Forestry Department

Food and Agriculture Organization of the United Nations

Fire Management Working Papers

Global Forest Resources Assessment 2005 – Report on fires in the Mediterranean Region

by
A.P. Dimitrakopoulos and I.D. Mitsopoulos

March 2006

Forest Resources Development Service
Forest Resources Division
Forestry Department

Working Paper FM/8/E
FAO, Rome, Italy

Disclaimer

The Fire Management Working Papers report on issues addressed in the work programme of FAO. These working papers do not reflect any official position of FAO. Please refer to the FAO website (www.fao.org/forestry) for official information.

The purpose of these papers is to provide early information on on-going activities and programmes, and to stimulate discussion.

Comments and feedback are welcome.

For further information please contact:
Mr. Petteri Vuorinen, Forestry Officer (Forest Fire Management)
Mr. Peter Holmgren, Chief
Forest Resources Development Service
Forest Resources Division, Forestry Department
FAO
Viale delle Terme di Caracalla
I-00100 Rome, Italy
e-mail: petteri.vuorinen@fao.org
peter.holmgren@fao.org

or: FAO Publications and Information Coordinator:
andrea.perlis@fao.org

For quotation:

FAO (2006). Global Forest Resources Assessment 2005 – Report on fires in the Mediterranean Region. Fire Management Working Paper 8. www.fao.org/forestry/site/fire-alerts/en

FOREWORD

Fires impact upon livelihoods, ecosystems and landscapes. Despite incomplete and inconsistent data, it is estimated that 350 million hectares burn each year; however, the nature of fires determines whether their social, cultural, environmental and economic impacts are negative or positive. Up to 90 percent of wildland fires are caused by human activities primarily through uncontrolled use of fire for clearing forest and woodland for agriculture, maintaining grasslands for livestock management, extraction of non-wood forest products, industrial development, resettlement, hunting and arson - thus any proactive fire management needs to adopt integrated, inter-sectoral, multi-stakeholder and holistic approaches. The situation varies markedly in different regions of the world.

As a supplement and complement to the Global Forest Resources Assessment, 2005, this working paper is one of a series of twelve prepared by regional and country contributing authors to provide a greater depth of data and information on fire incidence, impact, and management issues relating to the twelve UN-ISDR Regional Wildland Fire Networks around the world.

The working paper series assesses the fire situation in each wildland fire region, including the area extent, number and types of fires and their causes. The positive and negative social, economic and environmental impacts are outlined. Prediction, preparedness and prevention as key elements in reduction of the negative impacts of fire, rapid response to extinguish fire incidents and restoration following fires are addressed.

The working paper series also addresses institutional capacity and capability in wildland fire management, including the roles and responsibilities of different stakeholder groups for prevention and suppression, particularly the unique role of community-based fire management.

From these working papers, a FAO Forestry Paper on Fire Management will synthesize the highlights from each region, but also provide a global summary of important lessons that can be used in fire management in the future. These papers are a valuable resource in the process to prepare the Fire Management Code, the Global Strategy to Enhance International Cooperation in Implementing the Fire Management Code and associated capacity building.

ACKNOWLEDGEMENTS

This working paper is the product of a global team of dedicated people willingly giving of their time and specialist expertise within each of the twelve UN-ISDR Regional Wildland Fire Networks.

A.P. Dimitrakopoulos and I.D. Mitsopoulos, as the authors, obtained key information and data for this working paper from Algeria, Cyprus, France, Greece, Israel, Italy, Morocco, Portugal, Spain and Turkey.

We wish to acknowledge the dedicated work of Johann G. Goldammer, Global Fire Monitoring Center (GFMC), for contributing materials and for reviewing this working paper.

We also wish to thank Michèle Millanès for the excellent editing and formatting undertaken.

To all persons who contributed to this working paper, we express our grateful thanks.

TABLE OF CONTENTS

1. Background

Following the release of the Global Forest Resources Assessment 2000 (FRA 2000) report in 2001, the global FRA process has entered its next reporting cycle. Recommendations from the Kotka IV Expert Consultation in July 2002 on directions of global FRA's were confirmed by FAO's Committee on Forestry (COFO) in 2003. It included to embark on an update of the global FRA for the year 2005 (FRA 2005) and to increasingly involve countries directly in the assessment and reporting, in particular to submit national reports on the status and trends of a range of forestry parameters. More information about FRA 2005 is available at www.fao.org/forestry/fra.

FRA 2005 also includes thematic studies, including e.g. forest fire, forests and water, and mangroves. The thematic study on forest fire is built on regional reviews of forest fire management. The current report is a contribution and makes a review of the Mediterranean region.

This Working Paper FM/8/E has been written by A.P. Dimitrakopoulos and I.D. Mitsopoulos and does not reflect any official position of FAO.

2. Fire situation in the region

Fire is the main cause of forest destruction in the countries of the Mediterranean Basin. About 50 000 fires sweep through 700 000 to 1 million hectares of Mediterranean forest, other wooded land and other land each year, causing enormous economic and ecological damage as well as loss of human life.

The forest fire situation in the Mediterranean Basin is significantly determined by predominating climatic conditions. Prolonged summers (extending from June to October and sometimes even longer), with virtually no rain and average daytime temperatures well in excess of 30°C, reduce the moisture content of forest litter to below 5 percent. Under these conditions, even a small addition of heat (lightning, a spark, a match, a cigarette butt) can be enough to start a violent conflagration.

Together with heat and lack of moisture, wind is another influential climatic factor. The inland summer winds are characterized by high speeds and strong desiccating power: the periodic winds (meltem) that blow during the summer from the N-NE in the Eastern Mediterranean Basin, and the sea breeze that blows during daytime from the sea along the coast. The dry and cold winds of Mediterranean winters can also augment the danger of fire. For example, the foehn that blows southwards over the northern Italian Alps, and the southerly wind that blows across the north of Spain from the Central Meseta, often fan small, deliberately set fires out of control.

2.1 Land-use and climate change

The predominant factors are expected to play the most significant role in the fire regimes at the Mediterranean Basin during the 21st century: land-use changes and climate change.

In the Mediterranean Basin, many countries of severe human pressure resulting in burning, cutting and grazing on non-arable lands and clearing, terracing, cultivating, and later abandonment of arable portions, have created a strongly human-influenced landscape. The cultivation of marginal areas under increasing population pressure has been common in Southern Europe since the 16th century. It is not possible to understand current vegetation partners in the Mediterranean Basin without taking into account past anthropogenic activities and land uses. Human intervention has been so strong that is still making a significant impact on current and future vegetation patterns.

The changes in fire occurrence during the last decades closely reflect the recent socio-economic changes underway in the European Mediterranean countries. With industrial development, European Mediterranean countries have experienced: depopulation of rural areas, increases in agricultural mechanization, decreases in grazing pressure and wood gathering and increases in the urbanization of rural areas. These changes in traditional land use and lifestyles have implied the abandonment of large areas of farmland, which has led to the recovery of vegetation and an increase in accumulated fuel. In Southern Europe, human activity has dramatically increased fire frequency as a consequence of land abandonment and tourist pressure. Land-use changes produced during the present century in Southern Europe are parallel to the changes in the fire regime, from being few in number and affecting small areas, to becoming very numerous and affecting large

extensions every year. This trend is not observed in the Southern Mediterranean Basin where traditional land uses remain the major socio-economic system.

Although the main reason for fire increase in the last decades is probably changes in land use, climatic factors should be considered as a contributing factor. Fires tend to be concentrated in summer when temperatures are high and air humidity and fuel moisture are low. Predictions on climatic warning in the Mediterranean Basin indicate an increase in air temperature and a reduction in summer rainfall. Although there is uncertainty as to the mean and variance of the precipitation changes, all predictions suggest a future increment in water deficit. These changes would lead to an increase in ignition probability and fire propagation. Analysis of past climate data shows a clear increase in temperature and potential evapotranspiration and a reduction in summer humidity. These changes are correlated to an increase in the number of fires. The climate changes that are predicted to occur in the near future as a result of releasing greenhouse gases are likely to induce increased fire risk not only in the Mediterranean area, but also in the other fire-prone regions of the world.

2.2 Forest vegetation as fuel

As a reflection of the prevailing climate with its long summer droughts, Mediterranean forests are frequently characterized by fire climax species, i.e. those that depend on the presence of fire in the reproductive cycle. Pines form the largest forest stands on both the northern and the southern shores of the Mediterranean. The Aleppo pine (*Pinus halepensis*) is the most widespread on the coasts of Spain, France, Italy, Greece, Turkey, Morocco, Algeria and Tunisia. The stone pine (*P. pinea*), the maritime pine (*P. pinaster*) and the Corsican pine (*P. nigra*) on the western side of the Basin and *P. brutia* on the eastern side are the other main species. These species are characterized by physiological mechanisms that link natural seeding with fire, e.g. the opening of pine cones exposed to intense heat. These species also tend to have a particularly high content of resin or essential oils, making them extremely inflammable.

Other species, particularly the evergreen sclerophyll oaks, holm oak (*Quercus ilex*), cork oak *(Q. suber*), *Q. coccifera*, etc., have developed a morphological resistance to fire. For example*, Q. suber* has developed a characteristically thick bark that isolates the cambium, enabling it to resist sporadic fires. Likewise, the presence of a large number of dormant buds in oaks ensures the production of shoots and sprouts if the aerial part of the plant is reduced by fire.

However, these adaptive traits do not provide permanent protection. After repeated fires, the trees are replaced by a woody shrub cover that is not merely resistant to fire but typically pyrophytic, as with the dehiscence of rockroses (*Cistus*), or other species that produce seeds with a thick isolating tegument or rhizomes or running roots.

To this natural evolution of flora must be added human-induced changes caused by attempts to restore the tree cover in areas where excessive fire or other uses such as overgrazing and fuelwood extraction have caused a high level of degradation. Reforestation is usually carried out using pioneer species, predominantly pines established in monospecies stands. This in itself increases the risk of fire due to the continuity of fuels in closely spaced plantations as well as the concentration of fine, highly inflammable fuels.

There is still another important factor that increases the danger of fires. Socio-economic development in the region has led to a generalized decrease in grazing and in the collection of wood and forest scrub for fuelwood and fodder. As a consequence there has been a build-up of highly inflammable forest litter. This is a particularly serious problem in privately owned forests which, because of the low returns on labour, tend to be abandoned until they have reached harvestable dimensions. This problem is much more serious on the northern than on the southern shores of the Mediterranean, where the rural population still manages large numbers of ruminants and gathers great quantities of fuelwood and other products from the forests for domestic use.

Another cause of increases in forest fuels, especially on the European side of the Mediterranean, has been the shift of population from the rural areas to the cities. As a result, large stretches of marginal farmland, especially in mountain areas, have been left uncultivated and have been colonized by bush and even natural pine groves.

The population drift does not imply the total elimination of activities in the forest area. The remaining, often elderly pastoral population continues to use fire to eliminate stubble and renew pastures. However, the large accumulation of fuels often allows fires set for agricultural purposes to spread out of control and to develop

unprecedented intensities and severities that are the major reason for the difficulty of control and the ecological impacts of the wildfires. Furthermore, the scarcity of forest dwellers makes fire suppression more difficult.

2.3 Causes of fires

Statistics on the causes of forest fire in the Mediterranean region are far from complete, but it is evident that people set the majority of fires. Natural agents such as lightning do indeed cause forest fires, and when they occur in isolated areas the extent of the damage can be enormous. In aggregate, however, the number of naturally occurring fires is small in comparison with those caused by humans.

An important source of fires is shepherds who ignite forest and grassland to promote new flushes of growth for grazing animals. When this is done without the necessary precautions and coincides with high climatic risks, forest fires are practically inevitable. Although in the past there has been a tendency to blame pastoralists for nearly all Mediterranean forest fires, this appears to be an exaggeration.

Farmers also use fire to eliminate crop stubble, and to push back the forest to make room for agricultural expansion. In spite of the obvious risks, farmers can often be observed setting fire to agricultural residues even when large out-of-control fires are burning in the same area.

Urban populations in the Mediterranean region show a particularly poor understanding of the danger of fires and of their potentially negative consequences. Despite continuous preventive propaganda campaigns, many city dwellers do not consider a forest fire to be a threat even in the middle of summer. The carelessness of smokers and of excursionists who light cooking fires is the source of about one-third of the fires in the Western Mediterranean Basin.

An increasingly important cause is the burning of large quantities of solid waste left by tourists and other recreational users of forest areas. The disposal of garbage, usually by burning, is often carried out in conditions of high fire risk without taking the necessary precautions. The tourist areas along the European coasts of the Mediterranean are the scenes of frequent fires due to garbage burning.

Finally, there are a growing number of fires ignited not for utilitarian purposes but with destruction as their sole aim, especially in the western Mediterranean. These fires may be lit for a variety of reasons, including private vengeance and conflicts related to ownership, hunting rights, and even government forest policies, for example when reforestation is carried out at the expense of traditional extensive grazing lands or when areas which were formerly open to common use are declared protected zones or national parks. Another important motivation for destructive fires, particularly in the European part of the Mediterranean, is an attempt to change land-use classification. For example, in parts of Greece, unscrupulous housing developers have destroyed large areas of forest cover.

Ironically, there also seem to be a growing number of fires set by the auxiliary workers who are retained by national forest fire services during the critical summer months. These workers are paid a much higher salary when actually fighting fires than when on standby, and there are confirmed cases of deliberate fires to incur the higher pay rate.

2.4 Prevention

Prevention activities can be divided into two broad areas: those directed at the primary cause of fire, i.e. people, and those aimed at mitigating the inflammability of forest resources.

Public information campaigns are carried out in most Mediterranean countries, with the intensive use of mass communications media, mainly television, radio and the press. In most cases these campaigns are aimed almost exclusively at urban dwellers during the summer and stress the risk of fire caused by negligence, and its potential consequences. Although an appraisal of results is difficult, it appears that the incidence of fires caused by tourist carelessness is being positively affected.

Tourist movement during the summer produces an international public for these campaigns. Therefore it could be of value to use unified symbols or phrases throughout the Mediterranean, and to stress the regional nature of the danger.

The situation regarding the rural population, however, requires a different approach. In fact, campaigns developed for urban populations may even be counterproductive with a rural public. Generally, rural dwellers have a good basic knowledge of the positive influence forests have on the microclimate and of their effect in reducing erosion, and of the potentially negative effects of fire. The rural population needs to be involved in forest economics. People need to be clearly informed about the damage wildfire causes to the long-term potential of their farming and livestock operations. It is also necessary to give precise information on who is, in fact, affected by fires, with a concentration on the effect on both public and private lands.

Sociological studies to determine the behaviour and knowledge of rural people are one key to developing effective information campaigns aimed at the rural population.

Preventive efforts must be supported by legislation clearly establishing the setting of incendiary fire as a crime and penalizing offenders in proportion to the damage caused. However, this component should never be the main element of prevention efforts.

Information campaigns must be complemented by preventive silviculture, i.e. forest management techniques designed to minimize the risk of and damage resulting from fire. Fuel management involves such highly diverse techniques as grubbing and pruning, tree thinning, brushwood crushing, prescribed burning, controlled grazing and species selection.

Protective techniques need to be integrated into overall silvicultural practices, which have generally concentrated on regeneration and production. Selection of specific techniques must be determined by the prevailing physical, economic and social conditions. For example, in areas where there are forest-grazing conflicts, controlled grazing should be encouraged rather than prohibited. If properly timed and controlled, grazing enables fine fuel accumulation to be reduced and involves pastoralists in forest management.

The major problems in applying efficient preventive silviculture are the extent of the area to be treated and the cost of the labour required. Broad-based policies encouraging reforestation operations and care of existing stands are necessary. These policies may need to be supported by credits and other incentives, especially in the case of privately held forest areas.

2.5 Monitoring and detection

National detection and monitoring networks based on fixed and mobile stations have been established in all of the Mediterranean countries. In several countries, these operations are being automated with the use of infrared sensors and remote television monitors, in some cases powered by photovoltaic cells. Aerial monitoring has also been experimented with, primarily in Spain and Italy, but the high cost of this type of operation places serious constraints on its wider use in the region. In any case, hi-tech systems cannot replace ground-level technicians with a good working knowledge of the terrain. The experienced person is still and will continue to be a basic cog in the detection wheel.

Danger-rating systems are another essential element of fire control. This requires close cooperation with the national meteorological services, and the development of fire behaviour models and indices. Throughout the Mediterranean daily danger indices based on local weather forecasts have been systematically calculated for many years. However, in many cases these ratings are inadequately supported by meteorological data.

2.6 Suppression

Approximately 30 000 workers are mobilized for fire-fighting activities each summer in the Mediterranean region; in particularly serious seasons, the number may swell to 50 000 with the participation of members of the armed forces.

Having trained personnel available in sufficient numbers is a basic condition for successful suppression work. The organizational scheme providing the best level of protection is one consisting of a general, permanent fire service which is reinforced with additional resources and personnel during critical periods. The dimensions of the basic service will be determined by the overall risk of fire. As a guide, however, at least one fire brigade (of seven to ten workers) will be required for every 10 000 ha of moderate risk area; for high risk areas, a brigade must be deployed for every 5 000 ha. The correct functioning of such a system requires a suitable legal framework in which jurisdictions and responsibilities - which has the authority to mobilize forces, for example are clearly delimited.

The efforts of land-based suppression forces are reinforced in many Mediterranean countries by fleets of aircraft (mostly amphibious) and helicopters. Approximately 300 government-owned and contracted aircraft are used each summer for fire-fighting operations in the Mediterranean Basin. The use of helicopters is assuming increasing importance, particularly in the transport of fire crews to difficult locations.

However, airborne suppression activities must not be viewed as a substitute for land-based efforts, particularly in view of the high costs involved. If land-based forces are not sufficient, the introduction of additional airborne forces will not improve overall efficiency, and may even retard future development as resources which could have been better invested in the formation of land-based brigades are diverted. Apart from their direct costs, airborne forces require an additional infrastructure of personnel and facilities.

2.7 Forest fire damage assessment system

In order to improve the harmonization of burned area data and statistics, a map of burned areas of Southern European countries, is derived from the classification of satellite images acquired at the end of the fire season (end of September every year). This area map is further used in conjunction with EU-CORINE land cover database to estimate the damage to forest and other land cover types. The system produced already the cartography of forest fire damages in the European Mediterranean countries for the years 2001 to 2004. The fires larger than 50 hectares were mapped. The distribution of burned areas by land cover class in five Mediterranean countries (Portugal, Spain, France, Italy and Greece) is presented in the appendix.

3. Stakeholder / Actors Situation

3.1 Institutional and other capacities

International agencies and unions have developed policies and strategies to promote the protection of the Mediterranean countries from forest fires. Their role is in most cases theoretical. Treaties and agreements for cooperation exist, but only a few measures are taken on the ground.

Most agreements concerning forest fires are part of broader forestry policies, strategies for civil protection and environmental declarations. Furthermore, it seems that a holistic Mediterranean policy does not exist, since most organizations consider only parts of the Mediterranean, or cover an area much larger than the basin.

The European Union has measures for fire prevention (in fact pre-suppression) within its forest policy. The main EU Regulation on forest fires is 2158/92 that spent an amount of 70 million Euro for the period 1992-1996. Its context did not focus on the political and socio-economic causes of forest fires, but included mainly the classification of the Community territory according to forest-fire risk, the submission of forest fire protection plans from Member States whose territory is classified either partially or totally as a high-risk area and the establishment of a database to encourage information exchange on fires.

On 17 September 1998 the European Parliament stressed the heavy human and economic costs and the environmental damage to forests. It called on the Commission to make available, especially from the European Regional Development Fund (ERDF), the funds required to alleviate the damage suffered by the regions affected, to implement a Community forestry policy and to establish closer coordination between the Member States on preventing and fighting forest fires.

Regulation 1727/1999 of 28 July 1999 laid down certain detailed rules for the application of Regulation 2158/92, especially as far as financial arrangements are concerned.

The EU policy on civil protection includes combating - among other catastrophes - forest fires and its implementation is important for the Mediterranean part of the European Union. Its approach is a purely operational one, aimed at the quickest and most efficient mobilization of member states to help after a disaster occurs, inside or outside the European Union. Several operational instruments, pilot projects and self-training workshops have been established. Experience has shown that the present system lacks the capacity to mobilize sufficient resources from Member States and to coordinate interventions as required. Member States do not make sufficient use of the existing structure and the support and coordination potential it offers.

Forest fire is one of the areas targeted by research into environmental protection. The aim of this research is to understand the behaviour of fire and to give decision makers, technicians and firemen the tools to enable them to act with the necessary effectiveness and speed. Research activities have not been extended to policy arrangements against forest fires or forest management-based prevention. Several pilot projects have been funded in order to identify high-risk areas, improve detection methods and establish effective solutions to control and reduce the spreading of fires, and restore affected areas. So far no regional research programme has been conducted in the Mediterranean Basin that would comprehensively address the cultural, social and political history as well as the current and expected trends of wildland fires in the context of regional change.

However, under the Fifth Framework Programme, the Joint Research Centre has already provided scientific and technical support for Community Cooperation on Civil Protection, including monitoring of floods and forest fires, establishment of the Community disaster information exchange system, decision-support techniques, risk assessment, prevention of technological disasters and environmental quality assessment. The Joint Research Centre can also provide technical support in relation to natural and technological disasters, including risk assessment and preventive measures.

The Sixth Framework Programme is sponsoring the cooperative “Fire Paradox” project in which 32 partner institutions from 12 countries will investigate, besides some fundamental fire behaviour research, the technology transfer of prescribed burning and backfiring.

Towards the establishment of an EU-Mediterranean Environmental Policy Integration, the text of the Barcelona Declaration includes the need for assessing forest fires among the environmental problems in the Mediterranean region. It also refers to the need for proposals to establish and subsequently update short and medium-term priority environmental action programs coordinated by the European Commission and supplemented by long-term actions with respect to forest fire prevention and control. Transfer of Community experience in financing techniques, legislation and environmental monitoring is suggested as well.

The implementation of the above guidelines would be performed through measures, such as the Short- and Medium-term Priority Action Program (SMAP), including Mediterranean forest protection, in particular the prevention and control of erosion, soil degradation, forest fires and combating desertification. SMAP was intended to promote the transfer of Community experience in the field of financing techniques, legislation and environmental monitoring and integration of environmental concerns in all policies. However, the financing of the Program was not satisfactory, and the impact of the SMAP remains uncertain. It needs to compete with other objectives, for which politicians and business may lobby harder, as they offer more direct, short-term advantages for them.

In May 1998 the European Commission launched the “Twinning“ concept as the principal tool of pre-accession assistance for institution building. Twinning aims to help the candidate countries in their development of modern and efficient administrations, with the structures, human resources and management skills needed to implement the acquis communautaire to the same standards as Member States. The Twinning tool has been used for several countries to harmonize national legislation, collection of statistical data on wildland fires and development of fire management plans in accordance with the EU Regulation (EC) No. 2152/2003 concerning monitoring of forests and environmental interactions in the Community (Forest Focus). In 2005-2006, Hungary and Bulgaria received such assistance by Germany and the Global Fire Monitoring Center in the form of a “Twinning Light” project.

3.2 Responsibilities and roles

Different countries have different ways of organizing their fight against forest fires. Besides an ECE survey of the 1980s, there is no up-to-date comparative information about this issue for the countries of the study. Information about the system of some of the countries can be found in official reports given to FAO or EU, but almost all of them present just a short description of the actors and the procedures according to the official state dogma. Most descriptions are just lists of suppression means, especially airplanes, vehicles and firemen. There is no critical description of the weaknesses and advantages of the systems applied. This approach would be very useful for planning future activities and changes.

The philosophy of forest fire prevention is similar throughout the Mediterranean Basin. It is based on the creation of tracks, firebreaks and water reserves. This work is often designed within the framework of traditional management projects (e.g. in Algeria and Tunisia). Maintenance of these networks is an important issue, especially as the authorities responsible for creating the systems are often not the same as those who are responsible for maintaining them.

Two general trends can be described within the countries of the Mediterranean, as far as protection from forest fires is concerned:

- a system where the Forest Service is responsible for forest fire prevention and control,
- a mixed system, where the Forest Service is responsible of forest fire prevention and the Fire Brigade takes over suppression and pre-suppression activities.

In some countries, the mixed system is more complex and local and national authorities are involved as well.

The EU countries apply the mixed fire protection system, with various players involved, strengthened through expensive fire suppression tools (mostly aerial). In the rest of the Mediterranean countries, forest authorities have the full responsibility for fighting fires in the forest. There are three main trends observed in relation to forest fire protection, moving from the south to the north of the Mediterranean:

- a trend from a central agency to a more peripheral system,
- a trend for increased participation of private bodies in fire protection, and
- a trend of fire suppression from the forest services to professional firefighters.

Especially the third trend is actually a shift from a managerial approach to a more operational one. As prosperity and the means of countries for spending on fire fighting increase, the governments decide to invest their resources on a more complex system, where more different groups of professionals should work together. While this is principally correct, it includes a reduction of the participation of forest land managing authorities in the fire protection scheme, giving a more crisis-response character. This is especially true when one examines the huge expenses spent by governments and international agencies on suppression and pre-suppression, failing even to define prevention correctly.

Another reason for this development is the fact that most people of the EU countries live in urban environments and do not understand the managerial approach. For them fire is a bad thing and should be eliminated by all means a modern society may have.

The advantages of the mixed fire protection system are:

- improvement of the effectiveness of detection and rapid response,
- well trained personnel in fire suppression (not in all cases), and
- ability to use more personnel, expensive tools and high technology facilities.

The main disadvantages of the mixed forest fire system are:

- coordination between the agencies is an absolute prerequisite for the effectiveness of the system and this is not easily the case due to the differences in mentality, training and background,
- different players usually represent different policies and a common forest fire policy is not applied - or existing,
- forest fire management is a complex issue that needs feedback among all stages and cannot be separated in pieces.

While we recognize the need for the application of the best possible suppression measures, there should be a balance between all stages of forest fire protection. Suppression mechanisms should act complementary to the specific prevention and management measures, within the framework of a solid policy for forest fire protection.

Since the problem of forest fires becomes more and more severe in the countries with the mixed system, a change in the policies and decision mechanisms is necessary. These changes should not be understood as a comeback to the previous situations, when a central forest agency was in charge of fire management and suppression. The players involved in fire management are not the crucial question. What is important is the policy under which these players operate and their coordination. The data so far show that the current policy is not efficient.

3.3 Collaboration

Various Mediterranean countries have established cooperative relationships to address specific forestry issues in the region.

In 1922, the *Silva Mediterranea*, Mediterranean Forest League was established, with the participation of scientists and officers of forest services from many countries around the Mediterranean. In 1985 *Silva*

Mediterranea, reorganized as the FAO Committee on Mediterranean Forestry Questions, resumed intensive activity. In the 1980s, a Mediterranean Forest Action Plan (MED-FAP) was elaborated and officially adopted in order to highlight and enhance forestry planning in the different Mediterranean countries. *Silva Mediterranea* is the only international forum dedicated to Mediterranean forest issues. It deals mainly with policy issues, research and networking for a number of forestry issues, including forest fires.

FAO's Mediterranean Development Project, launched in 1959 as a result of a *Silva Mediterranea* recommendation (Nice, 1956), was the first concrete manifestation of the need for coordinated, integrated and lasting action in forestry development. Under the aegis of the Organization for Economic Co-operation and Development (OECD), seven southern European countries established the International Centre for Advanced Mediterranean Agronomic Studies (ICAMAS) in 1962; they were subsequently joined by the coastal countries of the southern and eastern Mediterranean. Among other things, the Center's Institute in Chania - Crete (MAICH), founded in 1983, develops cooperative research and advanced training activities in integrated rural development as well as Mediterranean forestry. MAICH has organized several short courses, meetings and seminars on forest fires for scientists, NGO representatives and firefighters.

Approved at the 1992 meeting of the *Silva Mediterranea* Committee, MED-FAP constitutes a conceptual framework for facilitating the review of forestry planning and policy, and also for harmonizing and strengthening international cooperation in the conservation and development of Mediterranean forests. Forest fire measures are included. However, the responsibility to have the forestry plans drawn up and applied at the appropriate administrative levels is up to each country, in accordance with its constitution and legislation.

The problem of forest fires is too large to be controlled at a single government level. It is a Mediterranean problem, but most international associations include forest fires as a small part of their activities, as a geographical or thematic sub-unit. There is a lack of a common perception of forest fires in the Mediterranean.

After 2002 the Forest Fire Network of *Silva Mediterranea* – chaired by Spain – has become increasingly active in promoting and developing international cooperation (mutual assistance) in forest fire emergencies. Two workshops on "Multilateral Assistance Against Forest Fires in the Mediterranean Basin" (held in Zaragoza, Spain, in 2003 and 2004) addressed procedures to coordinate the existing mutual agreements and common legal and logistical tools to improve multilateral assistance in extreme forest fire situations within the Mediterranean Basin by sharing resources. The momentum generated at these workshops considerably influenced those agreements and procedures that were activated in the fire seasons starting in 2003.

The Forest Fire Network of *Silva Mediterranea* constitutes the Regional Wildland Fire Network within the UNISDR Global Wildland Fire Network.

Data availability is a major problem in the countries of the region. Even where it is available, it is not comparable, due to different methodologies, definitions, perception and mentalities. In some countries this happens even between different years (e.g. Greece). The differences in the forest fire data are mostly due to differences in forestry data and definitions in general. Some countries name all non-urban fires "forest fires", others consider plantations as forest land. FAO, UNESCO and the EU have recognized the need for a common database on forest fires, but have again to rely on the same problematic national data.

The most common measures used to describe forest fires are obviously not sufficient to provide a useful set of information. Number of fires and burned forest area too sensitive on the method and comparisons between countries, or even between regions of the countries are almost impossible. The information they provide is also not enough by itself, since these measures are influenced by complex reasons (climatic fluctuations, terrain, effectiveness of means, stochastic effects, social and economic tendencies, methodology, etc.) and they do not lead to safe and useful conclusions about the factors that cause them. The causal analysis of forest fires is problematic. In many countries there are too many unknown fires, due to lack of investigation after the fire, or political and social reasons. In Portugal, after the investigation method has changed, the percentage of unknown fires decreased rapidly. Another phenomenon observed is an intense discussion on arsons, especially in countries where the state tries to cover its own ineffectiveness in firefighting. As a result of these problems, no comparison between the countries and no analysis of the problem is possible.

Lack of data on forest fires and their causes are a major obstacle in understanding the nature of forest fires and design strategies and measures in national and international level. International agencies often receive

wrong messages and respond in a wrong way. Information is needed to describe the magnitude and urgency of the problem to decision makers and to make them prioritize the necessary measures.

Differences in definitions concerning forest fires are a major obstacle for the realization of any international strategy on the ground. The EU and many countries consider measures such as fire break maintenance, road construction and patrolling as prevention, while it is actually pre-suppression. This causes a wrong balance in the money spent on prevention as opposed to suppression and presents a biased picture in the decision makers. Fire management measures incorporated within forest management are in general not promoted, because they are not even considered.

The EU policies related directly or indirectly to forest fires are not fit to address the issue in the Mediterranean, also because they are strongly influenced by the timber-producing northern countries of the continent. As a result, forest fire management becomes often a low priority and receives little attention and financial assistance. An effective Mediterranean forest fire initiative does not exist in any international organization, besides some meetings and research projects without any application. The Mediterranean has its own specific characteristics that define the way forest fires should be controlled and cannot simply be a sub-unit of a larger international policy. However, the above-mentioned activities of *Silva Mediterranea* with its role as a regional network within the Global Wildland Fire Network is a promising arrangement that may be instrumental for intra- and inter-regional cooperation in forest fire management.

3.4 Community involvement

A major element that comes up from the analysis is that local communities become less involved in forest fire management over the years, in all countries. In the EU countries, the communities no longer depend financially on the forest and its value is decreasing in comparison to other uses, such as tourism. The lack of local involvement in forest management has caused fuel accumulation, making forest fires uncontrollable when they are not suppressed at their start.

In the non-EU countries, the forest has lost value in comparison to other land uses, but people still depend on land uses for primary production. This has led to overexploitation, and degradation of forest quality and quantity. The burned areas are less than in the EU countries, but deforestation occurs through other means of land use and practices.

Forest fire management has changed dramatically, due to the lack of the involvement of local communities. There is a clear trend to move away from low (regional and local level) management approach, in which fire protection measures are part of forest management, towards a high-profile operational model, in which high tech equipment and professional specialized units are involved after the fire brakes out. In the latter case, suppression and prevention are assigned to different players. Coordination is too often very poor.

Local populations have a low level of awareness concerning their attitude to forest fire protection. They often burn forests by mistake, using fire as a tool in the wrong time and at the wrong place. People also burn forests on purpose in order to replace it with other land uses that may bring short-term profit. This indicates that people are not aware of the long-term value of forests and the services they provide. They cannot connect the forest with their own quality of life. A major factor that contributes to the lack of awareness is the inability of the Mediterranean countries to estimate and describe the impacts of forest fires on the society and the people.

Government policies seem to be unable to control forest fires. They do not manage to establish and apply simple management regulations for agriculture and pasture (such as season of burning, method), in order to stop accidental fires. In countries where a central forestry body is responsible for the whole range of forest activities (mainly North Africa and Turkey), the state often fails to control and coordinate all prevention and suppression measures planned. During years of extreme drought and many fires per day, the state mechanism is unable to respond successfully to all cases and the local populations are not part of the firefighting mechanism. In cases where the mixed system is applied, coordination before and during the fire is a major problem. More important, different actors perform different tasks, following usually different mentalities and implement different policies.

Governments also fail to recognize and report the problems rose. Almost all official reports present a very flattering picture about the organization of fire management of the countries, while the numbers show that the problem becomes worse. This is a result of the wrong understanding governments have on the issue of forest fires: through a pure operational approach, they fail to recognize the nature of the phenomenon and

consider the accumulation of aerial suppression means equivalent to the expected success of the mechanism. As shown in practice this perception is wrong.

3.5 Needs and limitations

From the analysis of forest fires in the Mediterranean Basin the following needs and limitations can be drawn:

- A common database on forest fires for all the Mediterranean countries is still missing. Data, when it exists, is scattered, non-homogenous and difficult to process.
- Collaboration between Mediterranean countries on forest fire issues is very limited.
- Research on forest fires is done in some countries but the results are not communicated through experts meetings and exchange of information.
- The analysis of the actual direct and indirect effects of forest fires is at a very preliminary level, failing to identify and estimate the real burden posed into the economy and society from forest fires.
- Mediterranean countries share common characteristics concerning forest fires and their ecological and socio-economic features. An integrated approach is needed both in forest planning and management of forest fires.
- Forests are not viewed as a common good having vital links with the local economies. Communities do not feel part of forest management.
- Public awareness on the values of forest other than direct timber production is not adequately promoted.
- There is a lack of a management approach on forest fires issues. Forest fires are treated as a natural disaster only and analyzed (depending on the case) as either an effect of the development and management policies of a country or a region, or an inherent part of the Mediterranean ecosystems, and in some cases as a management tool for forests.
- Sectoral policies (agricultural policy, tourism development, urban development, etc.), contribute to a non-sustainable process, which in turn increases the distortions between communities and the forests.
- Forest policy at a national or EU level is in most cases focused on production and forest fires constitute only a minor part of it, despite its importance for the forests of the region. In most countries forests and forestry are the lesser part of the broader agricultural policy.
- Fighting forest fires is in most cases seen as a reaction to a natural catastrophe, independently from the actual root causes and forest management policies and practice.

4. Country Analysis

4.1 Fire situation in Portugal

Portugal is a Mediterranean country with some Atlantic influence near the coast, strongly conditioned by physical, biological, and climatic environmental characteristics. The forest area is 3.3 million ha, and the mix of species is represented, in decreasing order, by *Pinus pinaster* Ait.*, Eucalyptus* spp.*, Pinus pinea, Quercus suber*, and with lesser representation by other coniferous and broadleaf species.

Private property is 87% of the total forest area. The size of private forest properties ranges from 2 ha in the northern part of the country to 100 ha in the south. Most of the owners, however, do not show any interest in the management of their stands, regardless of mature recently established stands. In addition to these facts the climatic conditions of the country – the precipitation in continental Portugal is ranging between 5 to 65% of potential evapotranspiration – and the low population density create conditions for forest fires very expressive both in number and in burned area.

The North of Portugal is affected by a higher number of forest fires, although its contribution to the total annual burned area is small.

On the contrary it is the centre of the country, with a mean size of forest property of about 30 ha, a very high rate of forest cover and reforestation (mostly by *Eucalyptus* spp., and *Pinus pinaster*), and low population density, that most contributes to the total area burned per year, with a few large fires.

In the South of the country the Mediterranean characteristics are very strong and the majority of the forest systems are the typical "*montados*" with dominant species like *Quercus suber* and *Quercus rotundifolia* in pasture lands regimes. For that reason the number of forest fires is not yet significant.

The Portuguese Forest Service has the responsibility of the management of the database on the forest fires and mapping of burned areas. Whit an average of 20 000 forest fires per year it is necessary to expeditiously develop a methodology for mapping and validation.

Since 1990 the Portuguese Forest Service, in collaboration with the Forestry Department, Technical University of Lisbon (*Universidade Tecnica de Lisboa* – UTL), is using satellite remote sensing (Landsat) imageries for mapping burned areas larger than 5 ha.

During the fire season major forest fires occur between June and October. At the National Co-ordination Operational Centre (CCON) the Forest Service supports a multidisciplinary team for decision making in large forest fire situations.

The Ministry of Agriculture is responsible for forest fire prevention and detection and coordinates 238 fire detection towers, which cover the whole country and are operated continuously during the forest fire season. Since 2000, the Forest Service is testing a pilot project that explores utilization of automatic fire detection systems, as a support to traditional systems.

Prevention strategies

The adoption of national forest management plans, with the support of advanced scientific and technical knowledge, will reduce the negative impacts of forest fires on the ecological and socio-economic systems.

Since 1999 regional forest management plans are in place for privately owned forests.

The elaboration of these plans by the Local Administration Service allows a geo-referenced information system which supports the actions of the management in each region for defence against the forest fires. In the country regions, where the level of forest fires is very high, these plans are very important for the Regional Forest Management Plans.

Statistical Database

Table 1. Forest fires statistics for Portugal (1995-2004)

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
1995	34 116	169 612	4.97
1996	28 626	88 867	3.1
1997	23 497	30 535	1.23
1998	34 676	158 389	4.57
1999	31 714	51 994	1.64
2000	34 109	159 605	4.68
2001	27 067	111 165	4.11
2002	26 488	124 411	4.70
2003	20 864	421 835	20.22
2004	20 268	120 530	5.95
Average (1995-2004)	28 143 per year	143 695 per year	5.52
Average (1995-1999)	30 526 per year	99 880 per year	3.12
Average (2000-2004)	25 759 per year	187 509 per year	7.93

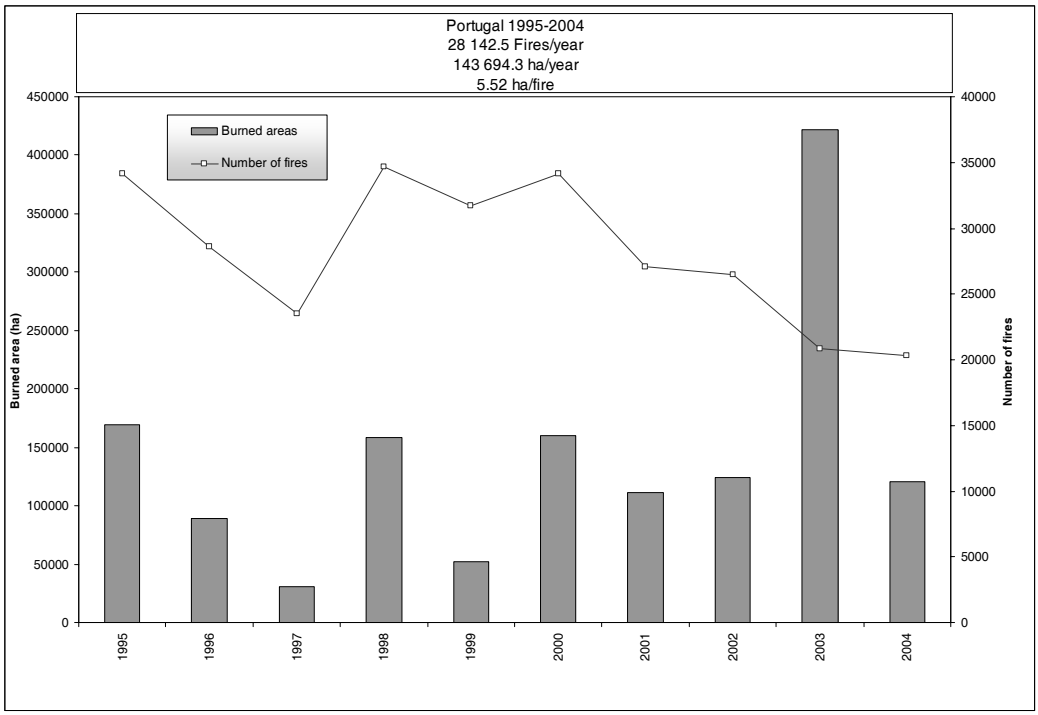

Figure 1. Number of fires and burned area in Portugal during the period 1995-2004

4.2 Fire situation in Spain

Fire causes

Lightning fires in the annual average cause less than 10 percent of the fires. However, they are frequently the cause of the largest burned areas. Light fuel accumulations (grass and brush) are the predominant fuels in which most fires start. A classification of fire causes can be established as:

- High probability motives in all regions,
- Agriculture and grazing land burning,
- Private vengeance.

The following probable motives for starting fires were identified in various localities:

- Conflicts related to game hunting rights,
- Conflicts related to wildland ownership,
- Conflicts related to forest policy: reforestation in communal areas; restrictions of local use in protected areas (national and natural parks),
- Fires set to chase off wild animals (wild boars, wolves),
- Fires set to create jobs in firefighting or in reforestation,
- Rubbish burning at the tourism areas where the urbanization process is expanding.

Other motives may possibly include:

- Fires set to influence (drop) timber prices,
- Fires set for political reasons.

Forest fire services in Spain have attained a good level of effectiveness with a high proportion of professionalism. However, there are several main difficulties to keep pace with the fire problem:

- Increasing fuel accumulations because of rural land abandonment,
- A huge number of simultaneous fires in certain regions,
- Diversity of the regional administrations that have the responsibility for first attack,
- Coordination at the large fires.

Statistical Database

Table 2. Forest fires statistics for Spain, 1995-2004

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
1995	25 828	143 468	5.55
1996	16 771	59 814	3.56
1997	22 319	98 503	4.41
1998	22 445	133 643	5.95
1999	18 237	82 217	4.51
2000	24 312	188 586	7.76
2001	19 631	66 075	3.36
2002	19 929	107 472	5.39
2003	18 628	149v224	8.01
2004	16 724	64 445	3.85
Average (1995-2004)	20 482 per year	109 345 per year	5.24
Average (1995-1999)	21 120 per year	103 529 per year	4.80
Average (2000-2004)	19 845 per year	115 160 per year	5.68

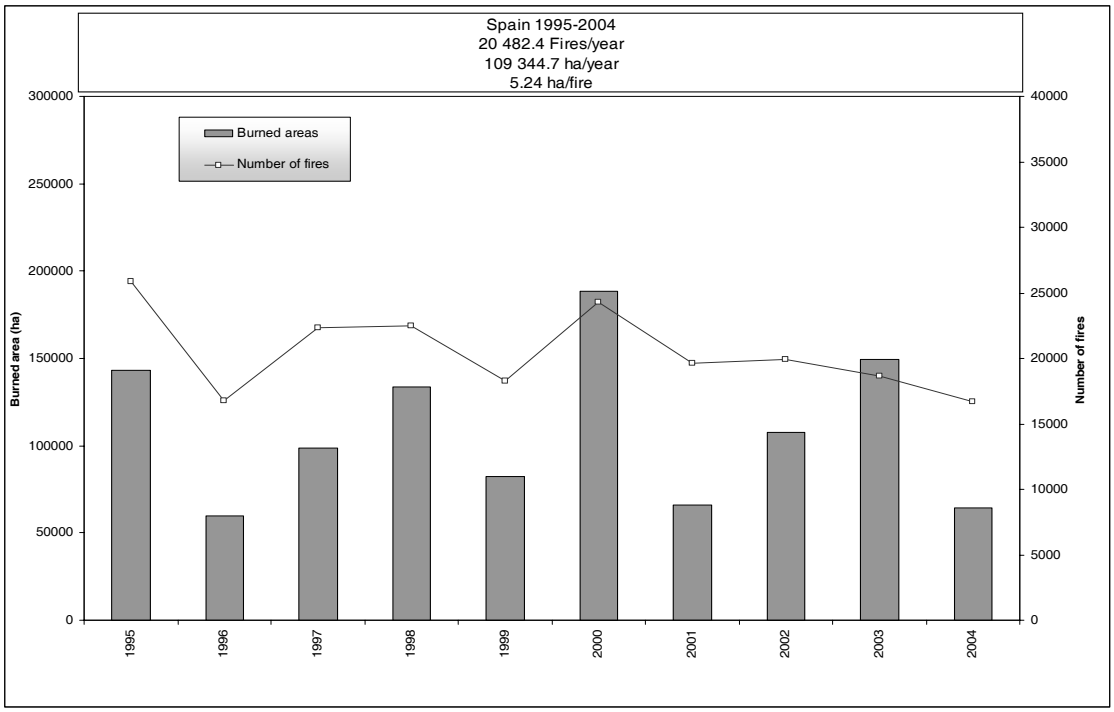

Figure 2. Number of fires and burned area in Spain during the period 1995-2004

4.3 Fire situation in France

Fire protection

In fire protection the French state services take three types of actions: (a) fire prevention education for the public, (b) surveillance of forested areas for early fire detection, and (c) vegetation management to reduce fuels.

(a) In the Mediterranean Basin, fire is traditionally used as a management tool by farmers or forest workers. Negligence (42%), accidents (27%) especially during forest utilization and agricultural activities, and arson (11%) are the main fire causes in France. Therefore information campaigns are organized each year in order to remind the public of the risk associated with the use of fire and the different obligations, e.g. house owners in forested areas are obliged by law to create fuel breaks with a radius of 50 m around houses.

(b) For the surveillance of forest land, all state services are mobilized (gendarmerie, national police, forest service, the administration for agriculture and forestry, fire brigades, private forest owners and hunting associations). By law active fire fighting is the task of the fire brigades. In addition, a specially trained forester was created in the sixties for the Mediterranean region: the fire fighting foresters.

In the Mediterranean climate, defined as a "red" zone of high fire risk, fire detection is primarily based on a system of fire towers throughout the region. In addition, fire spotting planes and mobile ground units of the fighters, equipped with water carrying four-wheel drive utility vehicles for rapid initial attack, patrol the Mediterranean forests and enforce the law. In the temperate areas of France ("orange" zone of average fire risk), fire detection is more extensive and primarily based on fire towers. To improve the surveillance and the prevention, the EU finances 70% of the measures in the "orange zone".

For all actions in which the state is not directly involved, a public association was established in 1963. This association regroups the fifteen French Departments with a Mediterranean climate. Its objectives are to inform the public, test new fire fighting equipment, train specialists, maintain special services (e.g. a water bomber air base) or fire fighting equipment (e.g. retardants).

(c) The third pillar of fire prevention is land management. Fire prevention measures, e.g. fuel breaks, are planned at the scale of an entire forested area without differentiating between ownerships. The private owners have to be convinced of the necessity and utility of proposed projects. In the rare case of refusal, a judicial proceeding in order to dispossess the owner is possible, but not recommended.

For hazard reduction not only classical techniques, e.g. roller-chopping, are applied, but research is carried out to develop more efficient alternatives at low costs. Moreover, prescribed burning has been introduced and a network for prescribed burning was created six years ago. The coordinator is the National Institute for Agricultural Research (INRA).

Another approach is the support and financing of silvo-pastoral techniques in the Mediterranean forests. Grazing of cattle or sheep is temporarily permitted for local breeders. Herds of the Ariege region descend to graze in the eastern Pyrenees and the cows of the Cantal region will graze in Herault. The most important action is the transfer of 500 heifers (young cows) from the Savoy mountains to the Maures forests near St. Tropez. In total 17 000 ha are managed with the help of silvo-pastoral techniques in Provence and Languedoc.

To complete the network of fuel breaks in the forests, the agricultural and forest services encourage the creation of green fuel breaks. These are strategic discontinuities separating forested areas by interlaid cultivated fields and help to limit wildfire disasters.

The scattered construction near and in forested areas is a major problem in south-eastern France. In 1992 this led to a decree that instituted a plan of risk zones. It authorizes local communities to classify their territory in function of the fire risk into categories and to prevent construction (buildings) in wildfire prone areas or to apply restrictive measures. The communities also have to manage their domestic waste dumps in a way that prevents spontaneous combustion.

Actual problems and research needs

In the last thirty years France has developed a well performing and highly competitive industry. It has a surplus of agricultural production within the European Union. In the Mediterranean area a low return on investment, high exploitation costs, low timber quality and a loosely organized wood processing industry, have created new problems for forest fire protection. Farming land is often abandoned and naturally and artificially regenerated forests cover the former agrarian countryside. Conifers, as typical pioneer species and fast growing, were favoured by this development. Since 1900 the French Mediterranean forest surface gained 220 000 ha (174 000 ha conifers) without counting the bush vegetation.

The question is to what extent the decreased areas burned by fires have been directly the result of better fire prevention and suppression techniques and not just of weather conditions. It is certain that wildfires of more than 500 ha are causing an increasing part of the burned area (32% in 1976, 57% during the last four years).

The more effective fire protection measures seem to lead to an accumulation of fuel in the French Mediterranean forests. The policy of rapid initial attack is very effective, but does not seem to be adapted to large fires. Parallel to these phenomena the biodiversity of the Mediterranean ecosystems is rapidly decreasing. The traditional mosaic-shaped forests and landscapes, rich in edge effects, provide niches for rare and endangered flora and fauna. Here, prescribed fire for hazard reduction and silvo-pastoralism for conserving the traditional landscape might offer an appropriate solution.

Forest fire research

Mediterranean forests are characterized by complexity and fragility. Their management with the objectives of protection, production and biodiversity necessitates the mastering of especially adapted techniques. The actual French research programmes aim to define the different vulnerable zones of the Mediterranean forest corresponding to soil characteristics, vegetation and relief. Different research projects funded by the European Union and international contracts show that scientific cooperation is considered as essential.

At the moment the knowledge about "traditional" preventive measures (e.g. surveillance, fuel breaks) and modern fire fighting techniques are relatively advanced in France. The introduction of Geographical Information Systems (GIS) in combination with more sophisticated satellite data have fostered fuel mapping and forest fire modelling projects and expert systems. While the basic characteristics of fire physics are known under controlled conditions, little research has been achieved to document fire behaviour and effects. Additional research is needed to better predict the behaviour and effects of prescribed burning and wildfires.

The Mediterranean Forest Research Division at INRA, with its forest fire prevention unit in Avignon, concentrates its research on (a) modelling of flammability and fire propagation, (b) traditional and new hazard reduction methods for fuel breaks, including modelling of vegetation dynamics on fuel breaks, and (c) effect on trees of surface fires and convective activities in prescribed fires.

The *École Nationale des Mines* is investigating digitized cartography of fire-prone zones. The National Centre for Scientific Research (CNRS) and various universities are working on the different aspects of fire ecology, e.g. plant succession after fire. Remote sensing of savanna fires and determination of gaseous and aerosol emissions is one of the major research activities conducted under the umbrella of IGBP/IGAC.

The National Centre for Agricultural Machines, Rural Engineering, Water and Forestry (*Centre National du Machinisme Agricole, du Génie Rural, des Eaux et des Forêts*) provides access to an important documentation on forestry and forest fires in the Mediterranean Basin.

Statistical database

Table 3. Forest fires statistics for France, 1995-2004.

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
1995	6 545	18 188	2.78
1996	6 400	11 210	1.75
1997	8 000	20 500	2.56
1998	5 600	20 880	3.73
1999	5 170	17 605	3.41
2000	5 600	23 700	4.23
2001	4 103	17 000	4.14
2002	900	20 850	23.17
2003	4 100	74 000	18.05
2004	5 301	10 690	2.02
Average (1995-2004)	5 172 per year	23 462 per year	6.58
Average (1995-1999)	6 343 per year	17 677 per year	2.79
Average (2000-2004)	4 000 per year	29 248 per year	7.3

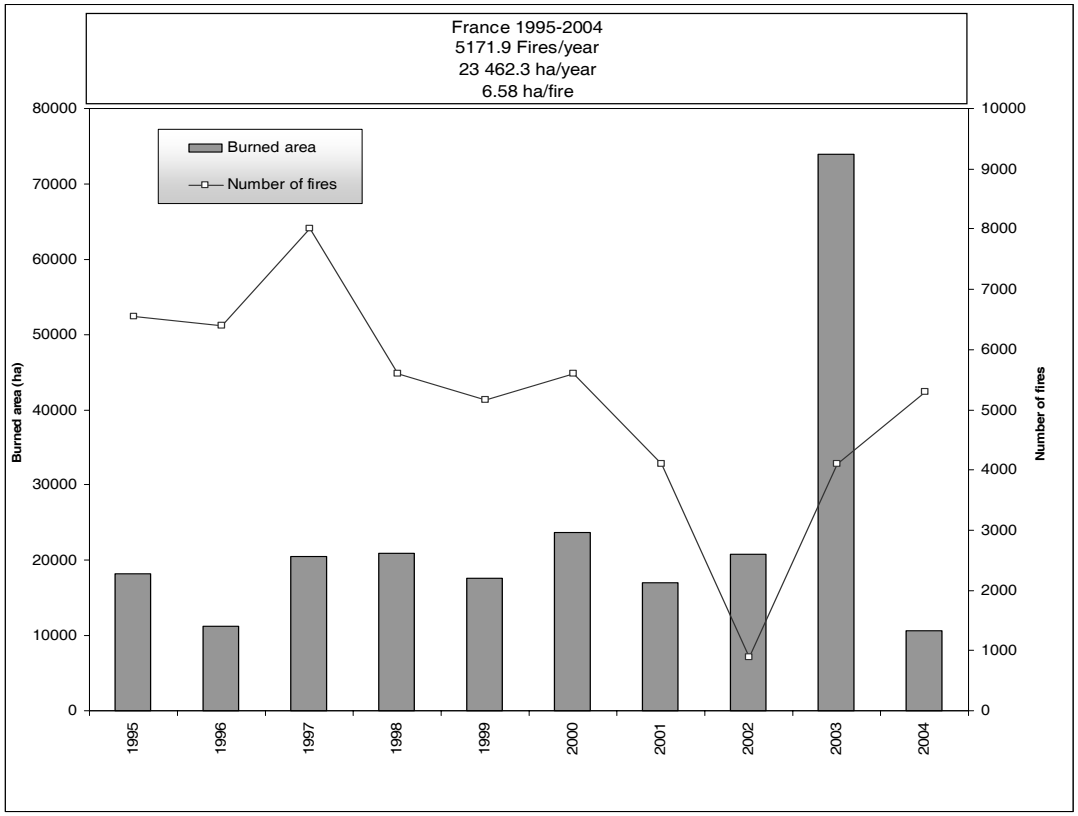

Figure 3. Number of fires and burned area in France during the period 1995-2004

4.4 Fire situation in Italy

Measures for forest fire prevention and control
Prevention activities do not take a great step forward because of the crisis in forest economy and growth of hazardous fuels and crime and arson as well. Therefore forest protection has to rely mainly on suppression. In 1990 the total expenditures of the State and the Regions in fire prevention and control were about 300 000 million lire.

As regards airborne equipment, in the same year the Ministry for Coordination of Civil Protection disposed of airplanes belonging to the Air Force (one Lockheed C-130 and three Aeritalia G-222), to the Ministry of Agriculture and Forestry (four Canadair CL-215), and of helicopters belonging to the Army (3-4 Chinook CH-47) and to the Navy (Two AB 212), as well as of other two Canadair CL-215 rented. The State Forest Corps operated with its ten light helicopters NH 500 and with its new five helicopters AB 412 s (carrying a bucket with a capacity of 900-1000 litres). Almost all regions rented more than 30 light planes for detection and 35 helicopters for initial attack. Altogether more than 90 aircraft were used in fire detection or extinction. The total hours flown were close to 20 000.

High technology for forest fire detection
Since 1979, television systems for forest fire detection are developing all over the country. At present more than 15 systems with 30 television cameras connected by radio (microwave band) are operational from Piedmont to Apulia. Colour television cameras tent to replace the older black-and-white models.

After the experience carried out by the Ministry of Agriculture and Forestry with the Italian company Selenia, a national law (Nr. 38 of 28 February 1990) has financed the installation of integrated detection systems with infra-red detectors and television cameras over the areas most exposed to fire in Sardinia, Liguria and Sicily, for a total amount of 90 000 million lire in the period 1990-1992.

Statistical database

Table 4. Forest fires statistics for Italy, 1995-2004.

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
1995	7 378	46 466	6.30
1996	9 093	57 986	6.38
1997	11 612	103 015	8.87
1998	10 155	140 432	13.83
1999	7 235	61 989	8.57
2000	10 629	114 468	10.77
2001	7 134	76 427	10.71
2002	4 594	40 768	8.87
2003	9 697	90 803	9.36
2004	8 550	48 651	5.69
Average (1995-2004)	8 608 per year	78 100 per year	8.93
Average (1995-1999)	9 095 per year	81 978 per year	8.79
Average (2000-2004)	8 121 per year	74 223 per year	9.08

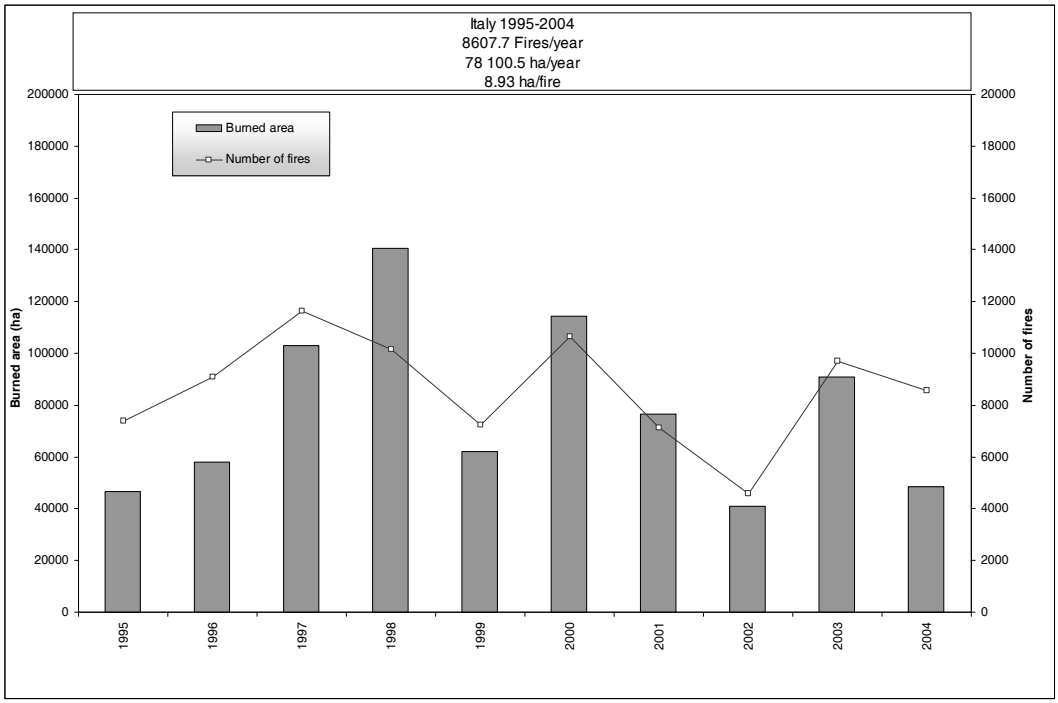

Figure 4. Number of fires and burned area in Italy during the period 1995-2004

4.5 Fire situation in Turkey

Turkey is a country with a land mass of 77 079 million hectares, of which 20 199 million hectares are forested, representing about 26 per cent of the country's total land area. The Mediterranean climate is predominant in the southern and western Anatolia where most of the forest fires occur every year. A continental climate with hot and dry summers accompanied by rain in the spring and fall, and snow in the

winter prevails in central parts. The Black Sea region has a distinct climate type with mild temperatures and precipitation almost uniformly distributed throughout the year.

Forest fires are a recurring phenomenon, and have always had a pervasive influence on Turkish forests. In the period 1937-1996, a total of 60 434 fires burned a total of 1 464 928 hectares of forest land. This represents 1 007 fires on 24 414 hectares annually with an average area burned of 24 hectares per fire. In recent years, there has been a gradual increase in the number of fires, but due to the increased and effective use of technology in transportation, communication and fire suppression, the area burned has been cut in half and kept at a range of 12 000-14 000 on average. The distribution of fires to different regions is as follows: 41% of the fires occur in Aegean; 24% in Mediterranean; 22% in Marmara; and 13% in other regions.

In the Mediterranean and Aegean regions, every place has a unique fire regime or pattern of fire activity resulting from the interaction of many natural and cultural influences. In the past, one of the major causes of forest fires was the use of fire to clear land for agricultural purposes. Although very little effort has been made to determine the fire regime in Turkish forests, many areas that are now covered by maquis formation (of mainly shrub species) were created by repeated fires set by people.

There are two major fire seasons in Turkey – short and long fire seasons. These seasons are characterized by the different climate and fuel conditions found in different regions. The short fire season prevails in the western Black Sea and Marmara regions. Depending on the local fuel, topography and fire weather conditions, the fire season may be two (July – August) or three (June – August) months long. The long fire season ranges from June through November in Mediterranean and Aegean Regions. Typically, there is very little winter activity, followed by an increase in May as the rain activity decreases and fuels start to dry up, a peak in the number of fire starts in August, followed by decreasing activity in the fall. Another but less recognized fire season is the spring/fall fire season. This type of fire season is seen in the spring and fall in broad-leaved forests in fire prone regions and in the eastern Black Sea region, one before leaf-out when the last years surface fuels are dried up before the new vegetation period starts and one in the fall after the vegetation period has ended and leaves fallen. Here, surface fuels are the only fuel component that becomes available for combustion, thus all fires spread as surface fires.

Fire causes

People cause the majority of forest fires in Turkey. People-caused fires account for 98% of all fires, while lightning is responsible for the remaining 2%. Of the people-caused fires, 23% was classified as arson, 27% as negligence and carelessness, and 50% as unknown. “Unknown” fires are the fires for which no known cause could be determined. However, it is very likely that the shares of the first two categories of fire causes (i.e., arson, negligence and carelessness) in unknown causes are similar to that of the known causes. In this case, arson accounts for about 35% of all fires, which is a little over the average value (32%) found in temperate forests of the northern hemisphere. This is definitely a very large proportion and is seriously taken into account in the process of fire prevention, pre-suppression and suppression planning.

Arson fires are set for several reasons. About 8.8 million people live in 17 445 villages in or near forests. Socio-economic life standards of most of these people are well below the national average. People with low income and low life standards see the forests as an earning ground for their sustenance. So, people set fire in the forest to create jobs that will earn them some provision or manipulate vegetation to improve and produce useful plants for their animals to graze. Personal conflicts between people and forestry officials or between shepherds or different villagers have also been reported to have been a cause for fires.

Fire management

Fire management in Turkey is a federal responsibility. Duties are carried out by state forest enterprises functioning under regional directorates. Fire control policies have developed around a strong emphasis on total fire control as a response to destructive fires. Regardless of the high costs involved, all required activities are planned and implemented immediately. However, the beneficial use and ecological role of fire has at no time been incorporated into the fire management planning process. Fire management, therefore, deals mainly with activities concerning prevention and control.

Fire prevention programs deal with all activities concerned with minimizing the incidence of forest fires. In this regard, determining and analyzing the cause of fires (i.e., who is starting the fires, where and when they are started and, to the extent possible, why they are started) are considered to be the first steps to justifying and allocating the budget for prevention and pre-suppression. For this reason, the Fire Fighting and Forest Protection Branch of the General Directorate of Forestry has put more emphasis on the determination of fire causes and the inclusion of the findings in fire report files. A national database on forest fires is being created containing information on all aspects of forest fires. Information gathered on location along with the

cause of fires is used to develop fire prevention techniques and prevention planning. In this regard, many techniques are being used to reduce people-caused fires, which fall under two general categories, risk abatement and hazard reduction.

Risk is associated with ignition, and risk abatement involves raising the level of awareness of the general public and various accountable groups to the dangers of ignition and subsequent forest fires through education and enforcement. It is the opinion of the forestry service that a strongly favourable public opinion is a vital necessity in any effort to reduce the number of people-caused fires. All available communication avenues have increasingly been utilized for this purpose. These involve the utilization of mass media and local media outlets of radio, television, newspapers and magazines, education programs in the schools, military bases, service clubs, signs, and personal contacts. Also, fire law enforcement has been a potentially valuable technique for forest fire prevention since the laws have a potential to educate the public as well as to deter the negligent or malicious from destructive behaviour.

Given that a majority of fires are caused by sheer inadvertence and accident, no matter how good the education and enforcement activities may be, some fires will always be unpreventable. These causes can be reduced only through modifications of the ignition sources or the fuels that act as ignition receptors. Many forms of fuel modifications have been practice in all fire prone areas.

Despite the high cost of construction and maintenance, fire breaks (fire safety roads) and fuel brakes have been widely used to break the continuity of forest fuels. It is interesting to note that when the planned fire brake network is completed, the forest area cleared to create fire brakes will amount to 5% of the total forest area (currently it is about 3%), and that the total area burned since 1937 is about 7% of the total forest area. This is also practice along and around the high risk areas such as camp grounds, disposal sites, settlements, major highways and railroads. Although very labour intensive, the practice of clearing and burning surface fuels along major highways within 15-20 m on each side of forest stands is a usual one.

As a general rule, fire breaks are constructed in plantation and naturally regenerated areas, and are supported by some fire resistant species (especially *Cupressus sempervirens* var. *pyramidalis*). These species are planted, with up to five rows, along the fire breaks. In areas close to settlements or critical areas, such species as stone pine (*Pinus pinea*) have been heavily utilized (planted) in place of other species. The local people look after these areas by pruning the trees and clearing underneath them and harvesting their cones. This practice not only helps to maintain an important fire resistant zone but it also provides an opportunity for the local people to make a living. One other activity worth mentioning concerns the fuel modifications in the charcoal production, where some bush species that would not normally be harvested or utilized are used. Those who produce charcoal purchase the wood they cut for a very low price (about 1/10 of what they sell charcoal for). Again, this benefits both forests and people.

Statistical database

Table 5. Forest fires statistics for Turkey 1995-2004.

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
1995	1 768	4 791	2.71
1996	1 631	14 922	9.15
1997	1 339	6 171	4.61
1998	1 932	6 764	3.50
1999	2 075	5 804	2.80
2000	2 353	26 353	11.20
2001	2 631	7 394	2.81
2002	1 471	8 413	5.72
2003	2 177	6 644	3.05
2004	1 762	4 876	2.77
Average (1995-2004)	1 914 per year	9 213 per year	5.11
Average (1995-1999)	1 749 per year	7 690 per year	4.55
Average (2000-2004)	2 079 per year	10 739 per year	4.83

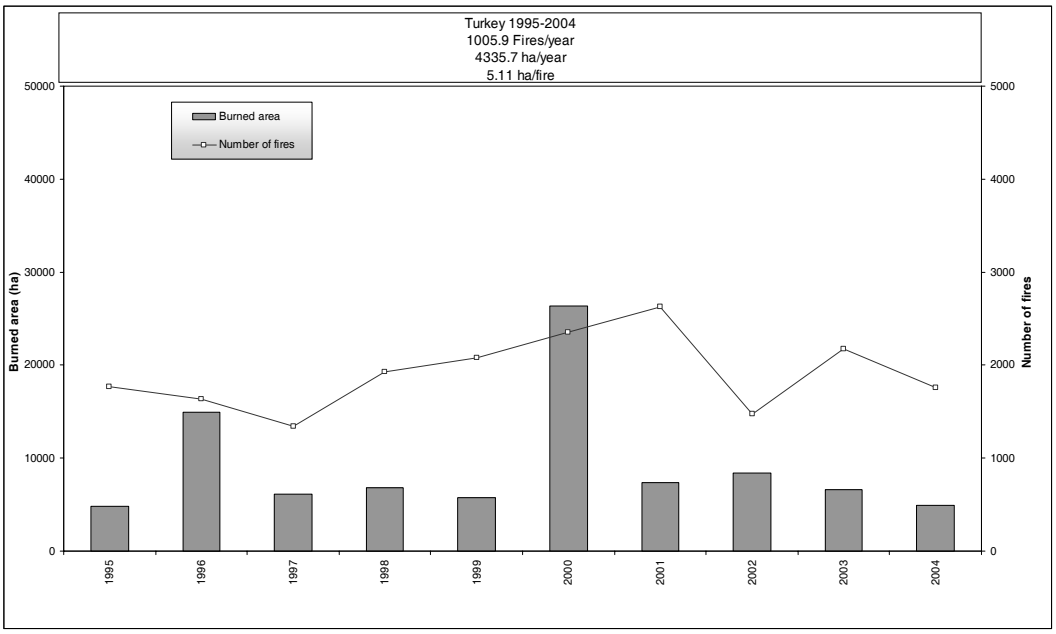

Figure 5. Number of fires and burned area in Turkey during the period 1995-2004

Fire Pre/suppression

Fire management relies on early detection, fast initial attack and powerful suppression. Each region has been provided with sufficient resources and manpower to combat forest fires. Available resources include 135 fire trucks, 12 helicopters, 11 airplanes, 882 fire look-out towers, 8 472 radios, 650 initial attack crews (of 12-15 men), and 120 standby forces (of 40-50 men). New resources are being added as needed and new technologies adopted. These forces are allocated to each district based on fire danger levels and the area in question. Overall, 71% of fires are controlled at less than 5 hectares and account for only 8% of the area burned. In contrast, only 1% of fires exceed 200 hectares in size, but these fires account for 37% of the total area burned.

Fire Research

Fire is one of the areas that have received the least attention in Turkey. There have been no major studies concerning fire ecology or the role of fire in Turkish forest ecosystems. Recently, however, attempts have been made to establish a national fire danger rating system. Initial work has been completed and weather measurements will soon begin. The Turkish Fire Weather Index System will be developed based on the litter moisture and weather measurements in a standard fuel type (red pine, *Pinus brutia*). Fire behaviour experiments will be conducted later in the season. Results of the experiments will constitute the first steps towards achieving the goal of developing the fire behaviour prediction system. Also, the use of Geographical Information Systems in fire management is being increasingly utilized. These recent developments have been the result of a genuine cooperation between Karadeniz Technical University and the General Directorate of Forestry.

Conclusions

Forest fires have a major impact on the sustainability on Turkish forests. With its complex social, economical and environmental aspects, Turkish forestry presents great challenges to the society in general and the forest service and fire researchers in particular. Fire policies were formulated in such a way as to exclude fire on the assumption that it is always bad. Today, however, pressures brought about by certain realities of ecology and economics, and our increased demands for multiple resources require the development of new policies and attitudes towards fire. At the same time, increasing complexity and sustainable forestry will require a deeper understanding of fire and the development of more effective management systems. Effective management systems will not prove successful unless they include the demands and acknowledge the role of the society on forests.

4.6 Fire situation in Israel

Only 3.7 percent of Israel's territory is covered by forest, either natural or man-made. The Mediterranean climate is predominant in about 40 % of Israel and around 70% of human-made forests are located in this region. Thus, the forested areas are proportionately very low, when compared to other Mediterranean lands such as Spain (13.8 %), Portugal (28.7 %), Cyprus (16.6 %) or Morocco (8.0 %). Even these limited forest areas were achieved only after an extended afforestation effort which was first carried out by the British Mandatory Government and the Jewish National Fund (JNF). After 1949, when Israel became an independent state, forests were planted by the Government and by the JNF. These bodies are responsible for the planting and maintenance of almost all the man-made forests in Israel. Overgrazing and over-cutting, thus not allowing natural vegetation to recover, destroyed most of the Mediterranean vegetation, including the forests, which covered Israel-Palestine in the past. Over-cutting of woods by the Ottoman Government of Palestine also suppressed vegetation regeneration.

In 1949, the Jewish National Fund faced the enormous task of maintaining natural vegetation and adding new forests to the bare land. In 1995, forests covered 826 598 dunams (82 659 ha). According to the outline of the national plan for forestation, by the year 2020, forests will cover 161 864 ha, namely, the present forest areas will double in size.

Fire causes

The first and most important cause of forest fires in Israel is arson. In the 1980s and early 1990s, arson comprised about one-third of all forest fires in Israel – a very large proportion. Some of the sources for this arson were identified as the work of criminals whose sole aim was to collect insurance money. Many cases of arson in the late 1980s, however, were directly related to the Palestinian uprising (Intifada). Palestinians used fire as a means of their resistance movement as early as the 1920s, 1930s and 1940s, but in the 1980s it was adopted as a highly visible action against the Israeli occupation in the West Bank. Arson was found to be easy to execute: all one had to do was to cross the old border, which was unguarded and open to all, start a fire in one of the many forests which straddle the mountainous areas near the border, and then disappear. The occurrence of forest fires in areas adjacent to the old "Green Line" border between Israel and the West Bank was very frequent: in the years 1988-1990 between 288 and 388 forest fires were caused by arson and took place in areas near the old pre-1967 border. In some of the fires which took place in northern Israel, Israeli Arab Palestinians were found to be responsible. These fires were extremely remarkable because 1988 was also rich in precipitation and, as a result, the vegetation concentration was highly combustible. Intifada-induced arson gradually faded out as the uprising started to die out in the early 1990s.

The origin of fires in Israel reveals a prominent human element, through both negligence and incendiarism, but also by arson. Most of the other causes of forest fires in Israel are classified as incendiary: hikers who light fires, military units in training, farmers, are among the major instigators of accidental fires. There are five major incendiary causes for forest fires in Israel. First is the military: Army units who train with live ammunition in fire ranges near wildlands and burning waste in army camps cause, on the average, 5-6 percent of the fires.

This type of fire prevails in northern Israel and the Golan Heights where many of the training areas (and forests) are located. A second category of accidental forest fires is the fires started by hikers and people who visit the forests for recreational purposes. Recreation in JNF forests became very popular in the second half of the 1970s, as changes in the patterns of leisure activities were taking place among the Israeli public. As a result of a successful effort to re-educate people who hike or camp in the JNF forests, figures for this type of fire have been greatly reduced. A third grouping of fires is that of agricultural fires, namely fires which were accidentally started by farmers who burn agricultural waste, such as dry wood and vegetation, or other, refuse which is a by-product of their everyday activities. Finally, the number of fires caused by arson, namely fires set with the sole intention of destruction, is on the rise.

One important factor, which may exacerbate the human nature of fires, is natural conditions. The first such condition has to do with the vegetation associations present in the Mediterranean ecosystems. After repeated forest fires the dominant plants and plant associations in both oak and pine groves are changed and replaced by a brush cover, small bushes and grass. Eventually, after some years, the pine will regain its hold.

Statistical Database

Table 6. Forest fires statistics for Israel 1995-2004.

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
1995	1 061	8 288	7.81
1996	1 075	6 476	6.02
1997	1 047	2 403	2.29
1998	1 445	7 813	5.41
1999	831	3 114	3.75
2000	972	3 486	3.59
2001	1 027	5 488	5.34
2002	779	1 834	2.35
2003	982	3 426	3.49
2004	840	1 029	1.22
Average (1995-2004)	1 006 per year	4 336 per year	4.13
Average (1995-1999)	1 092 per year	5 619 per year	5.06
Average (2000-2004)	920 per year	3 053 per year	3.20

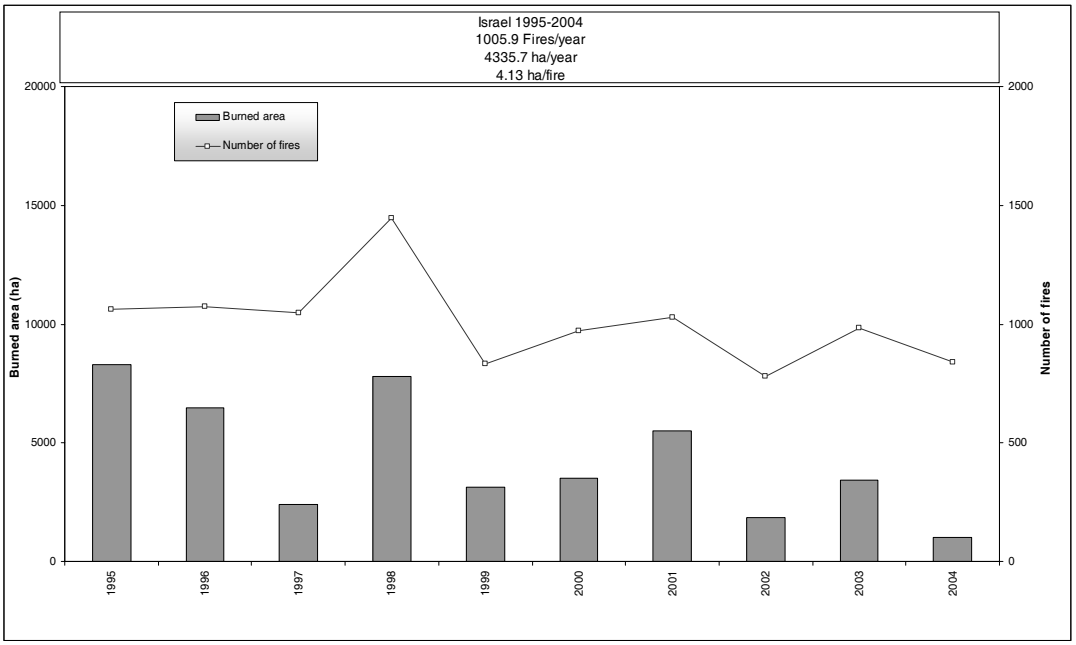

Figure 6. Number of fires and burned area in Israel during the period 1995-2004

Conclusions

In conclusion, the catalytic agents of forest fires in Israel are only slightly different from the causes of fires in other Mediterranean countries. Lightning as a cause of fires is more important in other Mediterranean countries than in Israel, but negligence and incendiarism are similar in their relative importance in both Israel and other Mediterranean countries. Arson comprises a large grouping in Israel compared to other Mediterranean countries. The most important category of forest fires in Israel and in the Mediterranean at large are fires whose catalytic agents remain “unknown”, as detecting unequivocally the causes of fires is often an impossible task. Improvement in forest fighting technology and in forest management has been found to be useful in reducing the damage caused by forest fires in Israel

4.7 Fire situation in Greece

Greece is the Southern tip of the Balkan peninsula covering an area of 132 000 km^2. About 40% of its total area is covered by Mediterranean vegetation types (maquis, low-elevation conifer forests) while the rest is forests of deciduous oaks (mainly *Quercus pubescens, Quercus frainetto, Quercus petrea*) or high-elevation conifers and beech.

Greece has a long history of forest fires extending from the birth of the country in 1830. Historical records on forest fires exist from 1955 till present. It is implied that the prolonged drought and socio-economic changes are the main causes for this dramatic deterioration of the forest fire situation of the country. During the period 1980-2000, on the average, about 53 000 ha were burned by 1 500 forest fires on an annual basis. The average fire size was 35 ha (the highest in Europe). Fortunately, during the last 4 years (2001-2004) there was a severe reduction in the annual area burned (less than 3 500 ha per year).

The Mediterranean ecosystems, extending along the coast up to an elevation of 600 m inwards, are the most fire-stricken accounting for over 80% of the total fires and 75% of the total area burned. Almost two thirds of total fires and 85% of total area burned occur during July, August and September.

Greece has primarily a large fire problem since while only 5.7% of total fires become larger than 100 ha, yet they account for about two thirds (66.4%) of the total area burned.

Given that most of the fires listed as ''unknown'' are caused by humans and that at least half of them are arsons, we can conclude that 97% of all fires are set by man and that at least 50% of them are arsons.

Forest fires in Greece cause severe economic damage (due to the loss of agricultural crops, livestock and human structures in the rural-urban areas) but, mainly, huge ecological loss, due to the soil erosion and degradation that come afterwards. Extended forested areas have become degraded shrublands or bare soils after repeated circles of fires and over-grazing. Forest fires also have a huge social impact, thus becoming a major political issue.

Over 85% of the total annual budget allocated by the State to forestry operations in Greece is spent for forest fire suppression. Presently, Greece has the largest fleet of firefighting aircraft (15 CL-215, 9 CL-415, 18 PEZETEL, 6 Grumman, 14 Helicopters) in Europe, which is extensively used. Ground forces are fortified during the summer by hiring seasonal firefighters. Most large fires are controlled by combined ground and aerial attack. The average initial attack time in Greece is 33 minutes, while only ¼ of total fires are attacked in less than 15 minutes from announcement.

Forest fire prevention planning is mostly concentrated in extending the forest road network and establishing numerous watch towers. There has been some limited and spatially restricted fuel management as well. Prescribed burning is forbidden by law in Greece.

Since 1998, the responsibility of forest fire suppression has been transferred from the Forest Service to the Fire Department. It is still dubious whether this was a sound decision.

Statistical Database

Table 7. Forest fires statistics for Greece 1995-2004.

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
1995	1 438	27 202	18.92
1996	1 508	25 310	16.78
1997	2 273	52 373	23.04
1998	1 842	92 901	50.43
1999	1 486	8 289	5.58
2000	2 581	145 033	56.20
2001	2 535	18 221	7.19
2002	1 141	6 013	5.27
2003	1 452	3 517	2.42
2004	1 708	10 266	6.01
Average (1995-2004)	1 796 per year	38 912 per year	19.18
Average (1995-1999)	1 709 per year	41 215 per year	22.95
Average (2000-2004)	1 883 per year	36 610 per year	15.42

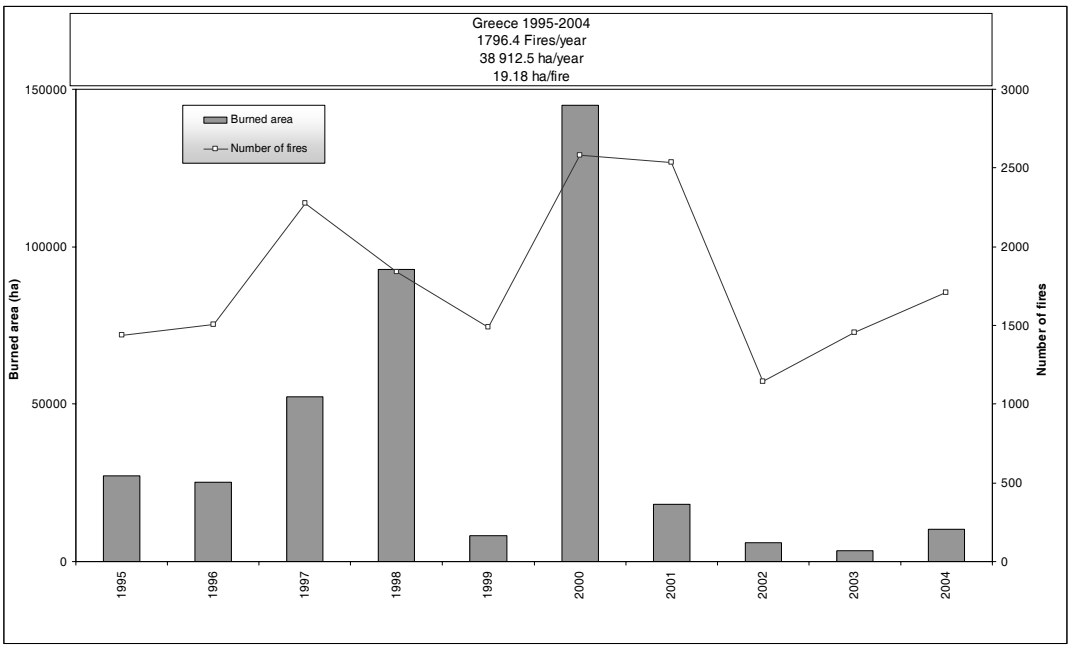

Figure 7. Number of fires and burned area in Greece during the period 1995-2004

4.8 Fire situation in Cyprus

Fire is by far the most destructive single agent, threatening the forests of Cyprus, and no real progress can be made in Forest Development unless the forests are adequately protected. The long hot and dry summers, the frequent strong winds, the configuration of the ground and the flammability of the vegetation favour the outbreak and quick spread of fires. Furthermore the urbanization, the abandonment of rural areas and the increased number of visitors in the forest for recreation raise the fire hazard to very high levels.

Causes of forest fires
In analyzing fire incidents for the years 1995-2004, it became evident that the biggest percentage of forest fires in Cyprus, and especially the most destructive ones, is of human origin. Nearly 93% of these fires are due to negligence or lack of care and attention, and 7% is attributed to incendiarism.

The main causes of forest fires are:

- *Agricultural activities*. Mainly the burning of grass, gorse or stubble by farmers without taking the necessary precautionary measures.
- *Recreation*. Fires caused by careless visitors and picnickers when using fire for cooking and grilling. Burning cigarette butts and matches used by careless smokers.
- *Military activities*. Military exercises with ammunition or explosives of any kind.
- *Burning of rubbish* at non-organized rubbish dumps.
- *Fires caused by people or machines* engaged in any activity associated with forest engineering and forest production.
- *Natural causes*. Lightning causes some fires but these fires are not significant because these fires are usually accompanied by rainfall.
- *Residence*. The rise of the number of country residences, constitutes a new cause of forest fires.
- *Deliberate*.
- *Other causes*. Fires can occur in lower extent also from other causes like hunting during summer time, use of different tools and machinery, etc.

Prevention of forest fires
The Forestry Department, which is responsible for the prevention and control of fires within or near the state forests, is fully aware of the high fire danger and takes a series of preventive measures for:

- The elimination of outbreaks,
- The quick detection,
- The rapid intervention and effective control of forest fires.

Education and publicity
Since the majority of forest fires in Cyprus are of human origin and especially due to negligence, the Forestry Department makes every effort to gain the support and co-operation of the general public through a well planned and directed publicity and educational program, including:

- Talks and interviews of forest officials through the mass media.
- Special programs through the radio and television services.
- Publication of texts and articles in the press and magazines.
- Lectures and film projection at schools, the Police, army clubs and other organized groups.
- Production and distribution to the public of relative leaflets and stickers.
- The degree of fire hazard is broadcasted on radio and TV several times a day and preferably immediately after the news and the weather broadcast. It is also indicated on special sign posts located at the main forest stations to warn visitors.
- Posters and signposts, which warn the public about the danger of forest fires, are made and placed at conspicuous places of roads and villages.
- Production and distribution to elementary and secondary schools of special leaflets.
- The “Save our Forest Week” is celebrated every year. A “Save the Forest Day” is also celebrated in all schools in co-operation with the Ministry of Education.

Fire danger rating and announcement
Fires in Cyprus usually occur from April to the end of November. During this period the public is warned about the danger of forest fires through a fire-hazard warning system, which is put into operation during this period. The degree of fire hazard is broadcasted on radio and TV every day immediately after the news and the weather broadcast.

Fire protection plans

For more effective fire management in the countryside, a "Pancyprian Fire Protection Plan" was prepared by the Forestry Department in cooperation with the Police Fire Brigade. The existing fire prevention measures and proposals for construction of new, supplementary infrastructure are the main elements of the "Pancyprian Fire Protection Plan". Preliminary estimation for the total amount needed for the implementation of the proposed Fire Protection Plan was calculated to 2.5 million Cyprus Pounds and was already approved by the Council of Ministers. The project is to be completed within the next 5 years.

For the detection and report of forest fires, look-out stations were established. A pilot project is being run by the Forestry Department, for the installation at "Akamas forest" of an automatic fire detection system in order to minimize the time lapse from the outbreak of a fire to its detection and first alert.

Statistical database

Table 8. Forest fires statistics for Cyprus 1995-2004.

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
1995	24	70	2.92
1996	20	116	5.80
1997	19	167	8.79
1998	19	566	29.79
1999	20	3	0.15
2000	285	8 035	28.19
2001	299	4 830	16.15
2002	243	2 196	9.04
2003	427	2 349	5.50
2004	221	1 218	5.51
Average (1995-2004)	156 per year	1 955 per year	12.55
Average (1995-1999)	20 per year	184 per year	9.04
Average (2000-2004)	295 per year	3 726 per year	12.63

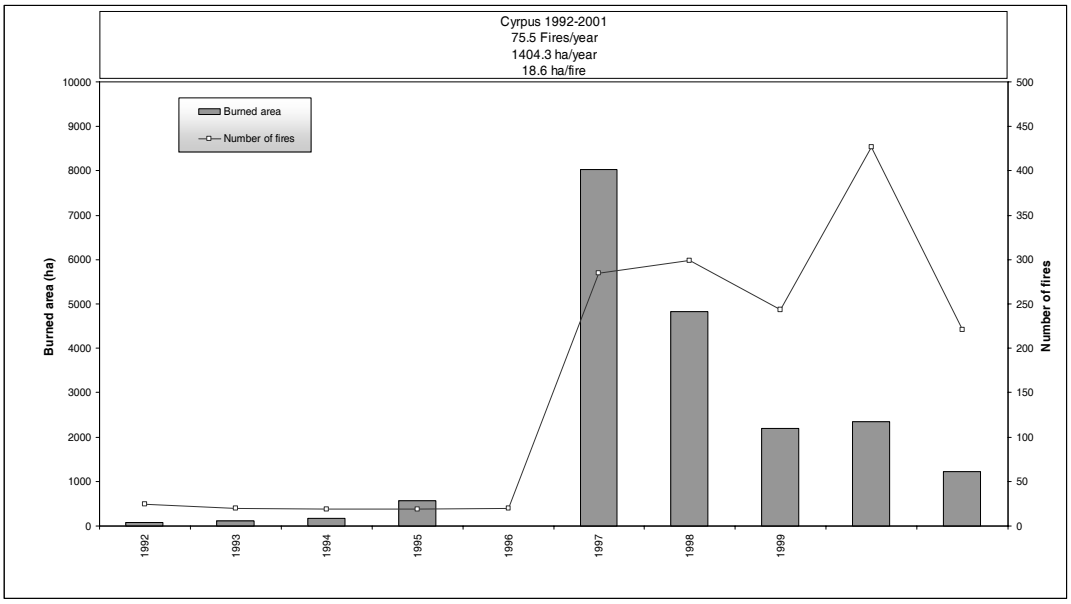

Figure 8. Number of fires and burned area in Cyprus during the period 1992-2001.

4.9 Fire situation in Morocco

The forests of Morocco cover about 9 million hectares, thereof forest formations (natural forests, plantation forests) cover 5.814 million ha, and alfa grasslands 3.186 million ha.

The forest formation is dominated by broadleaved species (63.09 percent or 3.668 million ha), followed by conifers (20.14 percent or 1.171 million ha) and secondary species (16.17 percent or 974 894 ha). Forest plantations cover 530 000 ha out of which 75 percent (395 500 ha) are part of the forest fund.

The forest land is an open space where access (except rare exceptions) is free. The population, especially those living at the forest edge, lives from subsistence economy (using forests for construction wood and firewood needs, the gathering of various non-timber forests products, and pasture). Consequently, forests are under a very strong human pressure and are overexploited.

This human pressure increases the fire risk, since Moroccan forests, as all Mediterranean forests, are extremely flammable, particularly during the summer season when the fuel moisture content of plants is very low.

Fire causes
It is often very difficult to determine the fire cause for the following essential reasons:

- The very criminal character of the fire setting: according to Moroccan forest law, arson is heavily fined, even with imprisonment.
- The multitude of stakeholders in forest areas: commercial loggers, logging sites, shepherds, farmers, bee-keepers, distillers of aromatic essences, illicit charcoal production, and hikers.

In general, the analysis of information and reports on forest fires allows the following conclusions:

- more than 50 percent of the fires are of unknown cause,
- more than 40 percent of the fires are due to negligence (burning of fields, honey collection, camp fires, vehicle exhausts, cigarettes, etc), and
- 10 percent of the fires are intentional (destruction of the forest for gaining agricultural land. This is the primary cause of forests fires in the north of the country).

It should be noted that the high percentage of fires of unknown cause renders it difficult to set up an efficient prevention policy.

Preventive measures
There are provisions which regulate the use of fire in forest or in the vicinity during the period of summer dryness, between 1 July and 31 October:

- charcoal production is prohibited at the logging sites of legal forest exploitations;
- dwellings, structures, camp sites, logging sites located inside the forest or in a radius of 200 m where fires are used for domestic or industrial purposes must be surrounded by a fire break of 25 m width removed from any understorey or herbaceous vegetation;
- burning of brush, grass, standing fields, between 1 July and 31 October, cannot be carried out by private individuals on areas located at a distance of less than 4 km from the forest boundary;
- from 1 November to 30 June, no burning of standing vegetation can be carried out within a radius of 500m starting from the forest boundary without preliminary authorization.

Statistical database

Table 9. Forest fires statistics for Morocco 1990-1999.

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
1990	179	2 118	11.83
1991	247	3 965	16.05
1992	182	2 579	14.17
1993	187	3 078	16.46
1994	417	6 072	14.56
1995	528	7 018	13.29
1996	220	1 185	5.37
1997	391	3 845	9.83
1998	416	1 855	4.46
1999	385	1 688	4.38
Average (1990-1999)	315 per year	3 340 per year	11.04
Average (1990-1994)	242 per year	3 562 per year	14.70
Average (1995-1999)	388 per year	3 118 per year	8.07

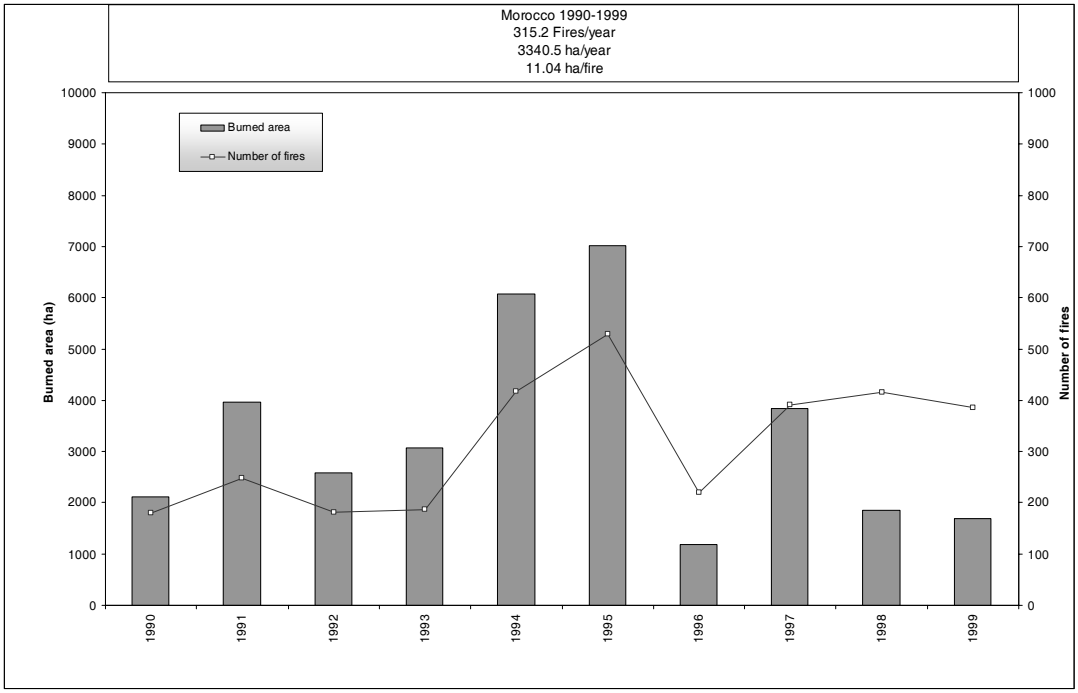

Figure 9. Number of fires and burned area in Morocco during the period 1990-1999

4.10 Fire situation in Algeria

Among the factors that threaten the forests of Algeria, fire constitutes the most dangerous factor and causes severe ecological, economic and, sometimes, human losses. Within some hours fire destroys what has naturally grown over years and centuries.

Fire causes

Vegetation fires are rarely ignited by natural causes. The activities of humans, either directly or indirectly, are exclusively causes of wildfires. Unknown caused fires represent 82% of all cases; they consumed more than

409 ha, equivalent to 94% of the burned surface. Ranking net are fires caused by carelessness, mainly by smokers who throw glowing cigarettes or matches which act as embers in the wind. Another underlying cause of fire is conflicts between residents and forest authorities. Those residents and forest owners who had been penalized by forest rangers due to violation of laws, such as illegal grazing or wood cutting, start fires as an act of revenge. This category of causes is hidden in category unknown and most likely represents a considerable part.

Conclusions

Fires in forest and other vegetation are a common feature in Mediterranean ecosystems, including in the biogeographical region of Algeria, and have contributed to shape vegetation composition and model landscapes. With the modern increase of wildfire frequency a catastrophic dimension has been reached and it is time to think seriously about taking action to reduce the negative impacts of fire. The statistical approach presented in this paper contributes towards a better understanding of the role and causes of fires and will facilitate the search for solutions. An analysis of the vegetation types affected by fire allows determining the need for reforestation including the selection of species which are best adapted to a fire environment.

Statistical database

Table 10. Forest fires statistics for Algeria 1991-2000.

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
1991	1 189	13 089	11
1992	2 014	25 471	12.65
1993	2 322	58 681	25.27
1994	2 292	271 246	118.34
1995	1 274	31 996	25.11
1996	737	6 918	9.39
1997	1 809	17 809	9.84
1998	1 826	28 568	15.64
1999	2 018	38 426	19.04
2000	1 910	55 763	29.19
Average (1991-2000)	1 739 per year	54 797 per year	31.51
Average (1991-1995)	1 818 per year	80 097 per year	44.05
Average (1996-2000)	1 660 per year	29 497 per year	17.77

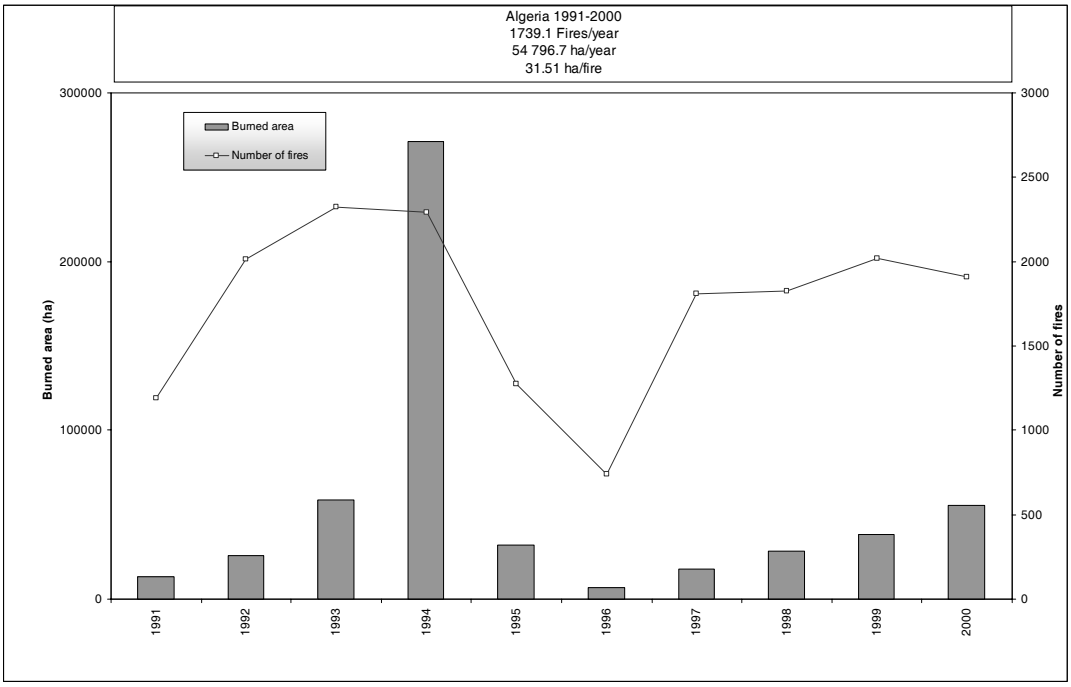

Figure 10. Number of fires and burned area in Algeria during the period 1991-2000.

REFERENCES

Alexandrian, D., F. Esnault, and G. Calabri. 1999. Forest fires in the Mediterranean area. Unasylva 197, Vol. 50.

Baptista, M., and J. Carvalho. 2002. Fire situation in Portugal. Int. Forest Fire News No. 27, 65-67.

Bilgili, E. 1997. Forests and Forest Fires in Turkey. Int. Forest Fire News No.17, 15-21.

Bilgili, E., and J.G. Goldammer. 2000. Fire in the Mediterranean Basin: Towards an Interdisciplinary Science Program. In: Proceedings, XXI IUFRO World Congress 2000, Sub-Plenary Sessions Vol. I, p. 45-54.

Chuvieco S.E. 1999. Remote sensing of large wildfires in the Mediterranean Basin. Springer-Verlag. 210p.

Dimitrakopoulos, A.D., and I.D. Mitsopoulos. 2005. Fire Situation in Greece - Country Report. Forest Fire Management in the Balkan Region. Global Fire Monitoring Center. 4-5 April 2005, Ohrid, FYROM.

European Commission 1996. Forest fires in the south of the European Union 1989-93. Pilot project in preparation for setting up the community forest fire information system (Regulation EEC No. 2158/92, on protection of forests against fire). European Commission, Directorate General for Agriculture, Brussels-Luxembourg, 61 p.

European Commission, 1998. Community Forest Fire Information System-Report 1985-1997. EU Directorate General for Agriculture, DG VI, FII-2, 41pp. and Appendix.

European Commission, 2004. Forest Fires in Europe - 2003 Fire Campaign. Report No.4, EU Directorate General for Agriculture, DG VI, 40p.

Goldammer, J.G. 1986. Legislation and regulation related to forest fire prevention and control. In: ECE/FAO/ILO Seminar on Methods and Equipment for the Prevention of Forest Fires, 217-225. *Instituto Nacional. Conservación de la Naturaleza* (ICONA), Madrid, Spain, 268 p.

Goldammer, J.G. 2003. Towards international cooperation in managing forest fire disasters in the Mediterranean region. In: Security and the environment in the Mediterranean. Conceptualising security and environmental conflicts, Chapter 50 (H.G. Brauch, P.H. Liotta, A. Marquina, P.F. Rogers, and M. El-Sayed Selim, eds.), 907-915.Springer Verlag, Heidelberg, 1134 p.

Hadjikyriakou, G. 2000. The Forest Fire Situation in Cyprus. Int. Forest Fire News No. 23, 71-76

Jewish National Fund, Forest Department. Fire Reports 1985-2004.

Le Houérou, H.N. 1973. Fire and vegetation in the Mediterranean Basin. Proceedings Annual Tall Timbers Fire Ecology Conference 13, 237-277. Tall Timbers Research Station, Tallahassee, Florida.

Leone, V. 2000. Fires in Italy. Int. Forest Fire News No 23, 84-87.

Madoui, A. 2000. Forest Fires in Algeria. Int. Forest Fire News No. 22, 9-15.

Moreno, J.M., and W.C. Oechel. 1994. The role of fire in Mediterranean type ecosystems. Springer-Verlag. New York.

Royaume du Maroc. 2001. Forest Fire Situation in Morocco. Int. Forest Fire News No. 25, 14-22.

Teusan, S. 1995. Forest Fire Profile of France. Int. Forest Fire News No. 13, 12-15.

Vélez, R. 1993. High intensity forest fires in the Mediterranean Basin: Natural and socioeconomic causes. Disaster Management 5, 16-20

Vélez, R.1996. FAO Committee on Mediterranean Forestry Questions - *Silva Mediterranea*. Int. Forest Fire News. No. 15, 48-49.

Vélez, R. 1999. The Red Book of Prevention and Coordination: A general analysis of forest fire management policies in Spain. Paper presented at the Symposium on Fire Economics, Planning, and Policy: Bottom Lines, 5-9 April 1999, San Diego, California.

Vélez, R. 1999. Mediterranean forest fires: A regional perspective. Int. Forest Fire News No. 20, 78-79.

Viegas, D.X. 1991. An Activity by the National Coordination of Actions Against Forest Fires. Int. Forest Fire News No. 5, 6.

Websites:

FAO *Silva Mediterranea*:
http://www.fao.org/FORESTRY/for/forc/silvamed/SM_ACTIV/Ac1fire.stm
http://www.fire.uni-freiburg.de/intro/silva.html

Global Wildland Fire Network:
http://www.fire.uni-freiburg.de/GlobalNetworks/globalNet.html and

Regional Mediterranean Wildland Fire Network:
http://www.fire.uni-freiburg.de/GlobalNetworks/Mediterrania/Mediterrania.html

Fire Paradox:
http://www.mtda.fr/fire_paradox/index.php
http://www.fire.uni-freiburg.de/programmes/other/FireParadox.html

APPENDIX

Table 1. Number of forest fires in the Mediterranean Basin countries.

Year	Portugal	Spain	France	Italy	Greece	Turkey	Cyprus	Israel
1995	34 116	25 828	6 545	7 378	1 438	1 768	24	1 061
1996	28 626	16 771	6 400	9 093	1 508	1 631	20	1 075
1997	23 497	22 319	8 000	11 612	2 273	1 339	19	1 047
1998	34 676	22 445	5 600	10 155	1 842	1 932	19	1 445
1999	31 714	18 237	5 170	7 235	1 486	2 075	20	831
2000	34 109	24 312	5 600	10 629	2 581	2 353	285	972
2001	27 067	19 631	4 103	7 134	2 535	2 631	299	1 027
2002	26 488	19 929	900	4 594	1 141	1 471	243	779
2003	20 864	18 628	4 100	9 697	1 452	2 177	427	982
2004	20 268	16 724	5 301	8 550	1 708	1 762	221	840
Average p/year 1995-1999	30 526	21 120	6 343	9 095	1 709	1 749	20.4	1 092
Average p/year 2000-2004	25 759	19 844.8	4 001	8 121	1 883	2 079	295	920
Average p/year 1995-2004	28 142	20 482.4	5 172	8 608	1 796	1 914	155.8	1 006
TOTAL	**281 425**	**204 824**	**51 719**	**75 627**	**17 964**	**19 139**	**1 577**	**10 059**

Table 2. Total burned area in the Mediterranean Basin countries.

Year	Portugal	Spain	France	Italy	Greece	Turkey	Cyprus	Israel
1995	169 612	143 468	18 188	46 466	27 202	4 791	70	8 288
1996	88 867	59 814	11 210	57 986	25 310	14 922	116	6 476
1997	30 535	98 503	20 500	103 015	52 373	6 171	167	2 403
1998	158 389	133 643	20 880	140 432	92 901	6 764	566	7 813
1999	51 994	82 217	17 605	61 989	8 289	5 804	3	3 114
2000	159 605	188 586	23 700	114 468	145 033	26 353	8 035	3 486
2001	111 165	66 075	17 000	76 427	18 221	7 394	4 830	5 488
2002	124 411	107 472	20 850	40 768	6 013	8 413	2196	1 834
2003	421 835	149 224	74 000	90 803	3 517	6 644	2 349	3 426
2004	120 530	64 445	10 690	48 651	10 266	4 876	1 218	1 029
Average p/year 1995-1999	998 79.4	103 529	17 676.6	81 977.6	41 215	7 690	184	5 619
Average p/year 2000-2004	187 509.2	115 160.4	29 248	74 223.4	36 610	10 739	3 725	3 053
Average p/year 1995-2004	143 694.3	109 344.7	23 462.3	78 100.5	38 912.5	9 213	1 955	4 336
TOTAL	**1 436 943**	**1 093 447**	**234 623**	**781 005**	**389 125**	**92 132**	**19 550**	**43 357**

EUROPEAN FOREST FIRE DAMAGE ASSESSMENT SYSTEM

2001

Portugal

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	5	0.07
Agricultural Areas	6 955	5.17
Forests and Seminatural Areas	67 516	94.72
Wetlands	28	0.04
Total	74 505	100

Spain

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	27	0.07
Agricultural Areas	1 988	5.17
Forests and Seminatural Areas	36 423	94.72
Wetlands	14	0.04
Total	38 452	100

France

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	0	0.01
Agricultural Areas	200	3.90
Forests and Seminatural Areas	4 929	95.97
Wetlands	6	0.12
Total	5 136	100

Italy

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	108	0.73
Agricultural Areas	3 359	22.63
Forests and Seminatural Areas	11 372	76.72
Wetlands	2	0.01
Total	14 852	100

Greece

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	4	0.09
Agricultural Areas	728	15.61
Forests and Seminatural Areas	3 916	84.00
Wetlands	14	0.30
Total	4 662	100

2002

Portugal

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	23	0.03
Agricultural Areas	14 251	16.43
Forests and Seminatural Areas	72 332	83.41
Wetlands	123	0.14
Unclassified	8	0.01
Total	86 714	100

Spain

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	19	0.03
Agricultural Areas	8 169	14.49
Forests and Seminatural Areas	48 103	85.35
Wetlands	77	0.14
Unclassified	8	0.01
Total	56 357	100

France

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	65	1.60
Agricultural Areas	301	7.40
Forests and Seminatural Areas	3 758	92.40
Wetlands	0	0.00
Unclassified	8	0.20
Total	4 067	100

Italy

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	1	0.02
Agricultural Areas	998	21.29
Forests and Seminatural Areas	3 681	78.54
Wetlands	0	0.00
Unclassified	8	0.17
Total	4 687	100

Greece

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	0	0.00
Agricultural Areas	995	45.73
Forests and Seminatural Areas	1 173	53.91
Wetlands	0	0.00
Unclassified	8	0.37
Total	2 176	100

2003

Portugal

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	198	0.10
Agricultural Areas	49 820	16.90
Forests and Seminatural Areas	244 725	82.80
Wetlands	435	0.01
Unclassified	354	0.01
Total	295 532	100

Spain

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	111	0.20
Agricultural Areas	7 928	12.00
Forests and Seminatural Areas	57 709	87.20
Wetlands	44	0.10
Unclassified	356	0.20
Total	66 148	100

France

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	330	0.80
Agricultural Areas	1 647	3.80
Forests and Seminatural Areas	40 798	95.40
Wetlands	5	0.00
Unclassified	0	0.00
Total	42 780	100

Italy

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	43	0.20
Agricultural Areas	4 647	24.30
Forests and Seminatural Areas	14 434	75.40
Wetlands	3	0.00
Unclassified	8	0.00
Total	19 135	100

2004

Portugal

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	90	0.10
Agricultural Areas	27 895	29.60
Forests and Seminatural Areas	66 295	70.30
Total	94 280	100

Spain

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	154	0.20
Agricultural Areas	7 997	10.70
Forests and Seminatural Areas	66 483	89.10
Total	74 634	100

France

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	240	3.10
Agricultural Areas	1 369	17.40
Forests and Seminatural Areas	6 259	79.6
Total	7 868	100

Italy

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	98	0.90
Agricultural Areas	5 038	47.30
Forests and Seminatural Areas	5 518	51.80
Total	10 654	100

Greece

CORINE Land use class	Burned area (ha)	(%) of total burned area
Artificial Surfaces	31	1.3
Agricultural Areas	612	26.3
Forests and Seminatural Areas	1 686	72.40
Total	2 329	100

PUBLICATIONS AVAILABLE ON FIRE MANAGEMENT

Fire Management Working Papers: Thematic Paper Series

Note:
In Code "Working Paper FM/xx", "x" indicates the WP series number and a suffix E, F or S indicates: E = English, F = French, S = Spanish, in case of multilingual papers. No suffix indicates E only.

Available at the Fire Management web site:

Working Paper FPF/1	*Guidelines on Fire Management in Temperate and Boreal Forests*. November 2002.
Working Paper FM/2	*International Wildland Fire Management Agreements Template*. Tom Frey, Ricardo Vélez Muñoz. January 2004.
Working Paper FM/3	*Legal Frameworks for Forest Fire Management: International Agreements and National Legislation*. Fernando Fernández Arriaga, Frédéric St-Martin, Tom Frey, Ricardo Vélez Muñoz. March 2004.
Working Paper FM/4	*Community-Based Fire Management in Spain*. Ricardo Vélez Muñoz. April 2005.
Working Paper FM/5	*Report on Fires in the South American Region*. María Isabel Manta Nolasco. March 2006.
Working Paper FM/6	*Report on Fires in the North East Asian Region*. Leonid Kondrashov. March 2006.
Working Paper FM/7	*Report on Fires in the Baltic Region and adjacent countries*. Ilkka Vanha-Majamaa. March 2006.
Working Paper FM/8	*Report on Fires in the Mediterranean Region*. A.P. Dimitrakopoulos and I.D. Mitsopoulos. March 2006.
Working Paper FM/9	*Report on Fires in the Sub-Saharan Africa (SSA) Region*. Alexander Held. March 2006.
Working Paper FM/10	*Report on Fires in the South East Asian Region*. B.J. Shields, R.W. Smith and D. Ganz. March 2006.
Working Paper FM/11	*Report on Fires in the Balkan Region*. Nikola Nikolov. March 2006.
Working Paper FM/12	*Report on Fires in the Caribbean and Mesoamerican Regions*. A.M.J. Robbins. March 2006.
Working Paper FM/13	*Report on Fires in the Australasian Region*. P.F. Moore. March 2006.
Working Paper FM/14	*Report on Fires in the South Asian Region*. A.M. Benndorf and J.G. Goldammer. March 2006.
Working Paper FM/15	*Report on Fires in the North American Region*. R. Martínez, B.J. Stocks and D. Truesdale. March 2006.
Working Paper FM/16	*Report on Fires in the Central Asian Region and adjacent countries*. Johann G. Goldammer. March 2006.