

Forest Fire Management in Cyprus.

From Prevention to Restoration.

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Abstract

In Cyprus as in many other countries of the Mediterranean basin, fire is considered as one of the principle destructive agents of forests and wooded areas. The prolonged hot, dry and windy summers, the configuration of the ground, the inflammability of the vegetation and various human activities, 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 at high levels.

The Department of Forests as the authority responsible for the prevention and control of fires in the forest or within a radius of 1km from the boundaries of the state forests, is aware of this high fire danger and takes a series of measures for:

The prevention of fire outbreaks

The quick detection

The rapid intervention and effective control of forest fires

The Department of Forests is also responsible for the restoration of the burnt areas.

INTRODUCTION

Cyprus is the third largest island in the Mediterranean with an area of about 925.148 hectares (9.251 km²) and is situated in the northeastern part of the Mediterranean Sea (Figure1,2). It is mostly a mountainous country with a typical Mediterranean climate.

It is believed that in ancient times, Cyprus was fully covered by forests and it was known in the Mediterranean basin for its wood that it was used for purposes, such as for the melting of copper and for the construction of ships. However heavy and uncontrolled fellings, extensive grazing and fires contributed to the gradual degradation of forests. Moreover, the bombardment by the Turkish air force during the Turkish invasion in 1974 caused serious damages to the Cyprus forests resulting in a reduction of their cover by 16%.



Figure 1-Geographical position of Cyprus



Figure 2-Satellite image of Cyprus

Climate

Cyprus has a typical intense Mediterranean climate that is characterized by hot, dry summers that last from May until October. Annual rainfall ranges from 250mm in lowlands to more than 1000mm in the highest peaks of Troodos range. The mean maximum monthly temperature fluctuates from 37-42 °C in areas with an altitude of less than 800 m, while in areas with altitude above 1000 m temperature is fluctuating between 30-35 °C. Relative Humidity ranges from 35-65%.

Floristic composition of the Cyprus forests

About 43% (392.662 ha) of the total area of the island is covered with natural vegetation. Forest occupies approximately 19% of this area and is composed mainly of coniferous species like the Calabrian pine (*Pinus brutia*), the black pine (*Pinus nigra*) the endemic Cedar (*Cedrus brevifolia*) and the Cypress (*Cypressus sempervirens*). Maquis vegetation covers 13% with species like Lentisk (*Pistacia lentiscus*), Juniper (*Juniperus phoenicea*), Maple (*Acer obtusifolium*) and Strawberry tree (*Arbutus andrachne*), while 9% is occupied by garigues with typical representatives the Rock rose (*Cistus spp.*), Thyme (*Thymus capitatus*), Thornybroom (*Calycotome villosa*), Thorny Gorse (*Genista fasselata*) and Spiny burnet (*Sarcopoterium spinosum*). The rest 2% consists of young coniferous plantations (Figure 3).

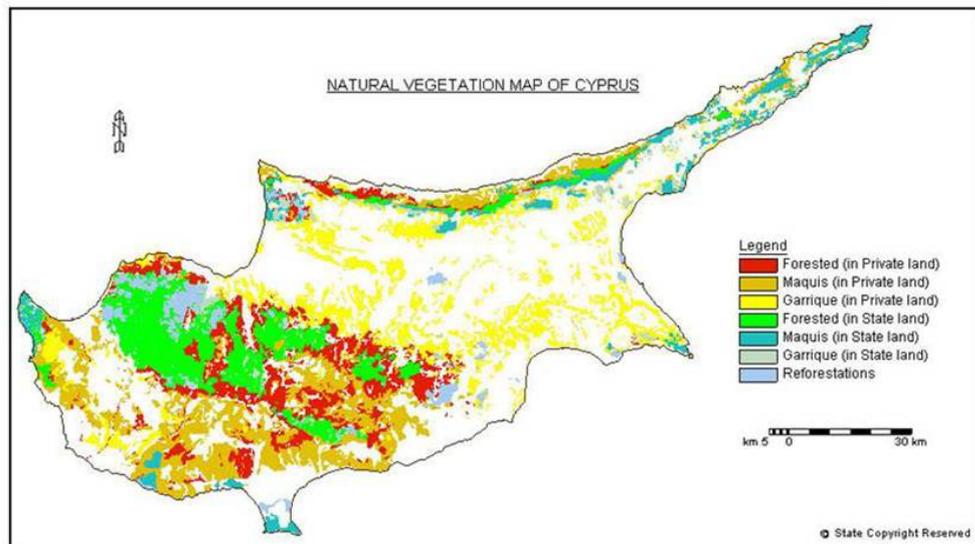


Figure 3-Natural vegetation map of Cyprus

Administration – Management

State forests are managed by the Department of Forests, of the Ministry of Agriculture, Natural Resources and Environment. For reasons of better administration the forests of Cyprus are divided into three Divisions: The Paphos, the Troodos and the Nicosia-Larnaca and Famagusta Divisions, with headquarters being at Stavros tis psokas, Platania and Athalassa respectively.

The State forests are classified into Permanent forest reserves, National Forest Parks and Nature Reserves. Fellings are confined only into the Permanent Forest Reserves while the National Forest Parks and the Nature Reserves are managed mainly for protection and recreational purposes.

Fire protection, afforestation and reforestation of bare and burnt areas, the improvement of forest productivity and the provision of recreation to the public are among the main management objectives of the Department of Forests.

A description and evaluation of the existing forest fire management system, which is implemented in Cyprus, as well as the restoration of the burnt areas will be presented in this paper.

Fire protection

Fire danger

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 inflammability 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 purposes raise the fire danger to very high levels (Figure 4).

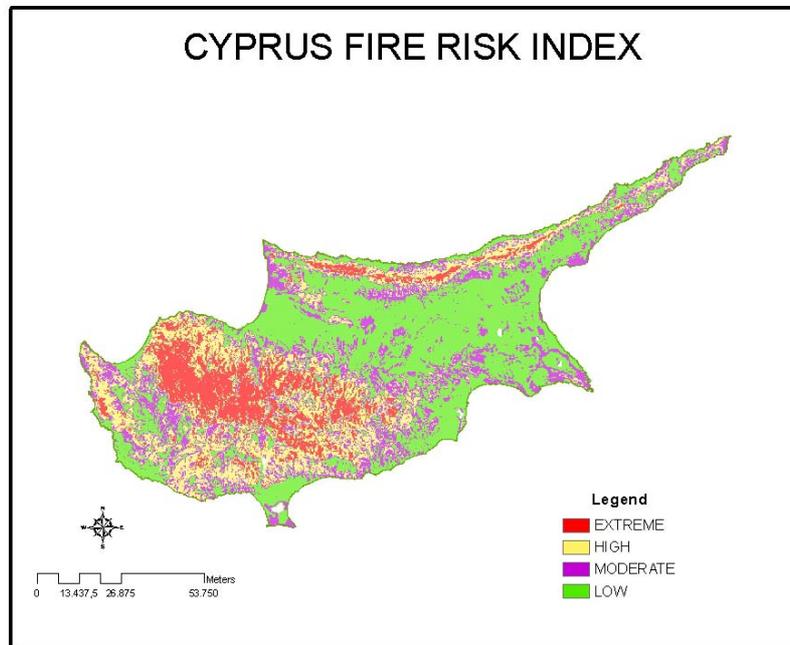


Figure 4- Cyprus fire risk index

Impacts of forest fires

Fires have many negative consequences the most important of which are:

- They endanger the safety of people and properties
- They result in excessive soil erosion and in certain cases they cause flood
- They cause serious economic losses especially to the farmers
- They induce negative impacts to the ecosystems and lead to loss of biodiversity
- They impair the aesthetic value of forests and damage historical and cultural values
- They hinder the development of private forestry

Where fires usually begin

Few fires start within the forest but most of the fires usually start outside the forests or on their fringes. The number of fires and the corresponding burnt areas for the period 2000-2006 are shown on the figures 5a and 5b. Fires set by villagers in their own lands found in or adjacent to the forest are a usual practice and the spread of these fires into the forest is a common event. The forest fires starting points for the period 1994-2006 are shown in figure 6.

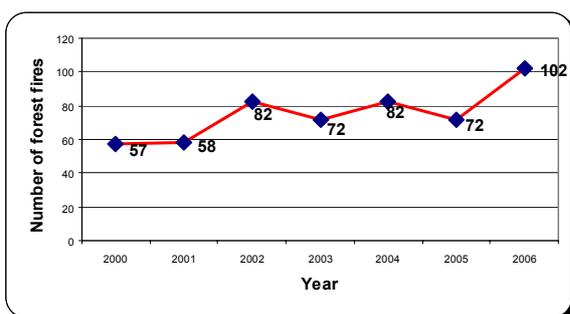


Figure 5a- Number of forest fires 2000-2006

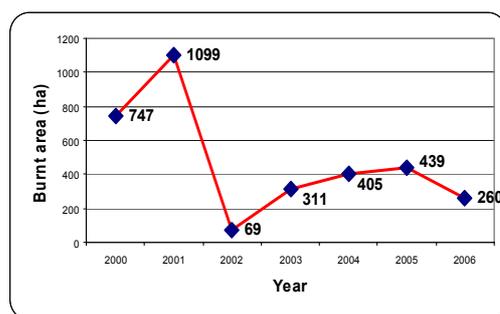


Figure 5b- Burnt areas 2000-2006

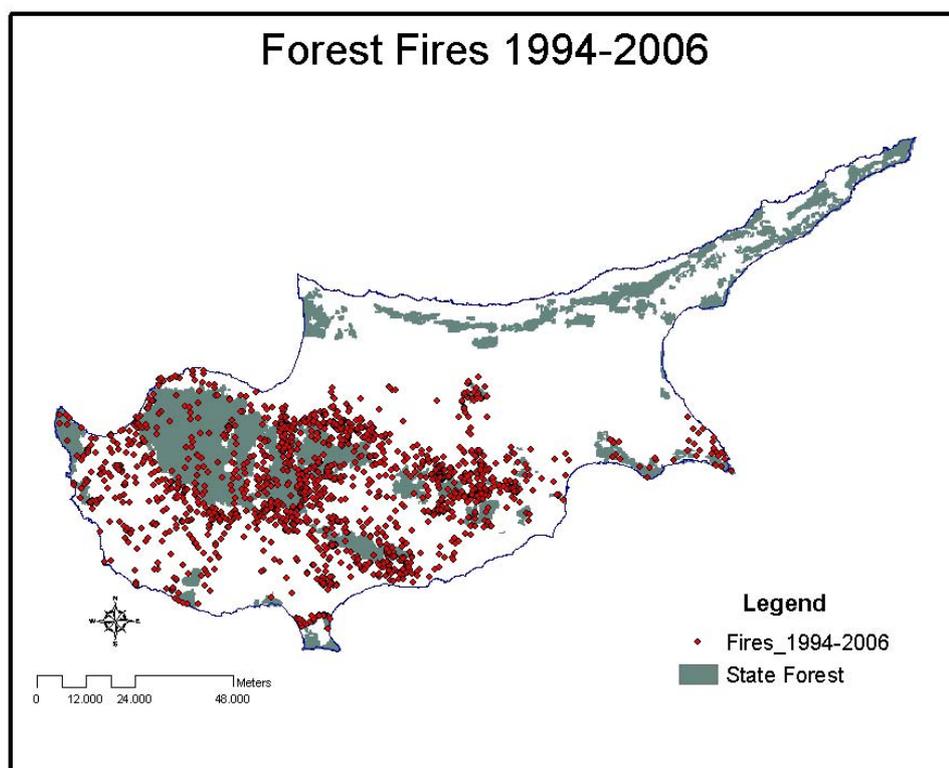


Figure 6- Forest fire starting points 1994-2006

Causes of forest fires

The knowledge and understanding of the causes of forest fires is of great importance since it helps fire managers in the decision making process and in taking the necessary and appropriate actions in order to minimize and even more to eliminate the risk of fire outbreaks. The biggest percentage of forest fires in Cyprus is of human origin. Nearly 80 % of these fires are due to negligence or lack of care and attention and 12% are attributed to arson. A considerable number of forest fires is caused from natural causes, mainly lightnings. However, these fires do not cause any significant threat to the forests, as the areas burnt are usually very small.

The fires caused by negligence or accidentally are the most frequent and mostly are related to the following human activities:

- Burning grass – gorse or stubble by farmers without taking the necessary precautionary measures.
- Fires caused by careless visitors and picnickers when using fire for cooking and grilling.
- Burning cigarette ends and matches used by careless smokers
- Military exercises with ammunition or explosives of any kind
- Hunting during the summer period
- Burning of rubbish at non organized rubbish dumps
- *Activities in country houses
- *Fires caused by people or machines engaged in any activity associated with forest engineering and forest production
- Natural causes. Lightnings

A more detailed analysis of the fire causes is presented in figure 7.

The main aim of the Department of Forests is to eliminate fires that are caused by human negligence. This is achieved through the enforcement of the Forest Law, the enlightenment of the public, the establishment of picnic and camping sites, and the organization of regular patrolling for enlighten and prevention purposes and for quick intervention in cases of fire outbreaks.

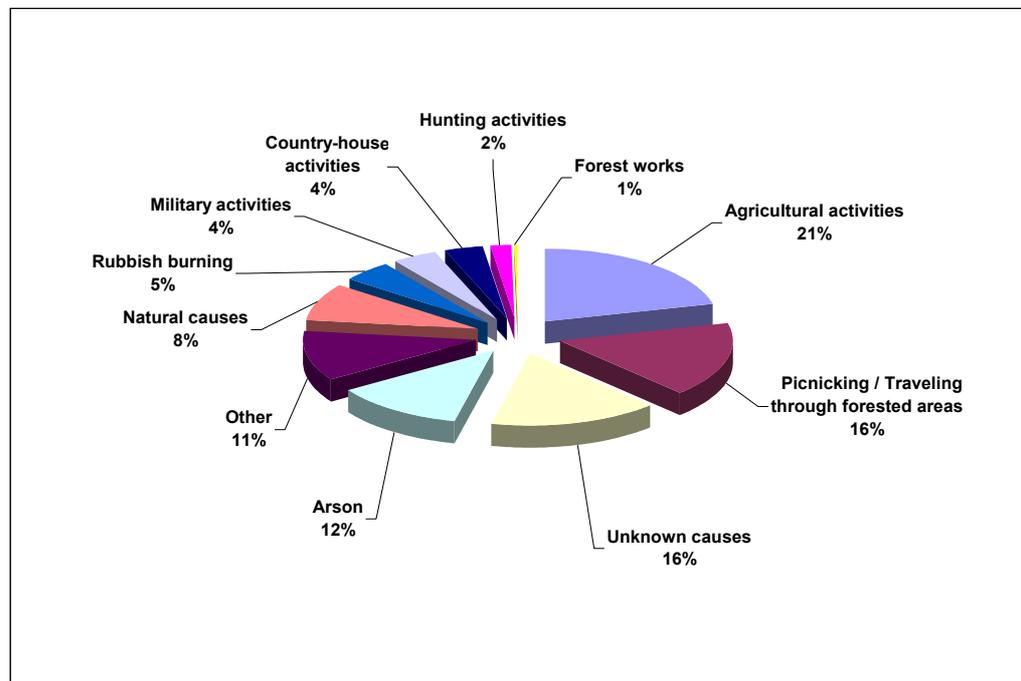


Figure 7- Analysis of the fire causes

Forest fire prevention

Fire prevention includes all activities and measures directed at reducing fire occurrence. Through prevention, the chariness of the forests is succeeded on the one hand and on the other hand, the expenditure for prevention is much less than that for the suppression of fires. The main aim of prevention is to eliminate the causes of forest fires. For this reason the Department of Forests gives much emphasis on prevention and takes many preventive measures in order to reduce the risk of fire outbreaks.

Preventive measures, which are taken to reduce risk of fire outbreaks, include the following:

Enforcement of the Law

The Cyprus Forest Law prohibits the lighting of any fire or the throwing of burning cigarette ends and matches in the forest or within a radius of 1 km from the boundaries of the forests. The Lawbreakers are liable to sufficient penalties being imprisonment not exceeding five years or to a fine not exceeding £ 5.000 (8.500 euro) or to both such sentences.

Education and publicity

Since the majority of forest fires in Cyprus are of human origin and especially due to negligence, the Department of Forests makes every effort to gain the support and co-operation of the general public through a well planned and directed publicity and educational program. Through this educational campaign the public is informed

about the causes and the consequences of forest fires as well as for the efforts made by the Government for the protection of the forests. The campaign targets the rural population, communities, schools, military camps, Police Stations, associations, organised groups of people and the visitors and picnickers of the forests.

The main activities related to the enlighten campaign are the following:

- 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
- The production and transmission of spots through the television and radio
- Lectures and film projection at schools, the Police, military camps and other organized groups of people
- Production and distribution to the public of relative leaflets and other printed matter
- The broadcast of the degree of fire hazard through the radio and television on a regular basis
- The placement of posters and signposts at conspicuous places of roads and villages
- Production and distribution of informative leaflets to students of the elementary and secondary schools
- The organization on an annual basis of the "Save our Forest Week" and of the "Save the Forest Day".

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-danger warning system, which is put into operation during this period.

The degree of fire danger is broadcasted through the radio and the television every day immediately after the news and the weather broadcast.

Picnic sites

The Department of Forests established and maintains a number of picnic sites in the forests to meet the recreational needs of the public. These places in order to be attractive to the public are provided with a number of facilities such as parking places, toilets, water, benches, tables, hearths, sheds, games for children, etc.

The picnickers are concentrated in these places instead of allowing them to roam and picnic anywhere without control. In this way the visitors and picnickers are supervised and therefore the fire danger is reduced.

Patrolling

During the fire season regular patrolling is done especially along the State forests delimitation line where most of the forest fires start. The main objectives of patrolling are:

- Detection, warning and intervention
- Public information
- Policing, law enforcement and fire suppression

Most of these patrols are using light vehicles equipped with radiotelephone and lightweight fighting equipment whereas some of them are using small rapid intervention fire engines.

Each patrol has its own sector and route planned in advance and keeps in a continuous contact with the Forest Fire Officer.

Detection and reporting system

For the quick detection and report of forest fires the following measures are taken by the Department of Forests.

Fire look-out towers

A network of fire look-out towers exist throughout Cyprus. These are located at the top of mountains to ensure a maximum coverage of the forest.

All look-out stations are linked to the existing telephone and radiotelephone network of the Department of Forests and they are manned during the fire season on 24 hour basis.

Ground patrol system

In hidden parts of the forest, which are not covered by the look-out stations, ground patrolling is arranged not only to detect fires but also for rapid intervention in case of a fire.

Detection from airplanes

Arrangements for reporting of forest fires by the Civil Aviation as well as by the Army Air Force have been made.

Detection by the public

The contribution of the public to the detection and reporting of forest fires is increasing year by year.

Forest Telecommunication

The Department of Forests maintains its own telephone and radiotelephone system of communication. All forest stations and look-out stations are linked to the telephone and radiotelephone system of the Department. All cars, lorries fire engines etc. are equipped with mobile radiotelephones and almost each forester has his own portable radiotelephone. Various repeater stations are installed on high mountain peaks so communication through radiotelephones can be directly done from and to any part of the forest.

This system plays an important role in the co-operation of activities regarding forest fire protection.

Pre-suppression and control organization

To prevent the quick spread of any fire outbreak and to facilitate the control of the forest fires a number of pre-suppression measures are taken by the Department of Forests which includes the following:

Roads and Jeep-tracks

For efficient management of the forest in general and for fire protection in particular, the Department of Forests has been developed and maintains a good road network.

These roads are planned in such a way to give access to all parts of the forests for timely intervention when a fire occurs.

Priority is given to the construction of roads and jeep-tracks along the boundaries of the forest where most of the fires start.

Fire brakes

To break up the continuity of the vegetation, fire brakes are constructed and maintained on ridges and other natural features.

Their width ranges from 6-30 meters depending on the vegetation and the adjacent crown of standing trees. Priority is given to the construction of fire breaks along gentle ridges where heavy vehicles and fire engines can travel in the case of a fire and especially in areas with young plantations which adjoin high fire risk areas.

Water tanks, hydrants, water valves

Concrete water tanks of about 90m³ capacity are constructed along roads in areas where natural springs are found in order to fill or refill the fire engines in the case of fire incidence.

Hydrants and water valves are installed on pipelines, which are passing through the forest.

Vegetation treatments

The Department of Forests proceeds on a regular basis on various vegetation treatments with the aim to reduce the risk of ignition and the spreading rate of forest fires. These treatments include:

- Pruning
- Cleanings
- Removal of both herbaceous and woody vegetation along roadside
- Planting fire resistant species
- Prescribed burnings
- Controlled grazing
- Mixing of conifers and broadleaves
- Seeding of species with low biomass

Vehicles, air means and machinery

A sufficient number of vehicles, mainly Land-Rover type are maintained by the Department of Forests for the transportation of the fire fighters to the fire.

Since 2000 the Republic of Cyprus hires 2 firefighting helicopters during the fire season period. Furthermore the Department of Forests is equipped with a small firefighting airplane. During 2007 the Department of Forests will be equipped with 2 new heavy duty firefighting helicopters. The use of helicopters in combination with the airplane was proved to be very effective.

During the fire season crawler tractors are removed from other works and are used for road maintenance as well as for construction and maintenance of fire breaks. During the weekends and public holidays these tractors are moved to loading points so that in case of a fire they can easily be loaded and transported to the scene by suitable lorries which were purchased for this purpose, by the Department of Forests.

Stores (tools and equipment)

Every forest station has its own store where tools and other fire fighting equipment are kept. Before the fire season starts, all tools and equipment are checked. Unserviceable tools are replaced with new ones and old ones are repaired in to a working condition.

Forest fire control (Suppression measures)

Fire fighting squad

During the fire season 360 persons are recruited to form the fire fighting squads. The Department of Forests has some regular employees who are well trained in fire fighting. These laborers are employed during winter time, on various forestry works and form the nucleus of fire-fighting squads during the fire season. When a fire breaks out they are the first to go.

The fire-fighting body is split up into groups of 10-15 men and is distributed in various forest stations, which considered as key points for attacking quickly, and effectively any fire outbreak.

Each group is provided with one or more cross - country vehicles equipped with mobile radiotelephone, and at least with one fire engine and other necessary equipment for fire fighting.

The Cyprus Forestry College

At the Cyprus Forestry College there are about 40 students every year. This is a significant force and is properly organized and used for fire fighting.

The Cyprus College is equipped with proper vehicles for transportation of the students, mobile and portable radiotelephones as well as with fire engines and other necessary tools and equipment and they form an effective body for fighting forest fires.

Stand by of Forest officials

During the fire season adequate number of forest officials remains on stand-by in all forest stations and divisional headquarters, according to a duty roster.

In case of a fire these foresters are the first to go in the scene of the fire and organize the firefighters.

Organization of forestry works

During summer, the forest works are organized in such a way so that laborers to be found at various strategic points in the forest. The foresters who are in charge of these works are continuously in contact with the divisional

headquarters and since they are equipped with the necessary tools they can move to the fire without delay.

Fire engines

The improvement of the forest road network changed the scene of forest fire fighting in Cyprus. Fire fighting, which in the past was carried out manually, today is done by fire fighting engines using mainly water.

The Department of Forests today maintains fire engines with a capacity ranging from 2000 - 12000 liters of water.

The majority of these fire engines are equipped with low-pressure water pumps but some of them are equipped with low and high-pressure pumps.

The Department of Forests maintains also small fire engines of a capacity of about 650-700 liters of water, which are used for patrolling and rapid intervention in case of a fire.

Availability of water for fire fighting in Cyprus is achieved by:

- Construction of concrete water tanks of a capacity of 90 m³ at strategic points along forest roads where springs are found.
- Installing of hydrants on pipelines carrying water from the forest to the villages.
- Constructing access routes to existing water dams.
- Creating small pools along perennial streams.

Co-operation with other Countries, Services and Institutions

The responsibilities and appositeness of the involved Services are determined by the relevant legislations.

The Department of Forests is in close co-operation with other Services of the Government of Cyprus like the Fire Service, the Police, the Army, the Game Fund, the District Administrations, the Civil Defense, and the various Departments of the Ministry of Agriculture, Natural Resources and Environment. This co-operation aims for the best possible results for the problem of forest fires. It is a multilateral co-operation that includes among others, the exchanging of information, trainings, preparation of fire protection plans, preventive strategic planning, and the availability of personnel and other equipment in case of fires.

There is also a harness co-operation with the United Nations Forces In Cyprus (UNFICYP) and the Royal Air Force (RAF) both for pre-suppression and fire suppression purposes.

The Department of Forests also co-operates with various territorial organizations and groups of people whom are adequately educated and trained in order to be able to contribute in the efforts for prevention and suppression of forest fires whenever they are asked. As a result of this is the formation of volunteer's squads, which are in most cases equipped with fire fighting vehicles and fire suppression equipment.

Furthermore, there is also a close co-operation with many countries such as Greece, Spain, Israel etc. In addition to this, there is close co-operation with a number of institutions, and research centers such as the Joint Research Centre of the European Committee and the Mediterranean Agronomic Institute of Chania. The basic purpose of this kind of co-operation is the exchange of knowledge, experiences and technical know-how regarding the use and adoption of new methods and practices as well as for the provision of assistance, mostly by air means, in cases of large and disastrous fires.

The Department of Forests forwards to various International Organizations like FAO and the European Union on a regular basis, statistics and other relevant data regarding forest fires in Cyprus.

The level of co-operation among the different Services of Cyprus, other countries and institutions involved in the issue of forest fires is at very high standards.

Evaluation of the existing forest fire control system

Response time (period 2000-2006)

The average response time for the period 2000-2006 is 12 minutes. The rapid intervention results in minimizing the extent of losses (Figure 8).

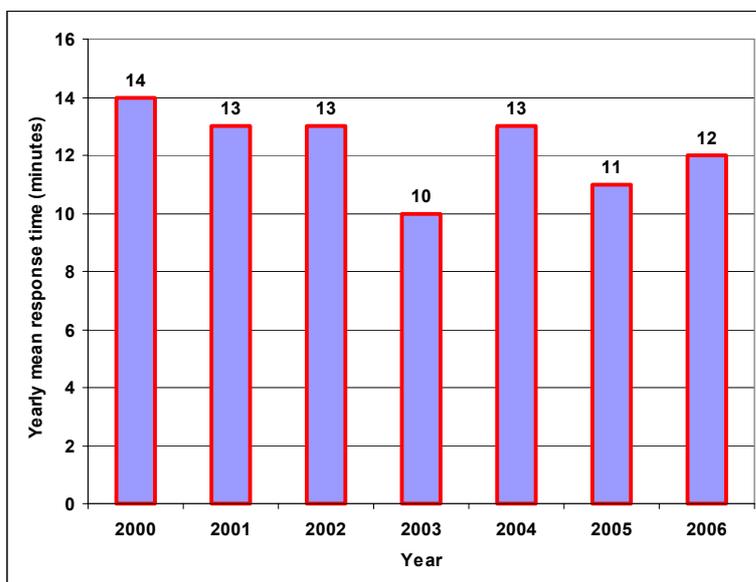


Figure 8-Response time 2000-2006

The total burned area of 80% of the forest fires during the period 2000-2006 did not exceed the 1 ha (Figure 9).

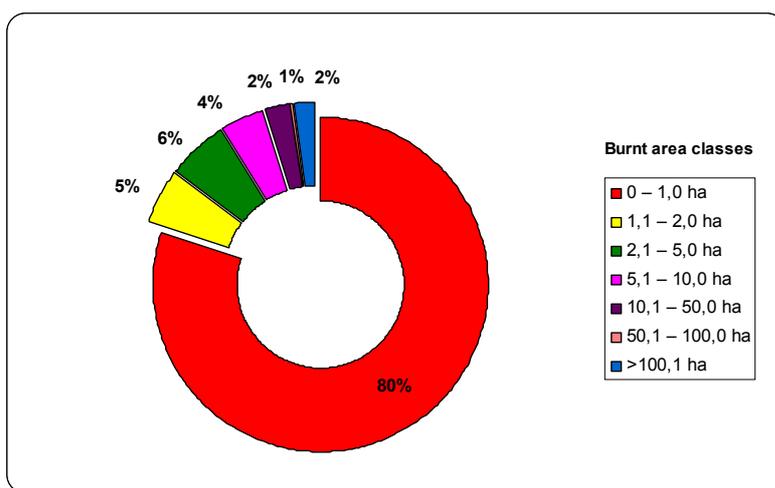


Figure 9-Classification of the burnt areas

The above mentioned results are indicating the effectiveness of the fire control system that is implemented in Cyprus.

Restoration

The restoration of the burnt areas is also under the responsibility of the Department of Forests and supplementary to the Forest Fire Management System.

The restoration system that used in Cyprus is:

For the burnt forest stands that are in a mature stage the regeneration process is left to nature. After a time period of 3-5 years, if the natural regeneration fails, then artificial regeneration is applied using either planting or seeding.

For the immature forest stands directly after the fire incidence artificial regeneration is applied.

In general the percentage of natural regeneration success after fires is very high especially for the *Pinus Brutia* stands.

Conclusions

Through this paper is clearly demonstrated the big and serious problem of forests fires that exists in Cyprus. Despite the efforts of the Department of Forests and of the other State Services which are involved in fire management, due to the peculiarity of the climatic and topographic conditions, the high flammability of the forest fuels, and the socioeconomic development, forest fires constitutes by far the most serious and permanent threat for the forests and wooded areas of Cyprus.

For rationale management purposes and in order to reduce the fire danger to the minimum possible, a persistent upgrading of the infrastructure, the prevention system, the detection system, the control system as well as the personnel's training, following the evolution of the technology and its nowadays tremendous capabilities.