-rocketed. Even if the Fire Service eventually does become more effective in forest fire suppression than the Forest Service, this will be achieved at a very high cost.

There are several long-term weaknesses in the current fire management scheme of the Fire Service, which contribute to the burning of ever increasing areas despite the availability of more water-bombing aircraft and fire-fighting vehicles:

- The technical means for fire-fighting acquired by the Greek State in recent decades are (contrary to reports in the press) of the best and most expensive equipment available globally for forest fire-fighting purposes. The fact that results on the ground still do not meet up to expectations is attributed by experts mainly to the lack of adequate knowledge and training to make best use of the new technical equipment. Xanthopoulos (1998) discusses several cases of errors in the use of new technical means.
- Massive initial attack from the air has become the basic principle of the Fire Service operational procedure. However, when demand exceeds the capacity of aerial means, the ground fire-fighting forces are not able to control fires effectively. Heavy reliance on aerial means during initial fire attack has also led to relative complacency from the ground crews. In 2007, heavy reliance on aerial means proved to be a failed approach due to the rapid spread of the fire and the large number of parallel fire events (Xanthopoulos, 2007).

- Ground forces today almost exclusively rely on water to extinguish fires. There is no provision for use of fire-for-fire control methods such as backfire or burning-out. As a result, effectiveness of fire suppression missions in areas with few roads (such as high elevation forests) is very low (Xanthopoulos, 2007).
- Monitoring of the eventual re-start of suppressed fires is not done systematically.
- There is a lack of fire-observation towers, guarding and monitoring of forests as well as no access to satellite pictures that could enable firemen to quickly find the exact location of blazes.
- The Fire Service lacks sophistication in coordinating large-scale forest fire-fighting operations. Use of maps, fire behaviour prediction tools and fuel maps are limited (Xanthopoulos, 2007).
- Since 1998, there are no trustworthy statistics on forest fires and their causes, under the coordination of an appropriate central service. This is a major obstacle to the formulation of any effective forest fire prevention strategy (Interview 2).
- The Forest Service, which has expert knowledge on forest management and forest fires, is not actively involved in fire suppression activities anymore (see previous section). Since 2001, a newly established General Secretariat for Civil Protection has made many efforts to make the Forest and Fire Services work closer together, for instance by drafting common fire pre-suppression plans at Prefectural level. Indeed, some progress has been made in this respect. However, the Fire Service tends not to cooperate closely with other State organizations.

As concerns the specific forest fires in summer 2007, Greek authorities apparently failed to enforce adequate safety measures and create firebreaks on time, despite the high risk of forest fires in an unusually hot summer. The 2007 fires revealed weaknesses in the effective coordination of fire-fighting forces. During the fire-fighting operations, there was inadequate coordination of the responsible persons and services, while *ad hoc* political interventions seemed to partly steer the deployment of the available fire-fighting means.

What was also remarkable in the 2007 events was the inaction of citizens when confronted with fire. In certain places, blazes were expected to arrive within 3-4 days but people still did not take basic safety measures like clearing their fields and groves from undergrowth. In the past, rural people were eager to assist the Forest Service in fire suppression missions. Dependence on the forest resources (and thus interest in forest protection) was greater and people were eager to maintain a good relationship with the Forest Service (foresters often provided jobs and resources to the rural population) (Interview 2). Following considerable rural depopulation, the Forest Service was forced first to acquire fire-fighting vehicles and then to hire seasonal fire-fighters. The negative side-effect was that this led partly to inaction in the remaining countryside population during fire events. When water-bombing aircraft were acquired, the inaction of citizens increased even more (Xanthopoulos, 1998). Eventually, the rural population lost knowledge and interest in forest fire-fighting altogether.

Last but not least, the strategic role of mass media in the 2007 forest fires should also be mentioned. The response of the mass media to the forest fires created an atmosphere of public fear and insecurity. In the same time, the media transmitted very detailed information on the location of fire events as well as the location and operations of the Fire Service. This strategic information was widely disseminated, making it very easy for candidate arsonists to start fires in locations not guarded by the Fire Service anymore (Interview 1).

2.3 Territorial planning and development regulations

In the search for the underlying causes of the 2007 Greek forest fires, discussions most often lead to weaknesses in Greek physical planning and development regulations, which encourage criminal actions like arson.

Greek officers concluded that at least some of the fires of 2007 could be attributed to arson. In the Peloponnese, suspicions of arson were reinforced by the fact that dozens of fire episodes started at the same time. Evidence suggests that the 2007 fires broke out due to a combination of criminal intent, carelessness and accidents. In addition to arson, the lack of maintenance of the electricity pylon network, carelessness of local farmers, villagers and forest visitors lighting up fires on hot days, illegal landfills left unguarded and the inability of elderly livestock farmers to control fires they started to maintain grazing land are frequent causes of fire.

As far as arson is concerned, arsonists certainly have strong motives for starting fires in Greece. Rising incomes have fuelled a construction boom around important urban centres but also in rural areas of recreational value. In the end of the 1970s, the construction of tourist settlements and holiday second homes in the Greek countryside, especially on the coastline, started with fast pace. Around many urban centres, extended interface zones between forest areas and urban areas appeared. In these interface zones, people know very little about forest fires. Thus, the hazard of fires due to negligence is high. Additionally, in these zones, urban settlements growing into the landscape are hardly protected from fire blazes. The possible damage to estates is thus very high and fire-fighting very difficult (Xanthopoulos, 1998; 2004).

Construction development after the 1970s rapidly led to the high rise in land value and this trend continues until today. At the same time, planning for such development has been very poor. Lack of a complete land register and the often unclear ownership regime in Greece were and still are problems hindering efficient planning. This situation created large private interests in trespassing and building illegally, especially in forest areas, bringing a large part of the population in conflict with the Forest Service (Xanthopoulos, 1998). The Forest Service did not allow constructions within forests, being protective of forest State ownership, and became more and more frequently involved in court cases against forest trespassing. Its popularity decreasing, most citizens did not defend the role of the Forest Service when it was deprived of key responsibilities in forest protection in the late 1990s (Interview 2). All these have been key background developments contributing to the systematic weakening of the Forest Service (as described in previous sections).

The aggressive intrusion of human settlements into the fire-prone Mediterranean Greek forests without proper planning is indeed facilitated by several factors.[37] Inadequate legislation is part of the problem, but the main issue is bad implementation of legislation (Interview 2). The following contributes to this situation:

- When a forest is burned, mapping is needed to declare it as an area intended for reforestation. The problem is that this is not always practised (Interview 2). It has been a usual practice not to reforest the greatest part of burnt forests, despite the fact that reforestation is a constitutional obligation since 1975.[38]

[37] Official joint statement of Greek Scientific Researchers on the '2007 Forest Fires'. Available online: http://www.arthro24.gr/pdf/paremvasi.pdf. Accessed: 10 December 2007. (in Greek).

[38] Newspaper 'To Vima', edition of 15/7/2007. Expert opinion of Prof. Kassimatis, University of Athens (in Greek).

- Politicians often declare an amnesty for illegal buildings in forest areas ahead of elections.
- The lack of a nation-wide forest and land register (as mentioned above) makes it difficult to prove that a burned area was forest land before the fire. There are only few local exceptions, like the National Park of Parnitha, where the Forest Service is relatively well organised and equipped with land register maps to easily define the exact area of the forest.[39]
- If an area is reclassified from forest to non-forest land, it can easily be released for development. In fact, reclassifying forest-land is very attractive because, in Greece, it is possible to build in areas outside town plans, with only certain limitations on the size of buildings. In many places, local officials with the power to re-classify forest land are open to bribery to ease the issuing of construction permits in former forests.
- In 2007, shortly before the summer period, a proposal was put forward by the government to revise the article of the Greek Constitution referring to forest protection (Article 24). The proposed revisions would make the re-classification of forests and forest areas even easier and would accelerate privatisation and commercialisation of forests. This legislative attempt, which was finally rejected, is alleged to have encouraged arson plans for the summer 2007.

2.4 Extreme weather events or climate change

The extended Greek forest fires of 2007 took place in a summer of three continuous heat waves. The exceptionally high summer temperatures, following a winter drought, made the resinous pine forests more flammable than usual and created very favourable conditions for extensive fires. Reports on the large fires of the Peloponnese described fires spreading with extremely high speeds, due to strong wind conditions, high temperatures and the specific relief of certain areas. In fact, in the case of the third fire wave that hit the Peloponnese, fire danger had been extreme. Temperatures above 39 degrees for three days were followed by a day of 50-70 km/h winds and extremely low relative humidity. The vegetation was severely water-stressed, since there had been no rain in Southern Greece for the whole summer (Xanthopoulos, 2007).

Nevertheless, although climate change in the Mediterranean region leads to hotter and drier summers and increases forest fire hazard, experts do not point to extreme weather conditions, scarcity and high temperatures as the main cause of the 2007 forest fires. In fact, following the prolonged water-scarce conditions of 2007, the probability of intense fire events was estimated to be quite high and, thus, more adequate fire prevention measures should have been taken in advance (e.g. clearing of dry forest biomass).

[39] Newspaper 'Kathimerini', online edition of 15/07/07. Interview with Mr. Amorgianiotis, Forester of Parnitha National Park (in Greek).

2.5 Other factors: Livestock grazing

Many forest fires erupt because fires lit by livestock farmers for the purpose of maintaining grazing land get out of control. In fact, livestock farmers start such fires without appropriate planning and scientific advice in the context of grazing management programs (Interview 2). In the 1990s, the problem of fires due to grazing on forest land worsened because of misplaced EU subsidies for livestock (Xanthopoulos, 1998). The mode of subsidy allocation acts as an incentive to increase the number of animals without considering the biological capacity of the grazing areas used.

This contributes, on the one hand, to the ecological degradation of grazing areas and, on the other, to the intensification of fires lit by livestock farmers. This situation is aggravated by the fact that there are different State services responsible for livestock and for forests (in the Ministry of Agriculture), which do not cooperate closely to develop an integrated livestock management policy (Xanthopoulos, 1996).

3 RECOMMENDATIONS AND CONCLUSIONS

Dealing with forest fires requires **reorganisation of the Greek system and policy for forest protection** on a national level, to ensure a consistent management cycle of fire prevention, suppression and management of burnt areas. The reorganisation of forest protection should be based on scientific and not on political criteria[40].

Investments are needed to **enhance the training and knowledge** of those who fight forest fires and less to acquire new fire-fighting equipment and water-bombing aircrafts (Xanthopoulos, 1998).

Fire prevention and forest protection should become the focus of attention, in particular:[41]

- Forest management measures specifically adapted to the flammable forests in the Mediterranean zone. The following are especially recommended: firebreaking zones around settlements and protected areas as well as management of flammable forest material through programmes of accumulated biomass reduction.
- Police measures and monitoring with continuous patrols to discourage arson and detect new fire events on time.
- Information measures for the public and forest visitors, awareness-raising and participation of citizens and local communities in forest protection.

The **Greek Forest Service should be enhanced as an institution**. It should be given adequate means to practice forest management, fire prevention and fire pre-suppression planning, including the use of techniques such as prescribed burning (Interview 2).

The **Forest Service should gain a vertical structure** again (in place of the strictly regionalised structure currently promoted) in order to have coordinated leadership from a central service. A central coordinating service could also better defend the mission and interests of the Forest Service in the political arena (Interview 2).

Forest fire suppression, which lies in the hands of the Greek Fire Service, should be shared with the Forest Service. The two services should complement each other and build a common body for fighting forest fires. Both the Forest Service and the Fire Service should be appropriately trained in forest fire management, including exposure and training of the Fire Service in fire prevention techniques. The available fire-fighting resources of the two services should be wisely distributed to different locations depending on local fire risk (Interview 2). Often, the option of substantial cooperation between the different authorities involved in forest fire management and suppression is presented as impossible. However, there are several international examples and organisational models convincing of the opposite (e.g. the US forest fire management model). Principles and ideas could be drawn from such models for the establishment of a suitable cooperation framework in the Greek context (Xanthopoulos, 2000).

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[40] Newspaper 'Kathimerini', online edition of 11/9/2007. Expert interview with forest scientist Mr. Eftychidis (in Greek).

[41] Newspaper 'Kathimerini', edition of 8/7/2007. Expert opinion of Prof. Dafis, Aristoteles University of Thessaloniki;
Official joint statement of Greek Scientific Researchers on the '2007 Forest Fires'. Available online: http://www.arthro24.gr/pdf/paremvasi.pdf. Accessed: 10 December 2007. (in Greek).

It is crucial to draft and implement **anti-fire plans**, specialised to different areas (special plans of anti-fire protection around settlements, archaeological sites, important protected areas etc.).[42]

In forest areas affected by grazing, **prescribed burning for grazing grounds** should be practised under strict standards and in cooperation with fire-fighting personnel. EU funding should be used to 'force' livestock farmers to cooperate with authorities in the context of grazing management programmes, which shall be scientifically controlled (Interview 2).

For improved **fire detection**, a network of fire-observation towers equipped with fire detection tools, communication instruments and trained personnel is needed. For fire detection and monitoring purposes, frequent satellite observation of forests is also recommended. Numerous flexible fire-fighting vehicles and forest 'commando-teams' are also needed for **better and faster initial attack from the ground**.[43]

As concerns territorial planning, emphasis should be placed on the **interface zones between forest and urban areas**. Although it is not possible to halt the spread of such zones, their development should be **strictly regulated** (Interview 2) on the basis of scientifically-sound laws and regulations. There should be an in-depth analysis of the effects of existing forest policy on the development of illegal and semi-illegal interface zones and on the difficulty of dealing with forest fires in such areas (Xanthopoulos, 2003).

It goes without saying that a general national **physical planning and land use strategy** should be set up without delay. This should include the finalisation of the land and forest register to determine the ownership regime of Greek forests. The drafting of **forest maps**, which can take place independently of the land register and is much less cost-intensive, could be an intermediate solution, releasing foresters from the huge work load of forest-area (re-)classification.[44] It is also necessary to **map burned areas** on an annual basis, to protect them from illegal construction development and to facilitate the drafting of ecosystem rehabilitation plans.[45]

Summary of the issues and core messages

Since 1998, forest fire management in Greece has been characterised by emphasis on fire suppression, which lies in the hands of the Greek Fire Service. The Forest Service, which is responsible for forest fire prevention, has been weakened in its competence and structure and is poorly funded. Nevertheless, since 1998, the total cost of forest fire management has increased enormously, with the greatest part of funding being absorbed by the acquisition of modern fire suppression equipment. Investments in water-bombing aircrafts and other fire suppression equipment and personnel are not bringing the desired results on the ground, since the area of burnt forest has increased. The forest fire events in summer 2007 were of immense extent and had a great toll on human life, infrastructure and ecosystems.

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[42] Official joint statement of Greek Scientific Researchers on the '2007 Forest Fires'. Available online: http://www.arthro24.gr/pdf/paremvasi.pdf. Accessed: 10 December 2007. (in Greek).

[43] Newspaper 'Kathimerini', edition of 8/7/2007. Expert opinion of Prof. Dafis, Aristoteles University of Thessaloniki (in Greek).

[44] Newspaper „Kathimerini', edition of 5/9/2007. Expert statements of Mr. Bouzinekis, President of Greek Foresters, and Mr. Diamantidis, Directorate of Forest Maps (in Greek).

[45] Official joint statement of Greek Scientific Researchers on the '2007 Forest Fires'. Available online: http://www.arthro24.gr/pdf/paremvasi.pdf. Accessed: 10 December 2007. (in Greek).

In this context, the need for substantial changes becomes apparent. The accumulation of dry biomass due to the lack of appropriate fire-preventive forest management makes fire control extremely difficult under adverse weather conditions. The lack of substantial fire prevention measures and policies leads to the eruption of many destructive fires. The uncontrolled development of fire-unprotected interface zones between forest and urban areas is a huge problem for fire-fighting forces and highly increases damages to homes and infrastructure.

To prevent the extreme spreading of forest fire events in the future, political choices should not remain focused on the acquisition of further fire-suppression equipment and personnel. A shift of emphasis to the substantial upgrading of the entire organisation of forest fire management is needed, with emphasis on forest fire prevention and forest ecosystem protection.

Acknowledgements

Many thanks to the interviewed experts for their time and very useful contributions as well as to Sophie Herbert for her assistance with statistical information on the 2007 fire events.

Interview partners

Int. 1: Kimon Hadjibiros, Assistant Professor, National Technical University of Athens, Faculty of Civil Engineering, Department of Water Resources and Environmental Engineering (13 December 2007)

Int. 2: Dr.Gavriil Xanthopoulos, Researcher - Forest Fires, Greek National Agricultural Research Foundation, Institute of Mediterranean Forest Ecosystems and Forest Products Technology (18 December 2007).

ANNEX 3 – OVERVIEW OF RECENT FOREST FIRE EVENTS IN THE EU (2007)

The table below summarises some information on relevant forest fires events which took place in summer 2007 across South-Eastern Europe.

Country	Region(s)	Time of occurrence	Scale of damage (environmental, social, economic)	Main causes (in order of importance)	Comments	Outside assistance
Albania	Korca, Erseke, Veleck, Mirdite, and Kukes	July and August 2007	Total burnt area in 20007 was 110,000 ha - mainly forest land Total CO_2 emissions: 2,000 Kton	1. High temperature and dry weather conditions	3rd country most hit in 2007. Rain helped put out fires.	NATO helped. Lack of fire fighting equipments
Bulgaria	Stara Zagora (main affected region). State of emergency in Topolovgrad and Svilengrad. Fires also in Sofia, Sliven, Smolyan, Bourgas.	End of July 2007	Villages consumed by fire (30,000 ha) in steep mountainous region Deaths (3)	1. Heat (in some places above 45° C)	Decreasing temperature and rain helped reduce fire	Help from Russia through bilateral agreement
Bosnia	Most threatened: Bileća, Berkovići, Neum, Stolac, Čitluk and Čapljina	July and August 2007	Total burnt area in 2007 was 54,000 ha - mainly forest land Total CO_2 emissions in 2007: 1,300 Kton	1. Heat wave, dry weather		
Croatia	Dubrovnik city	August 07	City not evacuated. One home burned. 500 ha burnt 20 people injured Coastal (tourist) areas not affected	1. Strong winds	1,000 fire-fighters with 2 Canadair planes brought fire under control and winds ceased.	

Country	Region(s)	Time of occurrence	Scale of damage (environmental, social, economic)	Main causes (in order of importance)	Comments	Outside assistance
Cyprus	Troodos range (50 km from capital Nicosia)	June 29 2007	Evacuation of 2 villages and hundreds of holiday homes.	1. Strong winds and heat	One of the worst fires in decades	Help from the UK, Italy and Israel
	Larnarca district	end of July 2007	Destroyed 1000 ha pine forest.	1. Strong winds and heat	Appeal for reforestation as Kalavasos village is now vulnerable from mudslides from barren slopes.	
France		July and August 2007	Total burnt area in 2007 was 2,300 ha Total CO_2 emissions: 50 Kton			
Former Yugoslav Republic of Macedonia (FYROM)	Most affected areas: Bitola, Tetovo, Strumica, Veles	July and August 2007	Total area burnt in 2007 was 36,500 ha - mainly forest land Total CO_2 emissions: 500 Kton Deaths (1 in July) In July 200 Roma people were evacuated and 3,000 ha of forest in 32 municipalities were lost	1. Heat wave, dry weather		
Greece	Halkidiki peninsula, Larissa prefecture, Attica (around Athens), Pelion	end of June 2007	Homes damaged Land and forest burned > 56km² (mount Parnitha forest crucial for Athens climate 30km²) Deaths (4-9)	1. Heat wave 2. Arson 3. (Electricity transmission towers in some places caught fire due to heat wave)	1st country most hit in 2007	Activated International Charter 'Space and Major Disasters'
	Northern Peloponnese, Athens outskirts, Ionian and Aegean islands	June 2007	Villages damaged and destroyed Land and forest fires Deaths (2-7)	1. Heat wave, drought, high winds, 2nd heat wave (parched land) 2. Arson to clear land for development (no land registry)		

Country	Region(s)	Time of occurrence	Scale of damage (environmental, social, economic)	Main causes (in order of importance)	Comments	Outside assistance
	South-West Peloponnese, Attica, Evia, Athens outskirts	end of August 2007	€5 billion worth of damage 110 villages damaged or destroyed Livestock, cultivated land and forests burned down High death toll (60-68)	1. Heat wave, drought, wind 2. Arson (political, economical)		
Italy	Central and Southern Italy	July 2007	Total area burnt in 2007 was 130,000 ha - of which 36,000 ha were on NATURA 2000 sites. Total CO_2 emissions: 1,800 Kton Damage to tourism (eg more than 4,000 holidaymakers evacuated from Gargano peninsula in Puglia) More than 5,000 ha of farmland destroyed, worth about €1 billion (according to Italian Farmers Confederation) Deaths (3)	1. Arson (including by organised crime, building speculators or farmers) 2. Rural areas depopulation 3. Hot dry climate	2nd country most hit in 2007	Canadairs provided by France and Spain
Montenegro		July and August 2007	Total area burnt in 2007 was 10,500 ha Deaths (1)	1. Heat wave, dry weather		
Serbia		July and August 2007	Total area burnt in 2007 was 41,254 ha In July direct damage from fires was €4.6 m (estimates of public enterprise for forest management). Fire engulfed parts of national parks and reserves	1. Heat wave, dry weather		

Country	Region(s)	Time of occurrence	Scale of damage (environmental, social, economic)	Main causes (in order of importance)	Comments	Outside assistance
Spain (Canary Islands)	Gran Canaria	28 July 2007	50 homes damaged, about 10,000 people evacuated. Significant species loss (about 10-15 species could disappear) - Gran Canaria contains 50% of species unique to Spain. 1/3 of forests burned. 35,000 ha pine forest in Morgan region and 65% of Palmitos wildlife park burned. Deaths (0)	1. Arson 2. Heat (40° C), low humidity and strong winds	Rough, mountainous terrain complicated the effort. Fires were brought under control when temperature and winds died off	Activated International Charter 'Space and Major Disasters'
	Tenerife	30 July 2007	100 homes damaged and 8450-12,000 people evacuated 2,600 ha pine forest burned Deaths (0)	1. Arson suspected 2. Heat (40° C), low humidity and strong winds	Fire on the southern front (which affects Teide National Park) died out because the area had 'hardly any combustible material'	
Portugal	Most hit areas (>1,000 ha burned): Beja, Braga, Guarda, Leira, Santarem	June-September 2007	1,600 occurences <1ha and 8,800 > 1 ha; 16,600 ha burned	1. Arson and hot and dry weather 2. Rural depopulation 3. Vegetation pattern	Improved system of fire fighting. Improved public behaviour. Awareness raising strategy applied for the first time	

Information and data based on:

Global Fire Monitoring Center (http://www.fire.uni-freiburg.de/)
European Civil Protection (http://ec.europa.eu/environment/civil/index.htm)
DGRF, 2007
DGRF, 2005
EFFIS http://effis.jrc.it
http://www.reliefweb.int/
DREF Bulletin no. MDRBA001 Glide no: HT-2007- 000105-BIH 8 August 2007
DREF Information Bulletin no. 02/2007 25 July 2007

ANNEX 4 – FOREST FIRES STATISTICS

The table below provides data on burnt areas in 2007 (up to 30 September 2007) and averages for 2000-2006.

Country	Total burnt area (ha) (Jan to Sept 2007)	Percent forest	Percent agriculture	Percent artificial surface	Percent NATURA 2000	Average number of fires (2000-2006)	Average burnt area (ha) (2000-2006)
Albania	127,880	95.6	4.6	0.2	NA	no data	no data
Bosnia-Herzegovinia	56,545	88.2	11.7	0.1	NA	no data	no data
Bulgaria	67,747	42.8	56.4	0.8	NA	617	13,601
Croatia	17,096	69.9	29.8	0.3	NA	4,747	51,231
Cyprus	2,534	75.9	24	0.1	7.4	262	3,089
France	2,601	96.7	2.1	1.2	9.4	4,658	27,358
Greece	270,563	56.8	42	1.2	11.5	1,774	28,878
Italy	153,884	62.8	36.2	1	25.9	7,149	67,338
Montenegro	19,925	no data	no data	no data	NA	no data	no data
Portugal	12,133	74.1	25.7	0.2	35	27,260	194,986
Serbia	34,736	no data	no data	no data	NA	no data	no data
Spain	55,956	85.7	14.2	0.1	54.6	20,779	144,177
Turkey	6,861	no data	no data	no data	NA	no data	no data

Data based on:

http://effis.jrc.it/documents/2006/ForestFiresInEurope2006.pdf
http://effis.jrc.it/documents/2007/EFFIS_Newsletter_2_2007.pdf
http://effis.jrc.it/documents/2007/EFFIS_Newsletter_3_2007_small.pdf