



LUMES

Lund University International Master's Programme in Environmental Science

M.Sc. Thesis

**Forests fires in Greece.
The analysis of the phenomenon affecting both natural and
human environment. The role of sustainable development in
controlling fire effects.**

By

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Abstract

Forest fires in the Mediterranean countries cause extensive damage to forested ecosystems. In Greece, wild fires are sources of environmental degradation, as well as disturbance factors to the economic and social life of the country. This study attempts to analyze the forest fire phenomenon in Greece in order to investigate the main causes of the problem. Based on relevant studies and past experience in neighboring countries, the study defines the main sources of un-sustainability of the system “Natural Environment-Human Social Life-economic Activities”. Changing in life styles and the transition from agriculture to service economy, urban sprawl into traditional wild land areas, large population densities and high land demand and pressure, are conditions that are favorable to increased fire hazard. Due to the rapid economic development that Greece experienced during the last years, the demand for recreational activities and tourism infrastructure has increased the pressure on natural ecosystems and created conflicts on land use. It was found that fires are indicators of tensions and conflicts in the management of rural areas.

This study also evaluates the present fire suppression policies and states that current policies are not enough to abate the present situation. Furthermore, the study suggests that a more comprehensive policy based on the concept of sustainable development is needed in order to overcome the current trend. Taking into consideration the present situation in Greece, the implementation of integrated type of rural development encouraging sustainable forms of tourism (eco-tourism) and land management is possible to reduce land use conflicts. Additional measures to develop rural areas are the encouragement of organic farming, sustainable forest management practices, and environmental awareness.

Keywords: forest fires, environmental degradation, socioeconomic changes, suppression policy, land use conflicts, rural sustainable development, eco-tourism.

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1.0 INTRODUCTION

According to the Greek mythology, it was Prometheus from the Titan tribe that gave the fire to humans in order to help them to develop their living conditions. It is true that fire played a significant role in human history, and it was used as a tool to facilitate development. Burning down forest is an achievement as old as human history itself. Even nowadays, there are places in the world, with the most representative paradigm the Amazon basin in South America, where thousands of acres of tropical forest are being burned every year in the name of agricultural development and expansion. Contrary to that, forests in the southern countries of Europe and in all the Mediterranean countries are under the threat from wildfires, which damage vast areas of forested land every year. It has been estimated that during the nineties, an average of 50,000 fires and 600,000 ha burnt, twice as many as during the 1970s (Palahi, 2000). Between 1989 and 1993, an average of 520,000 ha of forest was affected by fire. However, not all of this area is destroyed, since the forest is a "*living milieu*" with the ability to regenerate that enables it to resist the negative effects of fire. Sometimes, when fire sweeps through quickly, the forest is only partly destroyed and is still possible for the vegetation to regenerate. Through the passing of time, forests in the regions of southern Europe have developed mechanisms to withstand successfully to fire danger.

Greece, as one of the Mediterranean countries, is facing major problems due to wildfires with tragic consequences not only from the loss of forests but in human lives as well. What wildfires had caused to Greece was more than a biblical catastrophe, especially the last two decades. Different oriented policies have been implemented through out the years to manage the problem, but with inadequate results.

Over the last years, wild fires have become issues of great importance in the southern European countries, and numerous efforts are focus on controlling the negative effects. The present handling in the forest sector in Greece is still far away from what modern societies demand and sustainable development seeks for. Therefore, the present situation calls for immediate rehabilitation of implemented policies and reconsideration of the wildfire treatment.

1.1 Objectives

The first objective of this study is to analyse the phenomenon of forest fires (wildfires) in Greece as part of the regional problem that occurs in the Mediterranean basin for thousands of years, affecting both natural and human environment. The major precondition is to analyse the phenomenon not as something independent from human activities, but as coherent to human overexploitation over natural recourses.

The second objective has to do with the evaluation of the so far confrontation of wildfire events and the implemented suppression policies in Greece. The attempt will be focus on showing the real dimensions of wildfire, which is more than a natural phenomenon; is also an socio-economic one, reflecting the modern way of life. The scope of this thesis is to study the dynamics of the system "Natural Environment-Human Social Life -Economic Activities" and how forest fires as a phenomenon intervenes between the above three main essentials of the system.

Last but not least, the problem that Greece faces will be considered under the context of long-term sustainability, where the concept of sustainable development will be discussed as the concept that should help diminish the fire activity in the forest. The next schematic diagram portrays where the wildfire phenomenon lays, and as we are going to discuss in the coming chapters, how interacts with the three above-mentioned parameters.

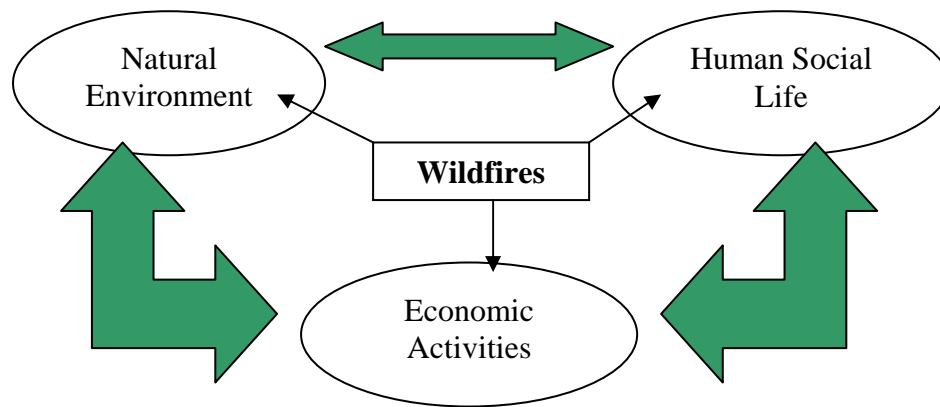


Figure 1. Wildfires affect simultaneously the elements of the dynamic system including economy, nature, and society.

1.2 Theoretical framework and Materials

The methodology of this study was based primarily on a theoretical formulation of the problem that Greece faces over the last years. Even though fire as a phenomenon is not something beyond ecosystem's functions, due to the changes in human's life it seems to be a factor that inhibits natural ecosystems preservation. At the same time affects various economic activities not connected directly with forests. The initial analysis of the system was shaped from personal knowledge gained from my forestry background. The next step was to investigate the links in the system "Natural Environment-Human Social Life -Economic Activities" in order to understand how different factors support or maintain the issue of wildfires. Special attention was paid in searching previous studies in the forestry sector as well as the existing literature on socio-economic matters in order to develop further hypothesis for what is the reason that is causing un-sustainability to natural ecosystem in Greece.

The literature review was mainly focused on gaining the knowledge from the countries that confront the same problem and these are the other southern European countries such as Spain and Italy. The task was to find recent data that will be used within suggested theoretical framework to describe and analyse the existing situation. Special attention was given to the proceedings of a number of seminars and advanced study courses, which focused on wildfire management and forest fire prevention and were held by the European Commission and the Food and Agriculture Organization of the United Nations (FAO). The survey on literature was completed from Greek sources such as the Mediterranean Forest Research Institute in Athens, the Department of Forestry and Natural Environment of the Aristotele University of Thessalonica.

Besides the above, interviews with people from the Greek Forest Service, Ministry of Agriculture and the attendance of a seminar meeting that was held in the island of Rhodes on October 2001 with the theme "*Forests-Tourism-Land Planning*" have contributed to gain an integrated viewpoint on the field of my interest. Last but not least, a small survey was carried out for the island of Samos, by asking people questions dealing with the effects of fires to tourism, with the purpose of gaining knowledge on this subject.

Finally, basic system analysis modes have been used to portray the relations and interactions between different elements of the system. Mental model and causal loop diagrams (CLDs) have been used to illustrate the relations and interactions that have been mentioned above.

1.3 Methodology and Limitations

The study comprises of a theoretical part, which provides general information about the role and the effects of wildfires to forest ecosystems. It presents also today's condition in Greece and in the southern European countries as far as the environmental degradation due to fires is concerned. Former experience together with new outcomes from recent studies based on the theoretical framework of sustainable forest management will be the guidelines to examine why forest fires have become major issues of concern.

The next field of concern is to examine previous implemented policies, evaluate the positive and negative outcomes and to go on by introducing new ideas on how to deal with the problem. The issue of forest fires in Greece is addressed in this study based on content analysis and survey. Such approach requires first of all understanding of the system structure and dynamics and to identify all the important system feedback loops affecting the problem. However, the multi-dimensional nature of the problem, the absence of valid data and the number of non-quantified variables were the obstacles for not utilizing computer modelling.

The following schematic string of concepts describes the approach that will be followed:

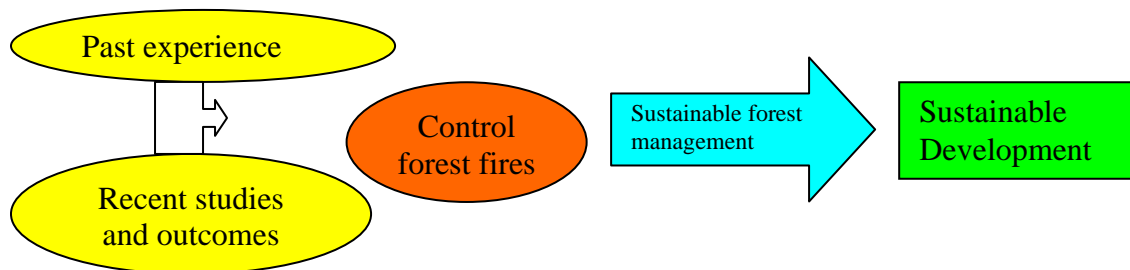


Figure 2. The methodology (mental model) that has been followed

1.4 Thesis' disposition

This thesis is divided into two parts. The first one is a broad introduction of the topic together with a short exposition of the problem as is presented in nowadays. The objectives, the theoretical framework along with the methodology and limitations are also being presented in the first part. A background and a thorough description of the problem are coming in the next chapters together with figures and data.

The second part dealing with the analysis of the problem where a CLD is being used in order to illustrate the interconnections among different actors, factors and events as well as their consequences. Historic data, impacts of wildfires to human and natural environment are been discussed in that part. Next filed of discussion are the present implemented policies in national and European level as well as the principle of sustainable development through the sustainable management of forestland. The thesis ends with the discussion and the conclusions, which can be drawn from this study.

2.0 INTRODUCTION TO THE PROBLEM OF FOREST FIRES

2.1 The role of fire to natural ecosystems

Natural fires were always dynamic factors affecting natural ecosystems periodically. In fact, pine forest for instance, need sporadic fires in order seeds to be released from cones and sprout due to heat exposition (Miller, 1999 p.664). The mode that a fire is spreading and the different heat intensity affects forest ecosystems in different way. Fires that burn only the ground vegetation and the dead biomass contribute to vitality of the ecosystem by recycling the valuable mineral nutrients and reduce the accumulation of flammable dead tree leaves and branches. On the other hand, fires that called "crown fires", under extreme weather conditions are responsible for vast catastrophic events in many countries all over the world. These fires, taking place in dense forests where large accumulations of living and dead biomass have taken place. Since such a fire will break out, then it is very difficult to be put out and significant loss of forest have to be expected.

The destruction of forest due to wildfires is a global phenomenon affecting countries all over the world with different climatic conditions and type of vegetation. Every year millions of hectares of the world's forests are destroyed by fire from the tropics till the northern parts of Unites States and from the vast forestlands of Siberia till the Australia's subtropical region. It has been estimated that in 1998 more than 7,000,000 ha of forestlands have been lost all over the world from fires that lasted for months (Efthymiou, 2000).

2.2 What is happening to the Mediterranean region?

As it was mentioned in the introduction, an average of 500,000 ha burnt every year in the northern Mediterranean sub region. Despite the enormous efforts that have been done so far, the phenomenon is far from stabilizing (it's difficult to say minimizing), and there are regions where the problem shows to be escalating significantly, mainly in the countries of Southern Europe. Even though it's not feasible to obtain an accurate picture of the total increase, in the countries where data have been available, a large increase of forest fires can be observed from the beginning of the 1970 (Palahi, 2000).

The situation has clearly worsened in Greece, Italy, Spain and Former Yugoslavia. Between 1989 and 1993, approximately 2.6 million hectares of forestland were destroyed by fire in the Mediterranean region. That is equivalent to a country like Belgium being destroyed every five years (source: *Europa* web site). Especially in Greece, where the problem of wildfires is going to be analysed, the statistics of burnt forest area is alarming. Throughout the period 1970-1997, the average burned area had increased from 11,000 ha/year, which was before 1970, to 30,000-80,000 ha/year. The figures in the last three years increased to about 100,000-220,000 ha/year (Efthymiou, 2000).

In fact, it is worth to mention some numbers that performs the significant increment of fires in Greece during the last decades. As it can be inferred from the first diagram (fig.3) there is a significant increment of the average burned area and the number of fires from the seventies till the last decade of the nineties. The same trend can be seen on the second diagram (fig. 4) where an increase in the number of fires during the last two decades took place, with a maximum in 1998. Finally the third schema (fig. 5) presents that annual burned area in Greece at the same chronological period (1980-1998).

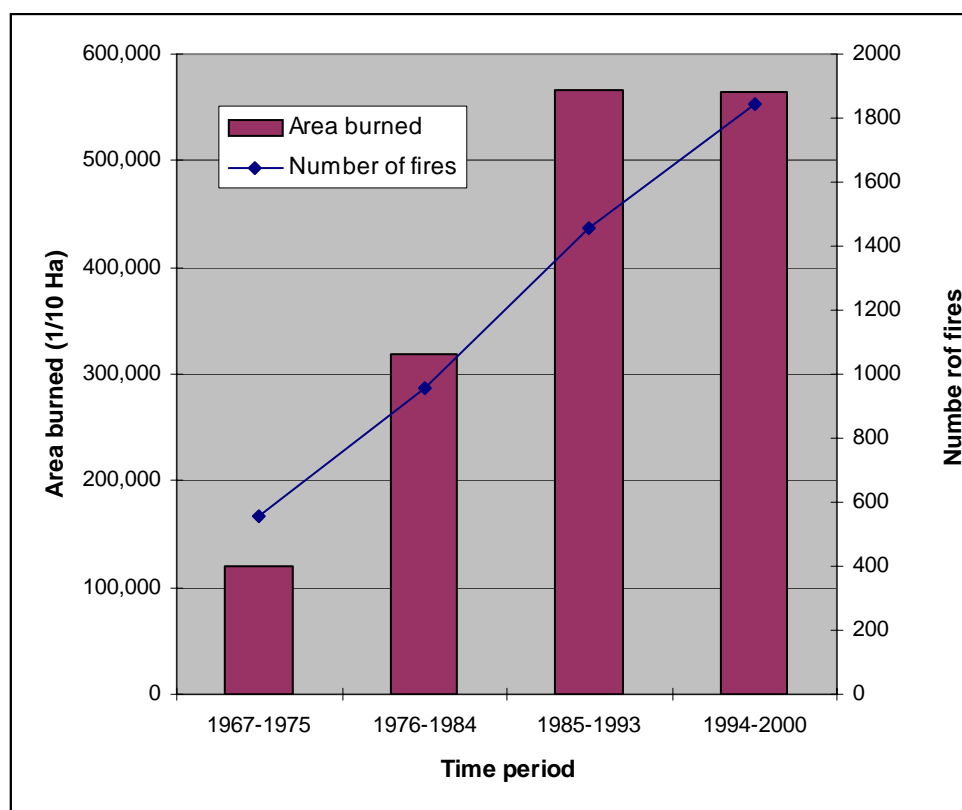


Figure 3. Comparison of forest fires in Greece between different time periods (Source: Ministry of Agriculture, 2001)

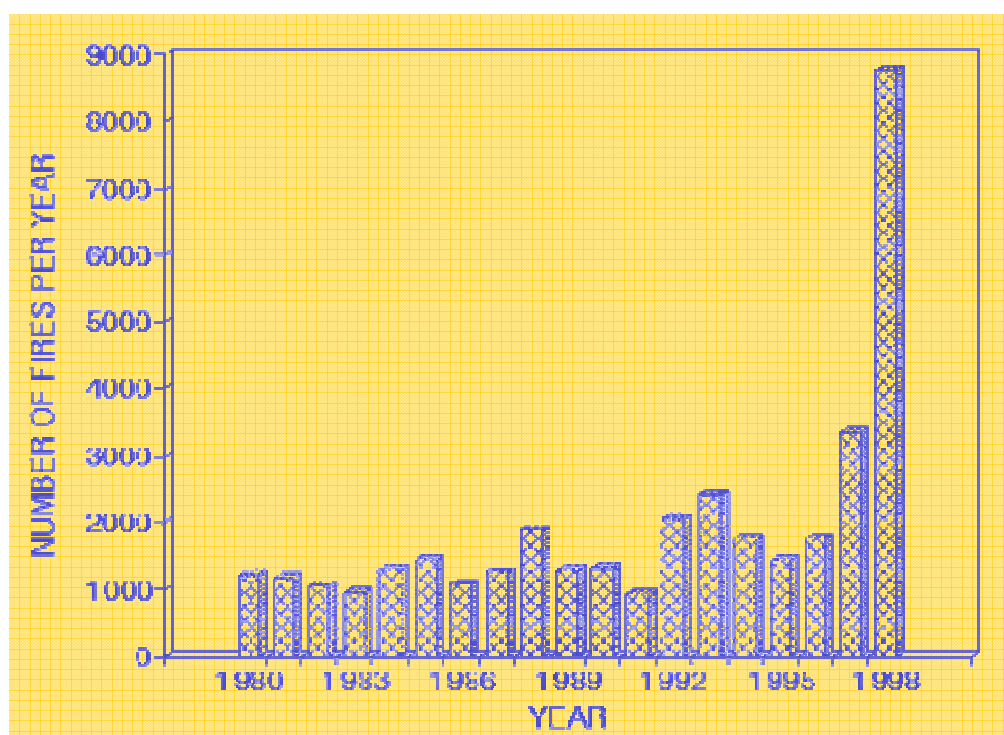


Figure 4. Number of fires in Greece in the period 1980-1998 (Xanthopoulos, 1999)

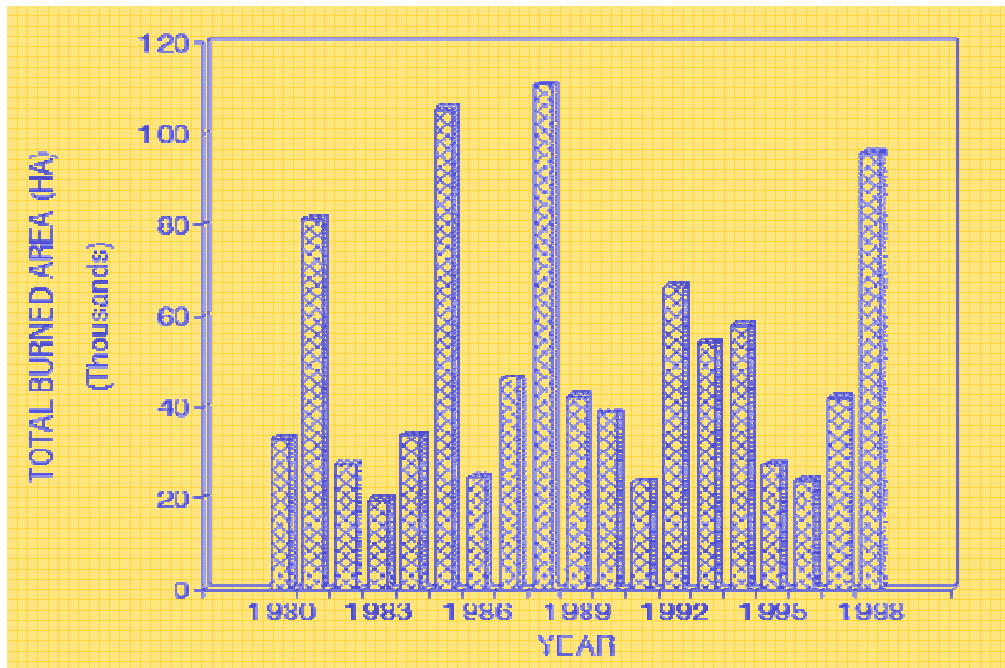


Figure 5. Total burnt area per year in Greece in the period 1980-1998 (Xanthopoulos, 1999)

The above figure 5 presents the fluctuation of the annual burned area over the last twenty years with some peaks in 1981, 1985, 1988 and in 1998.

2.3 Recent history of forest fires in Spain, Italy and Greece

In 1993, Italy experienced a dramatic fire event with more than 15,000 fires and 116,000 ha burned, a year that was characterized as “*annus horribilis*” (Leone, 1997). The same situation has been observed also in Spain in 1994, which was a turning point in recent country’s wildfire history. The total burnt area that year was one of the top three ever recorded in Spain (Moreno et al, 1998).

Nevertheless, the most worth to mentioned was the fact that both the number of fires and the total burned area since the sixties till the nineties has increased remarkably; the same condition that have been recorded in Greece, as described above. Another element that shows the trend of wildfires is that large fires become more common all over the country with the passing of time. What were the years 1993 and 1994 for Spain and Italy respectively was 1998 for Greece.

The 1998 fire season was for Greece far from usual and undoubtedly the most controversial. Wildfires caused unbelievable disaster in many regions such as areas of great ecological importance such as parts of the *NATURA 2000 network* (mount Taigetos) and the national park of mount Olympus (WWF, Greece, 1998). Attica, the area around Athens, was hit the worst, the fire destroying the remains of the forest on the mountain Penteli and re-burning previously burn area (Xanthopoulos, 1999). The severity of the situation forced the Greek government to request for international help and countries like Italy, France, Germany and Russia responded. More than 80,000 ha of forestlands have been lost. Apart from the forest loss, 10 humans lost their lives and hundreds of houses were burned.

Unfortunately the 1998 incident was not the only one. The year 2000 is the worst year that has ever been recorded in Greece’s wildfire history where 177,260 ha of forestland have been damaged (source: Ministry of Agriculture, 2000).

What was demonstrated in the previous paragraphs is that forest fire episodes in the above mentioned countries have changed either in the number of fires recorded or in the total surface burned by them, both of which have increased remarkably since the late seventies until present days.

2.3.1 Changes in Fire incidence in Greece and other Mediterranean Countries.

It is well known that only a limited number of fires in every country are responsible for severe forestland damages, and that the majority of them have not have severe impacts on environment. Thus, large fires contribute the most in the forest fire management not only for the suppression cost which is extremely high, but basically because they generate negative economical outcomes and loss of extensive forest cover.

In Europe it is acceptable that fires causing more than 1,000 ha are considered as large ones (Viegas, 1998). In Greece, large fires during 1970-1993 were only 5.4 percent of the total amount, even though they were responsible for the 72.6 percent of the total burned area (Markalas et al, 1996). However, this distinction does not represent entirely the real situation, especially when there are also other parameters such as the economical and ecological value of the damaged area that have to be taken into consideration.

The statistics that are provided above for the European Mediterranean countries show that a noteworthy change in fire incidents took place. According to Moreno et al. (1998) these kinds of alterations do not seem to be related with geographically determined climate differences, but to a certain extent to other dynamics particularly socio-economic ones. Even though extreme weather conditions in the years 1998 and 2000 was a crucial parameter that affected all the Mediterranean countries, all scientists seems to conclude that climate is not the decisive factors that increases forest fire incidences (Moreno et al, 1998, Baptista & Carvalho 2000, Madoui, 2000). The problem of forest fires in the region is both related to environmental and socio-economic factors which are going to present in the coming chapters.

2.4 Forest fires impacts to humans

Mediterranean-type ecosystems are among the most diverse areas in the world due to the favourable weather conditions that provides to various species ideal habitats. However, the Mediterranean climate is also a factor that due to long dry summers, favours wildfires. Natural vegetation (mostly pine trees and spiny evergreen shrubs) is adapted to periodic wildfires.

Apart from vegetation, people also settle down in this milieu. The expansion of the cities and all kinds of productive infrastructure over these ecosystems caused severe deforestation over the years. As it was mentioned previously, the number and area burned per year have significantly increased in the last decades due to rural emigration from the mountainous areas and to the change of the socio-economics conditions (Papanastasis, 1999). Consequently, fires have become more frequent, and more destructive to the ecosystems than used to be in the past. It is worth to mention that in Greece during the period from 1967-1975 there were an average number of 558 fires per year, which has reached to 1,841 per year in the last decade (table 1, p. 5).

The major impact of wildfires is the destruction of the aboveground vegetation. The adaptability that vegetation has to mitigate the fire effects, very often is being held back because of human interference. The intentionally or accidentally re-burn of an area shortly after a fire event can push back natural regeneration. As a result, the soil surface remains exposed for quite a long time after the fire, during which erosion may occur. Secondly, fires

pose serious threats to human-built structures and lives. In Greece human losses and destruction of human constructions of all kinds have always been recorded.

Human victims		Domestic animal loss		Houses		Agricultural infrastructure	
1993	1988-93	1993	1988-93	1993	1988-93	1993	1988-93
16	6	1218	1105	123	59	477	164

Table 1. Human losses and other material damages (Markalas et al, 1996)

The above numbers are indicators showing that wildfires are affecting human activities directly and the most significant is the invaluable loss of lives. In 1998 ten more people lost their lives (Xanthopoulos, 1999) where in Spain the victims were four and in Italy the casualties due to fires were rose to six people (Scipioni et al, 1999). All the above states that wildfire is a phenomenon with environmental impacts not only on nature but on humans as well and this is how to be faced up.

2.4.1 Fires and causes of ignition

The analysis of the causes of fires the period from 1968 till 1993 confirms once again the high incidence of human responsibility for the destruction of wooded areas struck by fires, of which 29.2 percent is due to deliberate action. The analysis of intentional causes throughout the last decades allows us to state that most fires that occurred for these reasons were due to agricultural activity (rangeland improvement) and arsons, which contributed significantly to the starting of fires.

Causes of fire	1968-1993
1. Lightning	2.4
2. Accidents	3.5
3. Negligence	36.0
4. Intentional (Arsons, rangeland improvement)	29.2
5. Unknown	28.9

Table 2. Causes of forest fires in Greece (%) (Markalas et al. 1996)

Table 2 shows the intentional and other types of human caused fires and confirms that other factors than those related to traditional use of land are responsible for the current fire situation. At the same time, the high percentage of unknown causes of fire is drawback that weakens the valid ness of the fire statistics in all Mediterranean countries (Stamou et all, 1995).

2.5 Geographical distribution of forest fires in Greece

During the period from 1971 till 1993, fires have been widespread all over the country even though the most significant fires incidents were restricted in the 6 geographical districts of Greece as it is shown to the next table.

Woodlands, bush lands and grasslands				
	Geographical district	Existent forestland (ha)	Burned area (ha)	Percentage (%)
1	Ionian islands	125,592	53,232	42.38
2	Aegean islands	548,983	107,613	19.60
3	Crete	412,191	80,182	19.45
4	Peloponnesus	1,165,617	150,118	12.88
5	Greek mainland	1,660,011	213,832	12.88
6	Thessaly	751,880	76,752	10.21

Table 3. Classification of the Geographical Districts of Greece according to the area burned annually during the period 1971-1993 (Markalas et al, 1996)

The most affected areas are the islands and southern parts of the mainland (Table 3), where the majority of Greek's economic activities are located. However, the last years serious fire episodes have affected also areas where the fires were very rare. For instance, large fire destroyed extensive areas in northern Greece and in high elevation where the most valuable from ecological and timber-produced point of view forests are found. The national park of Pindus, an important biotope of the brown bear, was threatened by fire in the year 2000. The same year a unique fir forest (endemic fir tree: *Abies Cephalonica* L.) in the centre of Peloponnesus have been seriously damaged as well as other areas of ecological importance were also been affected.

Thus, with the passing of time fires become more frequent throughout the country even in areas that there wasn't any fire history. The same situation has been observed in Spain (Moreno et al. 1998) and in Italy where wildfires have severely swept many nature reserves and national parks (Leone, 1997).

3.0 THE ANALYSIS OF THE PROBLEM IN GREECE

3.1 The importance of Mediterranean forests in Greece and the threats are facing

It is wide known that forest plays an essential role in maintaining biodiversity particularly as regards the soil, water resources, microclimate regulation, flora and fauna number of species. Furthermore, forests contribute towards the protection and development of agriculture and the countryside as well. However, the leading function of forests during the centuries was the production of raw materials. The overexploitation of timber stocks already had taken place from the ancient civilizations and led to declination of the Mediterranean forest ecosystems with consequences that still disturb human economic and social life.

Greece is one of the countries where the over-exploitation of natural resources is closely related with the growth of civilization that took place the last 3.500 years. However, when Greece achieved independence from the Ottoman Empire in 1830, it was estimated that 48% of its land were forested. A century and a half later, despite a considerable expansion of national territory, Greece is a "forest deficient country" with only 19 percent remaining forests (Pyne, 1997).

The demand for agricultural and grazing land and of course timber, were the main reasons for gradual deforestation. According to *EUROPA Yearbook 2001* Greece's total round wood production during the last decade (1989-1999) was fluctuated from 1,692 m³ to 2,546m³ which is considerably low comparing it with the production of other European countries.

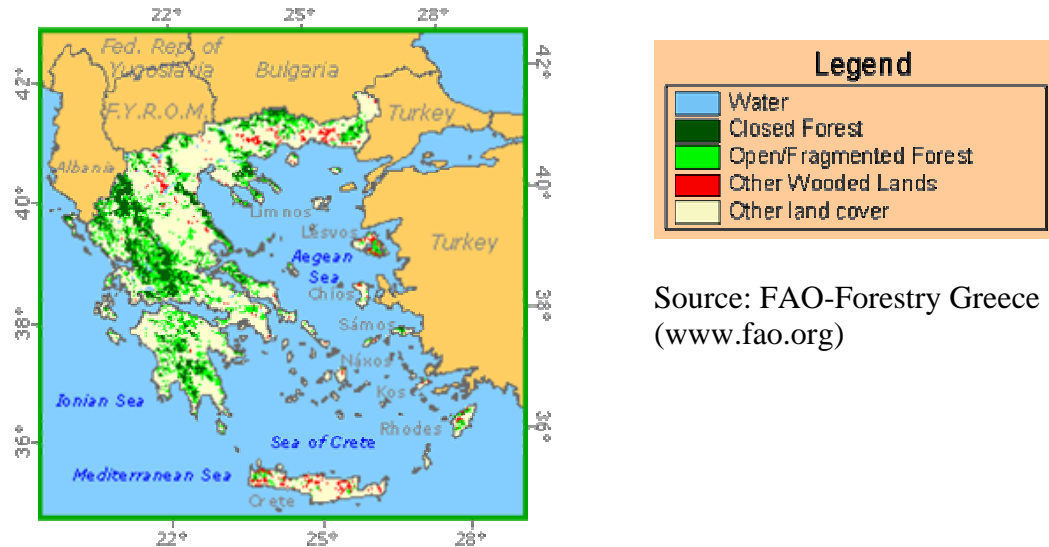


Figure 6. Forest map of Greece

However, in a mountainous country as Greece, with severe floods phenomena, forests beyond their economic importance (timber products), supply also the country with ecological benefits, which most of them are undervalued (Miller, 1999 p.646). Forests regulate extreme floods incidents and prevent soil erosion, recharge springs and groundwater layers, provide habitats for wildlife and improve living conditions in neighbouring urban built up areas. Besides their economic role, forests offer many other benefits that could be regarded as valuable to society. Increasing leisure time, for instance, has made more important the recreational use of forests. The ongoing environment degradation resulted to highly degree of awareness of environmental aspects associated with forests' protective functions. Therefore, all the implemented policies have been reconsidered in order to perform the modern needs on forest management in its new multifunctional role.

3.2 Socio-economic effects. Human-related stress on ecosystems

As it was stated above, the causes of wildfires are always external to the forests; fires are indicators of tension and tendency in the management of rural areas, therefore it is necessary to look for the causes in connection with other policies. In order to look deep into the problem of wildfires from socio-economic point of view, it is necessary to look up fire data in parallel with socio-economic information, such as rural out-migration, type of farming, tourism activities and land use policies.

Greece during the last century was a traditional emigration country that provided cheap labour hands mainly to Unites States, Australia and Germany. Spain and Italy have also experienced the same situation with the depopulation of rural areas (Moreno et all, 1998). Together with the population's exodus from marginal rural areas, the mechanization of agricultural work and the urbanization of former rural areas contributed to big changes in the traditional land use. Changing in lifestyle and the transition from agricultural economy to service had as a result the abandonment of country land and the biomass accumulation. The low ages of burned forests, the repeated burning of forested areas within a decade almost everywhere in the country, reflects the socio-economic and landscape changes that took place in Greece. The present situation of economic transition through the last fifty years had been reflected by the evolving geography of fire. The internal emigration towards the big urban centres has as a

result the loss of vital traditional practices, so important historically in absorbing surplus biomass.

Contrary to that, recreational use of nature and tourism, have lately brought people near countryside but with different lifestyles and support urbanization, often increasing fire risks by negligence. These new categories of settlements, they do not live off the land, using controlled burning to diminish the progressively uncontrollable fuels (Pyne, 1997). Summer homes spread over coastlines and tourism replaces traditional industries; political unrest during national elections, are some paradigms of these developments.

Another aspect of justifying the hypothesis that recent fire activity is not naturally induced are the years 1981, 1985, 1988 where the total burned area reached to large numbers (table 3, p.6). In those years the Greek general elections took place and according to Papastavrou (1992) periods of political unrest in Greece, mainly the periods before the elections, emphasize the rate of fires.

3.2.1 Human activities and wildfires

The customary land use that shaped the Mediterranean ecosystems through the centuries had contributed to the wildfire hazard limitation. Grazing of livestock, collection of firewood for domestic uses, resin collection from pine forests, were traditional practices that keeping down the biomass accumulation. Furthermore, watching over the neighbouring forests and fire fighting were two actions in which villagers were traditionally engaged. The changes in land use and demography resulted in a significant increase in fire hazard (Xanthopoulos, 1999).

The last decade, another trend has been observed. The inhabitants, of overcrowded cities like Athens, are moving back to countryside, especially to coastline near big cities for a second dwelling. Residential areas intermixed in forestlands, has been a new element in the relation between human and nature. The land use changes in mountain Penteli (which is located next to Athens) were studied from 1945 until 1998 and it was proved that more than one third of the forested area was urbanized throughout the years (Varela et al., 1999). However, the interdependence between wildfires and the modern urbanised society goes beyond the above interface (Goldammer, 1992). Nowadays, people all over the world travel a lot. Tourism has become a new form of land use, and has in some areas replaced traditional economic activities (farming and grazing).

It is, however, worth to mention that, unlike the rural population, that seasonable employee in tourists activities as well as tourists do not develop an attitude of responsibility towards the land they are visiting (Pyne, 1997).

According to Dimitrakopoulos (1992), areas in Greece with high population density and land value (coastal forests, bush lands in tourist regions) have the highest human-caused fire occurrence. The same situation was noticed also in Spain (Moreno et al., 2000) where recreational uses of nature and tourism have newly brought people again near rural areas but with different lifestyles, supporting urbanization on open areas. Conflicts of interests among conservation policies and land users arose as new causes of ignition. Policies dealing with the classification of certain areas as natural parks quite often have upset local people who prefer to retain the land's administration in the present status quo for other uses. These manners are leading to deliberate fires.

A noticeable example happened on October 11th in 2001, when a fire totally damaged the coastal forest ecosystem of the National Marine Park of Zakynthos (Greek island, where the most important egg-laying region of the *Caretta caretta* sea turtle in the world, is located) (WWF Hellas, 2001). People in that area were in opposition to the declaration of that Marine

Park because it was against their interests of constructing dwellings for rent purposes during summer period. Same attitudes were also been reported in Spain, where it seems that there is a correlation between the declaration of nature reserves and the ongoing number of fires (Garrido et al., 1999).

Even though in most of the cases causes of fires are unidentified or some are deliberate, there were no official proofs to back the hypothesis. However, the high numbers of deliberate fires and the fact that mostly public ownership of the land was affected, are reasons to assume that both the counties and local people have found as the only solution to indicate their disagreement on the authority's implemented policy by starting fires. Eventually these phenomena are destructive to their future economic development.

4.0 SYSTEMATIC APPROACH OF THE PROBLEM

The previous analysis of the forest fire phenomenon can be displayed in a Causal Loop Diagram where all the factors are presented together with the main driving forces of the problem as well as how wildfires as a phenomenon interact with human's activities.

But first, the coming figure presents the main factors that are responsible for the increase of forest fire incidents in Greece. Long dry summers together with low precipitations during wintertime, as it was mentioned above, are crucial parameters in wildfires worsening. The biomass accumulation due to forestland abandonment and at the same time the urban sprawl that brought people's activities close to forests contributed also to fire phenomenon.

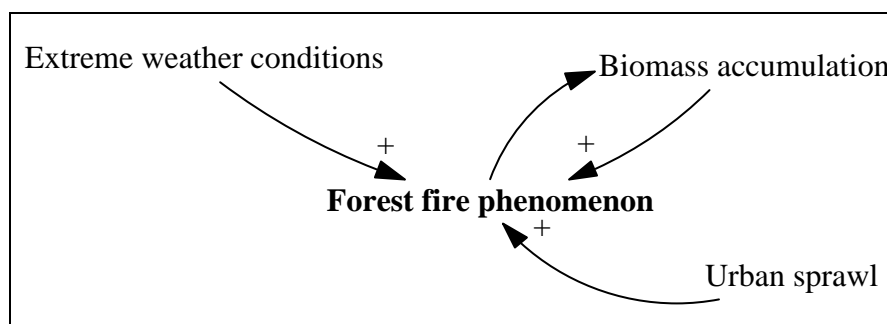


Figure 7. Parameters that escalate forest fires.

However, as it was discussed in the previous chapters, it was the changes in land use the main driving force that has escalated wildfires in Greece. The improvement of people's social and cultural life increased eventually goods consumption and consequently changed the demand patterns for forestland use. The demand for a second house in the countryside for summer vacations and the ongoing use of private cars together with the improvement of means transportation, increased forest land use for recreation and mountainous tourism (Papastavrou, 1999). At the same time, the low income from forest products and people's immigration to large cities left behind uncultivated forestlands.

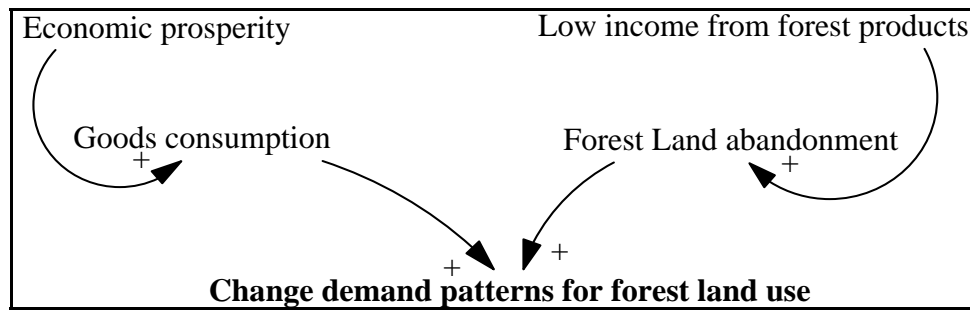


Figure 8. Driving forces in changing forestland use.

4.1 The Causal Loop Diagram

The following Causal Loop Diagram formulates the overall analysis in a more detailed approach:

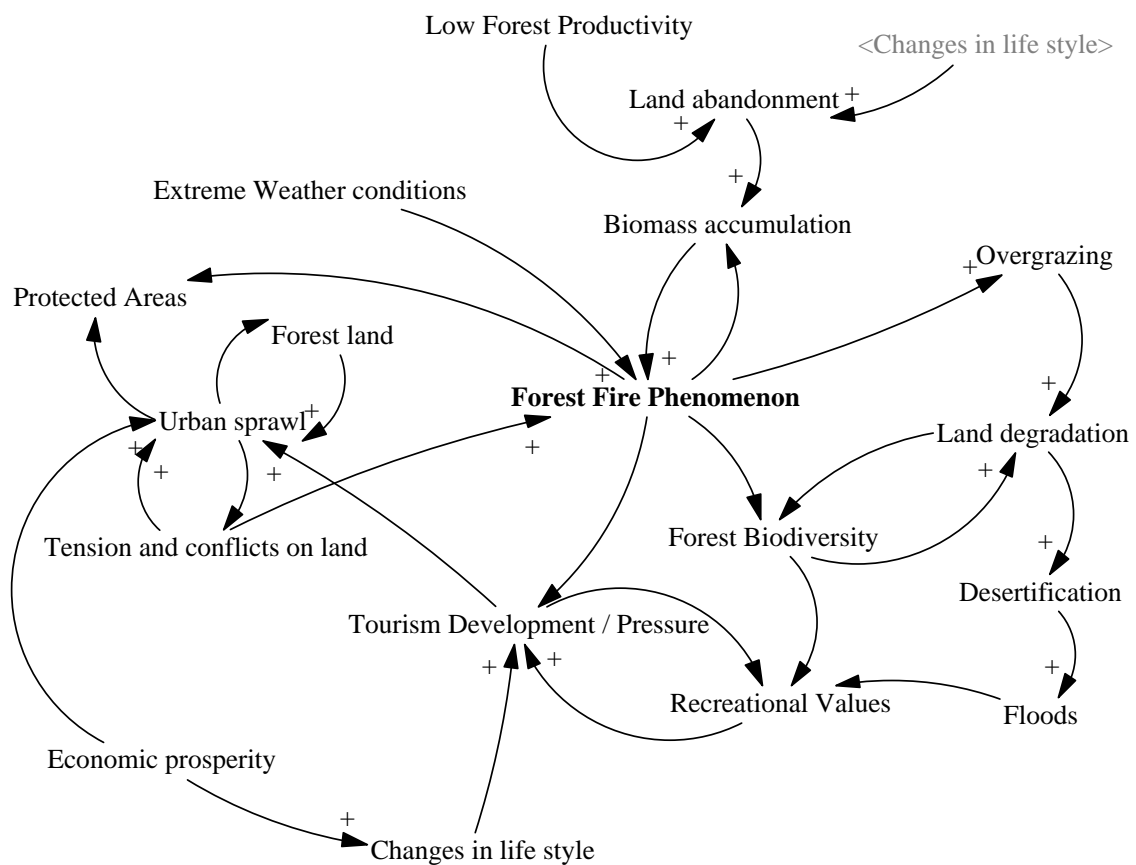


Figure 9. The CLD of the existing situation in Greece related to forest fires (where there is no (+) symbol a (-) symbol is meant)

What can be easily concluded from the above CLD is that forest fire is not only a natural-induced phenomenon but also a more complex system and that is the way to be handled. The change in demand patterns that it was mentioned in the figure no. 6, caused the alteration of land use system from forest management to a more recreational oriented one. The weather variable is of course a noticeable element in the system, which sets the presupposition for a fire event to occur. Large, with high intensity and rate of spread, fires has shaped the present-day's Mediterranean landscapes. However, as it was discussed in the previous chapters, there is also little doubt that landscape shaping is a synergistic factor that helped to shape the present form of Mediterranean ecosystems. Human's involvement through land use is the main reason for serious fire episodes affecting forests and forest biodiversity. Furthermore, the increase frequency of repeated fires in short time resulted in serious problems of land degradation with no returnable effects such as desertification.

Nevertheless, the major factor affecting land use patterns is the economic growth (prosperity) of the country, especially through tourism development and urban sprawl. In 1999, 12,6 millions of tourists visited Greece (source: Bank of Greece) and the number of nights spend in hotels reached up to 59,871,100 millions. These numbers are representative sample of what it happening in Greece every year and how important the "tourism industry" is for country's economic development. However, tourism pressure causing at the same time environmental problems to country's nature with direct impacts in areas with high recreational value.

Simultaneously, tensions and conflicts on forestland are not only due to tourism but also for urban sprawl and summer dwellings. Large fires in 1997 and 1998 destroyed vicinal forest of Thessalonica and Athens where the pressure for expansion of urban areas is enormous.

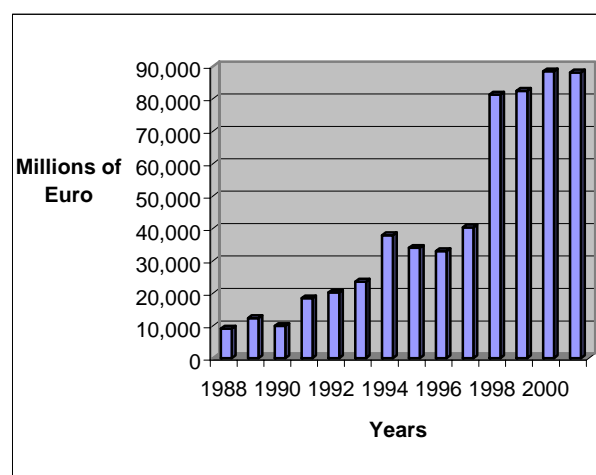
What can be concluded from the CLD is that the ongoing environmental degradation through the human induced wildfires apart from nature itself, affects foremost all human activities related with natural environment.

4.2 Presently implemented policies. Suppression versus prevention

Because of all the above, the state was forced to make huge investments in fire fighting. The state authority responsible for forest fires in Greece until 1997 was the Forest Service. The so far implemented policies in order to mitigate the wildfire effects are an army of fire fighters and a fleet of aircrafts. During the 1977-87, fire protection claimed 10-15 percent of the entire budget of the Greek Forest Service (Pyne, 1999). Since 1977, fire related fatalities and injuries have increased alarmingly. More efforts and more money invested in buying expensive fire equipment, mainly aircrafts, and during the 1991-1997 the expenditures on fire protection reached up to 18-26 percent of the entire budget of the Forest Service (Ministry of Agriculture, 2001). The results were still disappointing.

Then, in May 1998, the Greek government put into effect a new law that gave the responsibility for forest fire fighting to the Fire Service, which was responsible for municipal fires but also contributed to forest fire fighting. Most aspects of fire prevention remained with the Forest Service. The permanent personnel of the Fire Service reached 10,000 in 2000. Four thousand seasonal employees were added in the summer together with all the equipment that belonged to the Fire Service (Xanthopoulos, 1999). The total budget multiplied and reached up to 88,158,473 millions Euro (€). Even with the inflation included to the aforementioned un-inflated prices, fire-fighting expenditures grew significantly high due to the fact that the government wanted to deal efficiently and without any cost with the problem. The outcome however was still disappointing and forest loss was comparable to a tragedy.

Fire fighting expenditures in Greece (millions of Euro €)	
1988	9,081,490
1989	12,363,257
1990	9,952,956
1991	18,474,696
1992	20,225,223
1993	23,587,571
1994	37,908,287
1995	34,025,150
1996	32,972,765
1997	40,338,523
1998 ¹	81,291,269
1999 ¹	82,455,145
2000 ¹	88,472,487
2001 ¹	88,158,473



Sources: Ministry of Agriculture and Fire Service Department

Inflation in Greece fluctuated from 4-9 percent between 1988-1998 (source: ministry of national economy)

¹ After 1998 the responsibility for forest fire fighting was given to the Fire Service

Table 4: Fire fighting expenditures in Greece

As we discussed in the previous chapters, even though there is trend towards reduction of mean fire size, strategies based only on fire extinction are not sufficient under fire-prone climates. Given the increasing risk that large fires represent, as shown for the 1998, 2000 episodes, it seems clear that the current strategies based on extinguishing all fires is bound to fail, unless other factors, in particular the structure of the landscape, are considered. Fires that start under extreme weather conditions usually not be put out fast enough and damage landscapes, in which biomass accumulation was favoured by land use changes. This happens quite often, despite the adequacy of fire fighting equipment.

Unfortunately, the states authorities don't seem to understand that despite the amount of money spend every year the forest loss is still significant.

4.3 European Policy and interference

In order to reduce the number and extent of fires and area burnt, the European Union (E.U.) move towards to new legislation measures (Council Regulation EEC N.2158/92) on protection of the Community's forests against fire. The main strategies of the EU regulation were concentrated on the needs to combat the causes of fire and to provide fire prevention and forest surveillance measures (EEU 2158/92, *Europa* web site).

Especially in areas of high fire risk, like the Mediterranean countries, which are facing a permanent or cyclical fire risk, the council of the European Union instituted a "Community scheme" in order to put in the implementation of integrated forest fire protection plans, comprising measures to eliminate causes and to improve systems of prevention and monitoring

During the years 1989-1993 the Commission and the member states of the E.U. decided to set up an information system from all the European countries that are facing the trouble of wildfires. The information that was gathered from the regions that suffered the most from the

wildfires showed that 225,000 forest fires had officially recorded during the above-mentioned period and almost 2,600,000 hectares had been swept by fire (European Commission, VI FII.2, 1996). As it was mentioned in the European's Commission pilot project, the impact of wildfires could vary noticeably from one year to the next. The short observation period of the pilot project set limits to the argumentation on the phenomenon of forest fires. In this report it was pointed out that the impact of forest fires was in fact exceptional in some regions at that time (1989-1993), especially on account of the particularly unfavourable weather conditions (E.C., VI FII.2, 1996). However, data collected the years after the pilot survey, shows that the figures from that period of time were not so extreme and that unfavourable weather conditions have been also observed in the coming years.

The recent experience in the last years (1998-2000) appears to support the hypothesis that almost all forest fires originate through human activities and derive from negligence or deliberate actions. Furthermore, the rapid increase of tourism in the riparian countries of the Mediterranean Sea deteriorated the problem of wildfires through the ongoing demand for tourist infrastructure and due to negligence. In addition, policies for restoration and for classification of certain areas as nature parks are causes for fire episodes in areas where fire was a very scarce phenomenon. Wildfire is the consequence of the relations between man and forest or an indicator of tension in land management.

The survey that was carried out by the European Commission proved how forest fires indicate tensions in land management. Southern parts of the European Union were affected the most by outbreaks of fire. The following map indicates that southern parts of Portugal faced the most severe problems even though the climate in that area is not the typical Mediterranean one, with long dry summers and therefore is not the only parameter in fire risk. According to the Pilot project, the reason responsible for the high frequency of fires in that area is the strong density of rural population and the essential wild land/urban interface. The same problem are facing the island of Corsica (France) the Italian provinces of Naples and Tuscany famous tourist destinations areas. In Greece, even though the survey showed that the number of fires is relatively low, there is the same trend as it was stated in the previous areas. The years after the study support the hypothesis that areas with high human pressure such as those islands of the Aegean and Ionian Sea together with some provinces of mainland (Attica region) are susceptible to fire risk.



Figure 10. Number of forest fires in European Union member countries in the Mediterranean region.

On the contrary, it is common certainty in all the countries (Velez, 1998, Xanthopoulos, 1995) that the abandonment of mountainous areas due to immigration to big urban centres, will lead some forests ecosystems to become dense in vegetation and therefore more prone to fire. The next map shows the extent of burnt areas around the region. In Greece there are provinces where the percentage of burnt area is noticeable and especially along the coastline and the islands.



Figure 11. Extent of burnt areas (%) in European Union member countries in the Mediterranean region.

5.0 THE MAIN CAUSES OF UN-SUSTAINABILITY IN THE SYSTEM

In the third chapter of the analysis of the problem in Greece, is obvious that forest fire in most of the circumstances is the outcome of tension in land management. In other words, the location of the outbreak of fire occurs logically in the areas of tension. Some regions seem to have considerable problems to be solved regarding the causes of fire. As we showed in the above maps, the Greek islands and the southern coastline of the Greek mainland and recently some areas under protection or ain future protection under the *Natura 2000* network are facing the most serious problems.

After the Second World War, the people in Greece abandoned rural areas in a search of better living conditions. The migration towards the big cities and the simultaneously flourish of tourism as a main economic activity altered the status quo in the Greek countryside. Human's pressure on natural environment is getting bigger, especially by increasing the number of visits to the tourist and suburban areas; the risk of fire burst is rising because the left areas are now covered by dense forest vegetation. It is therefore more essential than ever to clarify and control the causes if we want to diminish the fire incidents.

Rural migration still happens because these areas are not offering job opportunities to young people or the wages are not satisfactory enough. In addition young people seeking for other life standards that only a big city can offer. Thus, it is urgent to reverse this trend by generating jobs in forests and by reviewing land use policies that have failed so far to keep people close to nature and to increase the interest to consider the forest as source of income. But firstly the state has to recognize the importance of a new forest policy based on the concept of sustainable development.

5.1 Desertification a future threat to sustainability

Mediterranean type ecosystems are generally high impacted by human activity, either directly by transformation for particular land use objectives, or indirectly by fire episodes – in the case of abandoned farmland in the Mediterranean Basin, by both. While the ecosystems trying to recover after a fire incident, the persistent human's pressure on burnt land is so multifaceted, that finally vegetation fails to come back. Desertification is the next threat that many areas in the Mediterranean region have to confront.

According to United Nations Convention to Combat Desertification, the term “desertification” means land degradation in arid, semi-arid and sub-humid areas resulting from various factors, including climatic variations and human activities. Even though desertification is not a recent phenomenon in natural ecosystems in Greece, nowadays have also socio-economic implications. The extensive forest fires are one of the procedures that help this phenomenon to expand. Intensive over-grazing especially after fire is also directly connected with the damage of vegetation cover.

Additional practices like over-exploitation of water and forest resources together with the increased demands for water in urban infrastructure resulted in the present situation where about 15,233 km² in the southern and central mainland, the Aegean islands and Crete is threatened by desertification (Greek Committee for desertification, 2000). In other words, 11.5 percent of the Greek territory is prone to desertification.

5.2 Tourism development in areas damaged by forest fires

During the nineties Greece experienced fundamental economic transformations, in order to make its economy to comply with membership requirements in the Economic and Monetary Union of Europe. Greece finally managed to reach the target and became the twelfth member that adopted the single European currency putting a lot of efforts in development especially on the three basic sectors of the economy: agriculture, industry and tourism (Kousis et al, 2001). Table 5 presents the contribution of each sector in Greece's Gross Domestic Product (GDP).

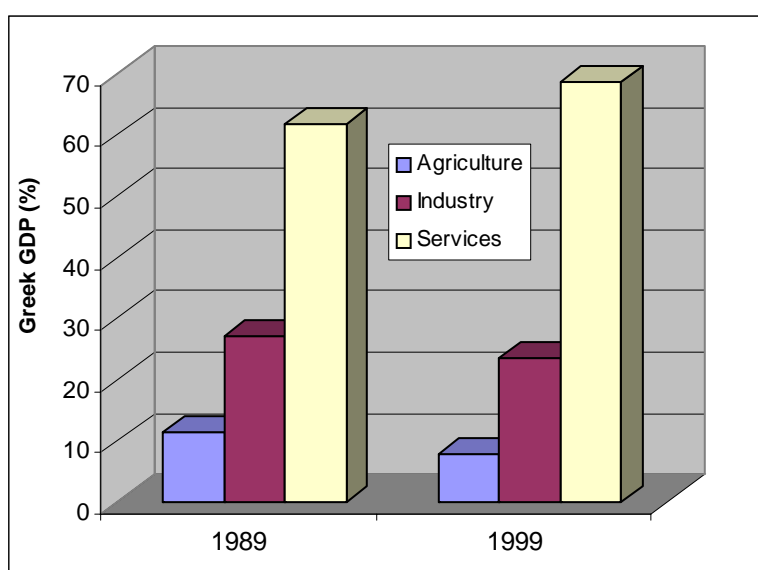


Table 5. Changes in Gross Domestic Product (GDP) within 10 years in Greece's most important economic sectors (Kousis et al, 2001)

What can be interpreted from the above is that unlike agriculture and industry sector, service sector's contribution to GDP rose from 61.7 percent in 1989 to 68.5 percent in 1999. The increase growth rate in market share, tourism is going to maintain its dominant position in the Greek economy in the future.

Nevertheless, according to the European Environmental Agency, the increase in tourism share of GDP implies increasing investment in tourism-related infrastructure. That means degradation of local natural resources and landscape because of the pressure in environmental sensitive areas, mainly coastal forests and mountain areas.

Fires in some of the most famous summer and winter tourist resorts in Greece occurred the last decade in these areas together with the blossom of tourism. Even though as we discussed there were no evidences to relate fire causes with pressure from local people to change land use, fires that damaged nature in coastal areas, disturbed and disparaged Greek tourism (Stamou et al, 1997). Many tourists cancelled their visits or even left earlier from their place of vacations after wildfire events.

At this point we will quote a limited research study that we did for the island of Samos (an island located in the eastern Aegean Sea close to Turkey). The aim for this research was to investigate what were the impacts to tourism after the 2000 fire event that burnt one third of the island's forest cover. We questioned three of the most important tour operators of the island that are responsible for providing to tourists all kinds of accommodation and facilities during their vacations to Samos.

Before discussing the results we have to mention that unfortunately there are no data in Greece about cancellations to hotel reservations and departures of tourists because of wildfire events. Furthermore, this survey has to do only with the case of Samos, which is not representative for the whole country. However, it shows the tendency and how people that works in the tourism industry perceive the problem.

All the tour operators pointed out that the fire event in 2000 caused massive cancellations to hotel reservations and many of tourists left the island before the end of their vacations. Next year there was a decrement in the number of reservations and the number of groups especially from Germany and Holland due to the feeling that fire damaged natural ecosystems. Both agree that there was a 20 percent reduction in hotel reservations and arrivals. The reason was that tourists used to choose the island of Samos as the place for their vacations because of the beautiful landscape and the chance they had to walk in the forest. These remarks come to verify the hypothesis that for tourists, one of the major purposes of visiting the country is to enjoy the combination of forest-sea (Eleftheriadis et al.1989).

In conclusion, there is a dynamic interaction between wildfires and tourism since tourism development depends on the nature in order to attract more people but on the other hand is sometimes the reason, directly or not, for large fire episodes.

6.0 APPLICATION AND RESULTS

6.1 Demand for other policies

From the above it is clear that forest fires in Greece seems to be as an insuperable obstacle in preserving natural ecosystems and at the same time affecting various economic activities. The apparently exponential growth of humans' demands on natural resources leads inevitably to more intense management of the Mediterranean ecosystems. Therefore all measures so far are not enough to confront the problem and simultaneously ensure the future preservation of forest ecosystems.

National forest policy during the last twenty years was focused on prevention and suppression measures in order to control the number and area burned (Papastavrou, 1992). Fires in forest were always viewed as natural phenomena and more of the efforts were on the way to suppress them. Little effort was put on the investigation and the analysis of the causes. Policy strategies were based on preventive and suppression measures. Even though Greece had regulated the sustainable management of forests through legislation from 1937, this was more timber-production oriented. During the last century, forests in Greece were managed in a sustainable way in order to provide certain amount of timber as well as other non-wood products.

6.2 Sustainable forestry in Europe and Greece

Today, sustainable forest management derives from the concept of sustainable development. This concept has become very popular term in all economic aspects in our modern life. The most acceptable definition of “*sustainable development*” is that of the Brundtland Commission (World Commission on Environment and Development, 1987) in the “*Our Common Future*” report. The term sustainable development was defined as:

“The development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.

Since the 1992 UNCED meeting in Rio, the concept of sustainability was adopted by the participant countries and became a principle of the future global economic development. In Europe, the consolidated version of the Treaty establishing the European Community, which was signed in Amsterdam in 1997 states, “*one of the European Union’s task is to promote balance and sustainable development of economic activities*” and “*a high level of protection of the quality of the Environment*”.

The above commitment that all the countries have to follow shows how vital is the protection of the natural resources. The concept of sustainable forestry was the outcome of the above agreements; sustainable forestry means today to ensure a reliable yield of timber and a multiple use of forests while preserving biodiversity and soil productivity.

To begin with the explanation of what is sustainable forest management is essential for a better understanding of the upcoming analysis. As we set the objectives in the beginning, the idea was to demonstrate that the so far implemented policies need reformation in order to meet the new demands of our society from forestry sector. As we already mentioned, fire phenomenon is a complex issue, which involves different dimensions and it has to be examined in close connection with present environmental, social and economic realities.

After the Second Ministerial Conference on the Protection of Forests in Europe, which was held in Helsinki in 1993, all the member-states have committed themselves to develop measures and criteria for sustainable forest management in their own country (Ministry of Agriculture, 2000). Among the general guidelines for the sustainable management of forests (Resolution H1 of the conference, 1993) that countries agreed to take into consideration, is the following:

“Forest management should provide, to the extent that it is economically and environmentally sound to do so, optimal combinations of goods and services to nations and to local populations. Multiple-use forestry should be promoted to achieve an appropriate balance between various needs of society”.

It is therefore essential for every country to revise its own environmental policy taking into account the multiple-use of forestry and the modern needs of local societies. Sustainable forestry calls for modern management with an equal handling of goods production, services and environmental consideration. Nordic countries had proposed a set of criteria for sustainable forestry, which are divided into economic, ecological and socio-cultural ones (table 7).

Based on the same commitments, the Greek General Secretariat of forests and natural environment, introduced in 2000 six criteria for the sustainable forest management in Greece. These criteria will be used as tools to assess the progress that has to be done towards sustainability in forest resources.

Criterion 1	Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles
Criterion 2	Maintenance of forest ecosystem health and vitality
Criterion 3	Maintenance and encouragement of productive functions of forests
Criterion 4	Maintenance, conservation and appropriate enhancement of biological diversity
Criterion 5	Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)
Criterion 6	Maintenance of other socio-economic functions and conditions

Table 6. Proposed criteria for sustainable forestry in Greece (Ministry of Agriculture, 2000)

ECONOMIC CRITERIA		
Economic development must be considered when drawing up the ecological and socio-cultural standard below.	Forest should be managed to enhance the value created for owners and the community. The total undertakings in the form of the below mentioned ecological basic requirements and targets and the socio-economic rules which the forest owner is expected to follow must not reduce the timber production of the certified unit or burden its finances more than is acceptable for long-term use.	To be drawn up at national level, may vary geographically and according to the size of the certified unit.
ECOLOGICAL CRITERIA		
Basic requirements are compulsory and must be complied with immediately.	<ul style="list-style-type: none"> - Protection of special management of areas of particular biological value: <ul style="list-style-type: none"> = Key biotopes = Wet forest land of high natural value = Zones adjacent to water and watercourses = Stands resembling virgin forest with high natural values and undisturbed biological continuity = Small open cultivated areas = Natural pasture and hay meadows - Appropriate use of: <ul style="list-style-type: none"> = Chemical pesticides = Radical scarification = Ditching = Fertilization = Exotic tree species 	To be drawn up at national level, may vary between different bio geographical zones/types of vegetations and according to the size of the certified unit.
Targets can be estimated or measured and should be attained gradually. Progress should be monitored within five years.	<ul style="list-style-type: none"> - Minimum number of old trees (eternity trees) - Minimum proportion/quantity of deciduous species Minimum quantity of dead wood - When necessary, burned wood 	To be drawn up at national level, may vary between different bio geographical zones/types of vegetation and according to the size of the certified unit.
To be drawn up at national level, may vary between different bio geographical zones/types of vegetation and according to the size of the certified unit.	<ul style="list-style-type: none"> - Conservation document for certifying unit. - Knowledge of conservation on the part of the owner or expert authority engaged by the owner. - Effective and non-damaging technical equipment and operation of this. 	Extent and documentation may vary with the size of the certified unit.
SOCIOCULTURAL CRITERIA		
Socio-cultural rules. National standards are defined and indicators stated.	<ul style="list-style-type: none"> - Cultural heritage document for certifying unit. - Agreements, international conventions and good labour market practice should apply. - Good access for recreational and outdoor life. 	Extent and documentation may vary with the size of the certified unit.

Table 7. Proposed criteria for sustainable forestry in the Nordic countries (Nordic Forestry Report, 1997)

Studying both the proposed set of criteria, it is obvious that apart from the primary ecological criteria, socio-economic objectives are prerequisites for future sustainability in forest management. It is clear that the key word is the preservation of natural resources without keeping down the development. It is essential to investigate possible solutions that will reduce the future fire hazard, which is human induced and is related with people's efforts for economic prosperity. No serious conservation efforts will succeed without properly taking into account all the previous mentioned factors that interact with fires and especially socio-economic ones. However, Greece efforts during the last decade were concentrated in improving its economic growth in order to meet the criteria for the Monetary Union. Country's environmental program is based on the sustainability principle but it was not top priority issue, since the same time the desire was to preserve country's developing efforts in agriculture, industry and tourism (Kousis et al, 2001).

In conclusion, a comprehensive policy strategy that aims to promote a more efficient and sustainable management is needed, in order to prevent forest degradation and at the same time fulfil the needs for economic prosperity.

6.3 Present land management -The holistic approach

The apparently exponential growth of human demands on natural resources will go on so it is inevitable that Mediterranean landscape will be managed intensively. This fact creates conflict between different economic interests.

The proprietary rights of the Greek forests belong to the state at about 65.5 percent of the total. The private owners hold 8% and the Church, municipalities and other organizations own 26.5% (source: Greek Ministry of Agriculture). Nevertheless, the performance of Greek forests as far as the timber production is small but productive, hydrological, aesthetic, hygienic and environmental functions are very important for the country's economy and the inhabitant's quality of life.

Thus, future economic development in Greece will be based on service sector and in particular to tourism. However, as we already have mentioned, environmental degradation due to forest fires is already harmful for tourism. Land management is the big challenge for the Greek State citizens. The idea to set off management priorities in every area will be complicated since ecology and politics should work together in the more sustainable way. According to Davis (1998), there are four stages that have common characteristics as far as the management concerns, each motivated different that has to put in order. These are:

- Conservation of resources
- Ecological services to human communities
- Productivity of systems
- Physical space for development of infrastructure for society

In other words, in every stage of concern, clear objectives should be put forward in order to satisfy local communities' needs and conservation demands as well.

6.3.1 The main obstacle-Conflicts

Humans' demands for land use are increasing and changing through the years and most of the times, these demands creating conflicts. Different were the conflicts decades ago when silvopastoral uses of forestland were popular. The economic transition brought up different

demands for land use, which sometimes are not compatible with the current land status. As a result new conflicts arose and fire regimes are more frequent and more destructive.

Conflicts for agriculture purposes and grazing tending to disappear in the Mediterranean region (Velez, 1992) when conflicts against the declaration of protected areas, the urbanization of rural areas and the expansion of recreational areas are going to be issues of great importance. Even though existent preventive and prohibit legislation covers all kinds of conflicts what is missing is the spatial planning policy. The major drawback of Greece proper land management is the absence of a Cadastral survey. The lack of land register under a systematic and unified land data-base is the cause for conflicts on land proprietary rights which many wanted to secure through practices like forest fire, illegal building etc. The construction of National Cadastre project that started in 1996 and will last for almost 15 years is supposed to solve all kinds of ownership's problems and furthermore problems dealing with:

- Setting definite boundaries between public and private property
- Protection and development of natural environment and resources
- Elimination of the forest fire hazard due to purposely alteration of land use
- Support regional and land use planning
- Assist the policy for sustainable development

(Greek National Committee for Combating Desertification, 2000)

However, the so far progress of the project is disappointing due to mismanagement of the Europeans funds and the lack of sufficient mechanisms that will overcome the Greek bureaucracy. There is at the present a debate between European Union and the Greek State about the overvaluation of the project and the cost that will increase enormously.

An important step towards this policy has been made in Greece with the new Law for "Spatial planning and sustainable development" that was approved in 1999. This law, sets specific goals, concerning conflicting issues in land use management. Such conflicts refer mainly to the urbanization trends of the coastal zones, for tourist activities and residential areas for second homes. The main objectives for the planning strategies were:

- The land use management of coastal zones
- The protection of natural resources, landscapes and sites
- The preservation of cultural heritage and the renewing of the urban network

In addition, according to the Ministry of Environment (2001), the conservation of the landscape and forests as well as the environmental particularities of the mountainous areas of Greece constitutes one of the main priorities of the Greek spatial planning policy.

6.3.2 Possible measures susceptible of achieving ecological, economic and social sustainability

Sustainable development goes far beyond the logic of fire suppression with any economic cost and requires a continuous effort towards the limitation of fire hazard. A programme of aggressive suppression can substitute only in select site; even here fire fighting does not put out fires so much as it puts them off.

What is required is a kind of land management that replicates, in suitably new forms, traditional practices of husbandry and the harvesting of wild land products, that provides an alternative to a social economy far beyond of what is happening today. Measure to induce

people to remain in the rural and mountain areas by promoting alternative employment opportunities are desirable.

What Greece needs, is to rebuild its landscape out of traditional materials but according to new plans. Intensive and sustainable management practices are important to develop and that they to be underlain by a thorough understanding of ecosystem function.

With a seven percent of GDP and ten percent of the total employment, tourism is the leading industry in the Greek economy and therefore one of the main fields of interest of the national policy. However, mass tourism over the last years didn't have only beneficial results to Greek economy. Unplanned and uncontrolled tourism development has decreased the quality of offered services and in some areas in Greece a decline in the number of tourists has been noticed (Karameris, 2001). Furthermore, after the fire episodes forest landscape quality has been harmed and consequently its economic and aesthetic value as recreational area has diminished. Tourists avoid visiting areas with environmental problems or after destructive fires incidents (the case of Samos island).

In order to alter this situation, the state has also introduced the concept of sustainable development in tourism. The proposal for alternative ways of tourism development where the accomplishment of all the economic, social and recreational needs will respect the environment and will preserve natural and cultural resources was put in the agenda.

Cause for land degradation is the grazing management and wildfires. The destruction of the above ground vegetation is, however, not the major reason for landscape declination but the overgrazing activities applied after them.

Mediterranean vegetation and landscape have been in an extreme environment with dry climate and overgrazing and they have developed mechanisms to endure or to moderate damage from livestock (Papanastasis, 1998). The grazing however, must be reasonable and adopted in the special conditions of each ecosystem and landscape.

The thorough analysis of the wildfire phenomenon proved that only methods reducing the biomass or fire suppression are not enough and thus, more comprehensive handling of the problem is needed. A combined approach to deal with fire problem is needed. The implementation of sustainable methods of land management is on the right way but still lacks of effectiveness. As we seeing in the CLD, human intervention is actually present in all parts of the system. This implies that more humans' participation is essential for better results in wildfire control.

The Greek state proposed plans for spatial planning, and the cadastral survey has brought good results so far. Nevertheless, from the small survey that we conducted in the island of Samos, came to front, that the people from the travel agencies are not well informed about the concept of sustainable development and how this implies to tourism. They are aware about different forms of tourism like eco-tourism but they doubt that this change will benefit their investments in tourism.

Demand for alternative policies with the participation of local communities in planning and managing appears to be essential at present. It is common belief that humans today consider environmental resources like consumer goods just to fulfil their present recreational demands. Employments and the majority of tourists have not developed an environmental attitude of responsibility towards the area in which they are working or visiting, respectively (Goldammer, 1992).

6.4 The integration of environmental concerns policies in mountain and coastal agriculture economy

Demands for recreational opportunities and expansion of urban areas will be more persistent in the coming future and suppression or banning measures are not going to improve the problem. The upcoming challenge will be to link the development to environment in a manner which to support the implementation of sustainable policies without threatening natural resources and social bonds of local societies.

There is an ongoing movement of proposals to promote agriculture as a dynamic factor for sustainable development and land management. The so far unbalanced tourist development and over-exploitation of resources in most of the islands, coastal areas and some of the mountainous areas where the antagonism between tourism and primary sector (agriculture, animal husbandry) has favoured the first one have to be avoided.

Motives to induce local population to remain in their land and engaged with business such as the development of eco-tourism and mountain tourism are welcomed. There are number of successful cases where rural exodus of people was controlled, and at the same time a remarkable boom in local economy was observed.

6.4.1 The example of mountainous region of Evritania, Greece.

Evritania is a mountainous region Central Greece and like the most rural areas in the Mediterranean part of Europe, are facing rural exodus and migration to big cities of Greece. The abandonment of agriculture and forest related activities are reality. However, the area during the last decade experienced a boom in tourism development because of the unique and untouched natural ecosystems. Now it is considered to be one of the most famous places for mountain tourism (Greek National Tourism Organization). Regional development agency has promoted a bunch of development policies under the framework of European Union programmes such as the Integrated Development Programmes, Leader and others for rural development (Katsaros, 2000). The majority of the funds were used to improve tourism infrastructure. Together with the increase in tourism activity, the demand for local agricultural products was also gone up.

This trend motivated many families and young people to become farmers in order to produce local products like milk and meat for tourist demands. It was actually very encouraging that recreation activities affected positively the primary sector of the local economy.

In other words, small-scale tourism that respects nature is completely compatible with farming that provides the visitors with local products. Katsaros (2000), is using the term “*tourism extensive livestock system*” to define that sustainable development is practicable in parallel for various economic activities that will meet humans needs.

The Evritania case is an ideal example of how integrated rural development can be successfully implemented. Same paradigms can also be found in coastal places where mass tourism hasn't caused completely abandonment of the primary economic sector. In these areas fire events related to land use conflicts are absent since there is a balance in human interest on land.

7.0 RESULTS AND DISCUSSION

After the comprehensive analysis of the wildfire phenomenon it is evident that the integrated type of rural development is the alternative proposal to mitigate the forest fires effects. The current study suggests sustainable rural development as the main solution towards the limitation of natural environment degradation. Changes or justified uses of land are only those that secure long-term sustainability and don't jeopardize productivity and social prosperity.

The promotion of integrated developing policies, taking into account the multifunctional nature of agriculture, environmental constraints and social needs is a key factor of controlling conflicts over land use in every region. Greece faced a forced transition from agriculture to service economy without having the appropriate planning policies. The common background for both the economic sectors was Greece's "natural and cultural heritage" used however in different ways. Today's intensive economic development is a threat to the viability of the ecosystems but synchronously to social stability. Forest fires are phenomena of social discrimination as far as the economic prosperity of local population concerns. Therefore, the future policies should be based on the fire and land management.

Regarding fire management policy has to include both prevention and suppression measures in a balanced way in order to secure forest viability. Policy that promotes only suppression activities is not on the right direction creating economic loss. The annual budget for suppression expenditures has reached to enormous amount of money without a consequent reduction of forest loss (see table 4, p.15) In the field of suppression the policy should focus on limiting the increasing cost of fire fighting, and to a better coordination of the involving partners of the suppression mechanism (Fire Brigade, General Secretary of Civil Protection and Forest service) (Xanthopoulos, 1999).

In the field of prevention special attention should be paid to fire behaviour models and to the sociological analysis of fire causes (Dimitrakopoulos, 1998). The analysis of causes in every region should identify the present and future trends regarding land use and possible conflicts dealing economic interests.

System analysis methods including CLDs would be a very useful instrument in order to explain the interconnections among different actors, factors and events in a local or regional scale. According to Haraldsson (2000), a systematic approach of the phenomenon would be the initiative to understand the mutual influence from each factor to another. Then, having in mind how the system works, the interest would be concentrated on the introduction of new policies dealing with rural land management.

Over the last years, European Union policies measures and development projects were effectively implemented and applied at national and regional level with positive results (Evritania case). The various projects have promoted rural development by mobilising the indigenous people to remain at their patrimonial land and develop economic activities compatible to the concept of the sustainable development. Eco-tourism or agro tourism was the first, quite successful step, towards this direction. However, to help ensure the balance of the system "human-nature" extra policies are needed. A study that came out from the "Euromontana Organization", assessing the impacts of the E.U. measures on "the integration of environmental concerns in mountain agriculture" suggests the below additional proposals:

1. Environmental awareness and information. Special emphasis is being given to inform people that preserving and mitigating fire effects is a "common responsibility". The loss of valuable landscape and forested area will disorder firstly local communities. In

addition, as the survey in the island of Samos showed, there is a lack of information about what is sustainable development and how the reconstruction of local economy will satisfy social prosperity and environmental protection.

2. Encouragement of organic farming since the market demand for organic products is growing fast. Moreover, tourists are looking for places to spend their vacations where they can find organic products (Samos case).
3. Strengthening agro-environmental measures by increasing subsidiary funds to farmers. European Union should subsidize any actions with an environmental purpose, which have additional cost (e.g. cost for purchasing the suitable equipment, compensation for lost income related to additional work, cost for new implemented methods of agriculture etc.).
4. Measures for forest related business such as resin collection from pine forests, cultivation of medical herbs and mushrooms, establishment of wooden handicraft workshop etc. Promoting sustainable tourism practices in order to keep the number of tourists under the limit of the carrying capacity that each area can resist. Furthermore, to enhance alternative forms of tourism (mountain, ecological, rural tourism, trekking activities etc.). Giving incentives in tourism business to invest in environmental friendly projects.

7.1. Re-design the Causal Loop Diagram

In dealing with sustainable development issues, the systems approach can offer a more useful perspective than the analytical approach, since sustainable development clearly implies the need for integration across environmental, economic and social dimensions. Therefore the problem can now be presented in the CLD together with the proposed measures and policies. The implementation of policies encouraging sustainable forms of tourism and land management will reduce the conflicts on land for uncontrolled urban sprawl and tourism facilities. Consequently, the trend for human induced fire causes will be reversed.

On the other hand, organic farming will be a motive for young farmers to stay at rural areas, since the demand for organic products is increasing with positive expectations to be very profitable. Farming together with sustainable forestry methods are the only ways to reduce biomass accumulation that is responsible for severe fire events.

Similarly to the above, environmental awareness and educational policy will make people change their attitudes and think about how to benefit from nature without threatening future viability.

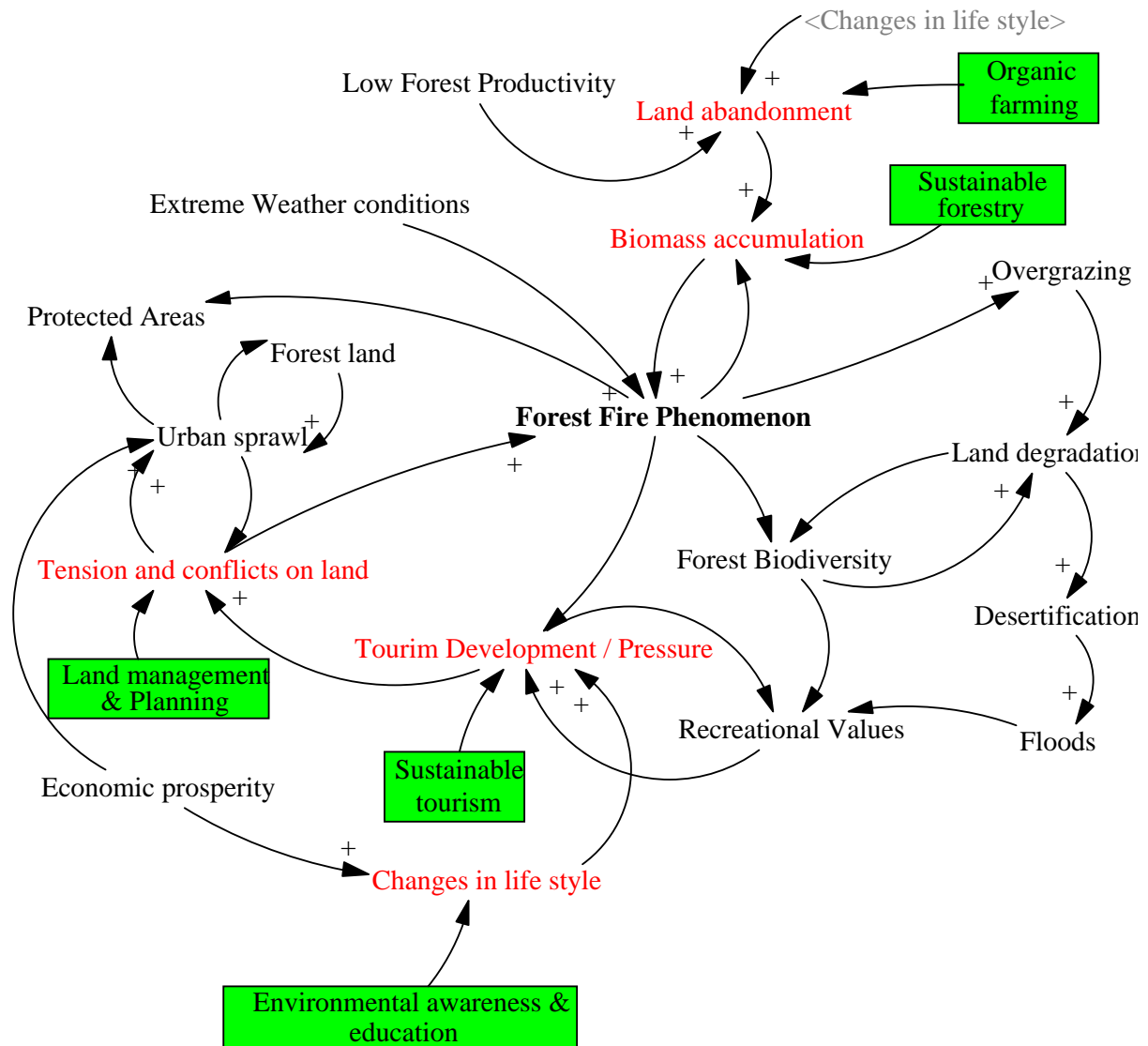


Figure 12. The CLD with the proposed measures and policies (where there is no (+) symbol a (-) symbol is meant)

8. CONCLUSIONS

The most important conclusions that can be reached from the thorough analysis are the following:

1. Forest fires is still increasing in number and burned area in Greece with huge economic and social loss
2. Forest fires is more than a natural phenomenon; is also a socio-economic one reflecting the modern way of life
3. Arising conflicts on land use and the increasing pressure for tourism development are responsible for the escalation of fire events

4. Fire suppression policies failed to control the problem. The cost of fire suppression is still increasing

Moreover, we related the concept of sustainable development as a more comprehensive and holistic approach of the problem. The upshots were:

1. Land management is the proposed policy in order to reduce tensions and conflicts on land use. Legal procedures should target land ownership issues and land use properties on a basis of environmental and socio-economic criteria
2. Integrated developing policies with special attention in subsidizing rural, environmental friendly, activities.
3. Promotion of alternative forms of tourism (combination of tourism and forest) in opposition to mass tourism. Implementation of sustainable tourism practices

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