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Euro-Mediterranean Wildland Fire Laboratory, a "wall-less" Laboratory for Wildland Fire Sciences and Technologies in the Euro-Mediterranean Region

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The Interest of Socio-Economical Sciences in Wildland Fires: a State of the Art

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SUMMARY

Damage to forests caused by forest fires is a common phenomenon during dry periods in Mediterranean countries. This continual harshness brings about serious damage to the forests economy, to the social functions of the woodland, to the maintenance of natural ecosystems and, frequently endangers human life.

This situation which has become so evident over the past decades has prompted research work aiming , on one side, at the creation of models or risk functions to **predict** the outbreak of a forest fire. On the other side, it tries to **explain** the impact or effect of different factors associated with this phenomenon.

The first aim (prediction) has been approached by way of three lines of research:

i) A prediction based on the historic tendency of forest fires in a specific geographical area. This model offers a historical risk level which only changes in the medium term. This is the usual process used for the distribution of fire fighting resources.

ii) A prediction based on danger indexes measuring the harshness of the climate in connection with types of vegetation and topography. This model offers a dynamic risk level, which changes in the short term. It is used to assess the degree of alert for fire extinction crews.

iii) There is a third line of research which-due in a good measure to a lack of interdisciplinary work-has been yet very little explored, and consequently it suffers of a shortage of historical data: This model offers a prediction based on socio-economic factors. When combined with the two previous models, this new approach is able to offer a more accurate prediction.

The second aim (explanation) can be reached from two different perspectives:

j) Causal Attribution Model

This traditional model assumes the most probable cause (of each fire) according to the fire report carried out by the Forest Service. This model is sometimes completed with information provided from survey data. A weakness of this model is the bias derived from the fact that persons responsible for fire prevention and fire fighting are the same who attribute the cause to each fire.

jj) Risk Factors Model

This model substitutes the "attributed cause" for the "objective risk situation". It is presumed that the ignition process and fire development arise from a matrix that combines physical and socio-economic factors; the interaction of these factors determines the level, the potential damage and the type of risk. The two main kinds of factors can be described as follows:

Physical factors (Climatic, biological and topographic) are natural conditions independent of human action, which characterise the fire typology in the region. Research in this area is quiet considerable.

Socio-economic factors (Economic, demographic, social, cultural and organisational) define the human environment that can affect the outbreak of a fire. The measurement of the impact of these factors allows the Administration to plan preventive actions aimed at solving social conflicts (and changing human actions) that increase fire risk. Research in this area is very scarce, but promising, according to the surprising contributions that can already be observed. Socio-economic logic is used to reduce the impact of these factors reasoning that cause arsons or intentional fires.

GLOSSARY

None

LIST OF ASSOCIATED DOCUMENTS

None

1 INTRODUCTION

Forest fires historical evolution in Mediterranean countries shows relevant changes in fire behaviour, according to the socio-economic characteristics of each society, whose impact is more or less favoured by climatic conditions over time.

A common trend shared by all of these southern European regions is a generally high increase in the number of FF.

The need to understand this severe phenomenon forced social scientists to design explanatory models, able to precisely define risk factors as well as specify their interactions, in order to explain FF incidence and the forest surface area affected.

This appears to help with the predicting and preventing of catastrophe.

These models must go beyond the traditional approach of identifying "the most probable attributed cause" that attributes most FF to arsons and offenders, by a socio-economic risk approach based on an objective risk situation.

In this sense appropriate analytical categories have been established and risk factors identified.

This approach is hardly present in forest fires research and in the users' strategies.

This task gives the basic information about advances made in the field (theoretical insights, methodologies, relevant socio-economic factors).

References included were selected because of their contribution either to the historical development or to the understanding of the models.

This task was divided in four complementary sections:

- a) extended summaries (of the most significant publications, works developed by users or potential users -Public Forest Administrations-, and European projects);
- b) research and publications developed specifically;
- c) other interesting reviews, and
- d) general references. The review helped to describe and classify the socio-economic factors and indicators used in the different works.

One of the crucial dimensions of any quantitative model is to have access to available and reliable data.

This has shown to be is the biggest difficulty to make operational the socio-economic models, because there is a scarcity of regular and standardised information sources.

To get suitable data, usually it is necessary a lot of work, because most of them need to be cleaned and transformed from different media.

The main task is to integrate all the analysed variables into a socio-economic causal model.

These factors are:

Forestry profitability (it measures the forest accumulated value and present productivity);

Demographic pressure (it describes population distribution and density, measuring population evolution and demographic pressure over time);

Social tension (it estimates the level of social conflict, particularly the existence of conflicting forest land uses and the fussy urban demands);

Forestry culture (it determines the degree of dissonance between the social dominant values and norms versus the discourse regarding the overall requirements for the sustainability of the forest.

Within this factor, an important lack of objective and standardised information has been detected as well as the sometimes conflicting new social demands with the landowners expectations);

Organisational logic (this factor measures the forest fighting effectiveness and efficiency, both of the forest fighting administration and forest management models).

Each variable has to be determined by different indicators, in such a way that comparisons between variables can be established even in the case that primary data sources may be relatively different.

Annual or periodic characteristics of forest fires (FF) taking place in past years in European areas, which have a dry season, bear a close relationship with peculiarities of the climate over the same periods of time.

Within the same region and year, fire characteristics from one geographical area to another change largely in terms of physical conditions of the territory and in the terms of physical characteristics of forest formations.

However, the variation of some characteristic parameters of regional fires from one year to another is only partially explained by factors or components of climatic harshness.

The variation of some characteristic parameters of the local fires from one territory to another in the same region is also partially explained by physical factors or components of the corresponding territory, including the typology of forest vegetation.

This situation has lead to the preparation of survey-based researches that attempt to measure factors of social, economic, political, organisational, and intentional causes.

In addition, in order to predict fire occurrence, or its most probable characteristics, and to prepare plans of preventive action, a system of socio-economic analysis is being prepared.

Preventive planning of FF requires the elaboration of a fire-forecast system in terms of socio-economic and cultural risk in order to join its designs and approaches to the specifications of the socio-economic risk models.

To accomplish this goal, a study of the state of the art has to be done:

- Making a review of the available bibliography regarding socio-economic risk factors of fire.
- Assessing on the methodology of projects related to the prediction of fires and using factors of socio-economic character.

As a primary issue, this document makes a critical review of existing documentation related to this topic so as to incorporate conclusions arrived at from our design.

2 REVIEWED BIBLIOGRAPHY. SUMMARY

2.1 MAIN PUBLICATIONS ON THE TOPIC

2.1.1 VÉLEZ, R. *Incendios forestales y su relación con el medio rural*. Revista de Estudios Agrosociales. Number 136. July-September 1986.

2.1.1.1 Introduction

The essay begins with a review of the general problems created by FF at a global level as a consequence of their progressive growth in intensity.

Furthermore, this essay will examine the problems of FF in the Mediterranean environment.

The presence of FF has always been decisive in shaping the countryside and the vegetation in the communities of the Mediterranean countries whether it was by natural fires provoked by sun beams or by the use of fire as a traditional tool in agriculture or ranching.

In recent years the form of human presence in forest areas is reaching a very elevated degree of complexity and because of this the causes associated with the risk of fire have developed and diversified.

It is said that the periods of necessary fire use are shortening and that in most Mediterranean zones the damage produced by erosion is beginning to create irreversible consequences.

As far as the actions of administrations to resolve this problem, what persists are poor results from repressive policies that absolutely prohibit the use of fire.

A considerable decrease of damages is recognized with the increase of combative resources, yet a reduction in the number of fires or in the intention is still not observed with the increase of preventative measures.

2.1.1.2 Causes of the fires

In the first place, a traditional classification of the causes has been determined and the results are quantified for the period 1979-1983.

The causes of fire are classified in:
- Natural occurrences.
- Negligence.
- Deliberate.
- Unknown.

In the countries of the Mediterranean area the following average percentages are presented as:
- Natural occurrences: 1%
- Negligence: 21%
- Deliberate: 31%
- Unknown: 47%

What is observed here is a high percentage of fires of which the cause is not determined and also an overall notable increase of deliberate fires in the Mediterranean countries.

The second part is intended to pinpoint the existing motivations in a much wider period of time from public opinion studies among forestry officials.

The motivation of FF are classified in:
- Fires benefiting its author (deduced from the nature of the burnt area):
  - a) . creation of pastures
  - b) . elimination of agricultural waste
  - c) . to save cultural operations in the forest
  - d) . interest in timber
  - e) . aspects related to hunting
  - f) . to force termination of contract
  - g) . to change rural land into building land (including deforestation next to isolated, new or old buildings and houses)
  - h) . to force the creation of jobs in the forest
- Fires without material benefit for its author:
  - i) . resentment towards administration
  - j) . resentment because of pillaging of forest lands
  - k) . destruction of species considered damaging
  - l) . family, local quarrels
  - m) . conflicts because of the creation of preservation areas
  - n) . revenge for sanctions considered to be unfair
  - o) . acts of vandalism
  - p) . arson
- Fires provoked by a political motive:
  - q) . electoral periods
  - r) . terrorism
  - s) . concrete political disputes
  - t) . subversion of the political system or governor discredit
- Fires provoked by socio-economic reasons:
  - u) . main factors considered:
    - proportion of forest area within the unit of analysis (municipality) in relation with the area studied (region)
    - proportion of forest surface publically or privately owned
    - population density
    - agrarian population
    - relative per capita income (regional)
    - relative wood production (regional)
    - usage of fire as an agricultural resource
    - risk level (relative to the area studied)
    - proportion of fires started intentionally

2.1.1.3 Motivations of deliberate fires in galicia

The case of Galicia is treated in full detail for being the most damaged region inside Spanish territory.

Galicia is a zone with a high proportion of forest area inside the Mediterranean seamark.

Emphasized is the abundant area of private property and the predominance of rapid growth species.

Galicia has a high percentage of active population in the agrarian sector which live dispersed in a vast number of population entities.

This region occupies 5.8% of the national territory and in this surface alone occur 50% of the fires in Spain, of which a minimum of 70% are known to be deliberate.

The use of fire for the preparation of agricultural terrain and the regeneration of pastures is habitual throughout the whole region.

The study of the occurence of fires in Galicia reflects a complex combination of factors that have changed over the course of time.

The following are highlighted as the most important:

- The existence of conflicting uses of the soil, principally: forest repopulation/extensive ranching.
- Changes of entitlement of the local woodland.
- Compulsory imposition of re-forestation on the part of administrations.
- Increase in the area of thicket with the drift from the land or the decrease of the population of trees designated to the agrarian sector.
- Conflicts of property.
- Interests of the timber merchant in lowering the price of wood.
- Social change and complexity.
- Diversity of motivations.

2.1.1.4 Motivations of deliberate fires in other locations

2.1.1.4.1 Asturias and Santander

Like Galicia, the employment of fire for the preparation of agricultural terrain and the regeneration of pastures is habitual in every region.

The conflicts are similar to those in Galicia: changes of entitlement of woodlands, restriction of areas dedicated to grazing, damages caused by hunting species, etc.

2.1.1.4.2 Other regions of Spain where intentionality is clearly dominant

This deals with isolated regions where a clear intentionality of FF exists, in contrast with the rest of the region.

- In the Valley of Tiétar (Avila) fires due to the burning done by the ranchers are predominate.
- In Las Hurdes (Cáceres), a region that has been forested within the last fifty years, no specific motive has been discovered.
- In Sierra Morena (Jaén) the fires seem to be related to hunting: damages from wild boar and deer on the land areas, poachers or legal limitations.
- In La Almijara (Granada) they are, for the most part, due to the creation of pasture for livestock.
- In Creus (Gerona) fires occur in the form of burning for the regeneration of pasture also predominates.

2.1.1.4.3 Zones in which deliberate fires do not exist

In Spain there are vast mountainous regions that occupy part of the provinces of Soria, Teruel, Cuenca and Guadalajara, which all have similar characteristics to those previously mentioned but where deliberate fires hardly exist.

These are regions of public property with little population and an extensive presence of ranching, yet with a conditional dependence on timber production.

2.1.1.4.4 Other examples of non-European countries

In the United States the number of intentional fires oscillates between 25% and 30% overall.

However, in the zones with a relatively low economic level, like the Appalachian Mountains, the numbers rise to 64% of intentional fires.

The reasons are attributed to: forms of protest against the government, elimination of brushwood, eradication of parasites and expulsion of pests, as well as other motives.

It is observed that the traditional use of fire in ranching is deep-rooted, despite the chang towards a preponderantly timber economy.

In Central America the fires are almost entirely intentional.

The dominant factor is the practice of a traditional agricultural technique that consists of cutting of a plot of forest, burning of the trunks and branches, then spreading about the ashes and finally the cultivation of this plot for three or four years or until exhaustion of the soil.

2.1.1.5 Conclusions of the study

The analysis of the most relevant socio-economic factors of the chosen areas of study allows to obtain conclusions of great interest for the design of a socio-economic risk model.

These conclusions can be summed up by the following points:

- The fires have an anthropogenic origin in almost every case.
- The greater demographic concentration, the higher the number of fires.
- The more predominant is an agrarian economy, the higher the number of fires.
- The cultural component has a large influence (contrast Galicia/Soria).
- The more dependence on forest activity and the more labour occupation that exists in this sector for the inhabitants of the region, the number of provoked fires will be less.
- Deliberate fires have a correlation with the level of income, yet the behaviour differs from one zone to another, perhaps because of the interaction with other factors, given the slightly homogeneous geographic units. However, it is observed that the lower the level of income, the higher will be the number of provoked fires.
- The less traditional is the use of fire by the labour force in the countryside or on a ranch, the less will be the intentionality of fires.

2.1.1.6 Deductions for a fire policy

The high level of incidence of FF in recent times is contributing very seriously to the environmental deterioration in extensive zones of the Mediterranean countries and in many other regions around the world.

These circumstances should compel the administrations of these countries to adopt a preventative policy directed at resolving the socio-economic conflicts that generate the risk of fire.

The basic lines of action to achieve this end could be:

- The application of a progressive policy that clearly typifies the offence of deliberate fires and sanctions proportionally to the damage caused.
- To favour the reconciliation of interests through a correct application of policies and techniques that reduce the problem to a simple delinquency in its extremes.
- To promote forest production in areas of low productivity.
- It seems necessary to set into motion actions of diversification and the function of local resources: complimentary diversification and sustained occupation of the work force.
- To achieve non-contradictory policies by public administrations. This is a crucial point.
- Protection of property interests and increased support to its management.
- Prohibition and prosecution of fraudulent misuse of the woodland such as extensive ranching in wooded areas.
- Fire management fitted to agrarian necessities: burning of stubble, regeneration of pasture and operations of forest culture.
- To avoid the emergence of economies of subsistence surrounding FF.

2.1.2 VÉLEZ, R. *Los incendios forestales y la política forestal*. Revista de Estudios Agrosociales. Number 158. October-December 1991.

2.1.2.1 Characterisation of forest fires in the mediterranean

The characterisation of FF in the countries of the Mediterranean region is not exclusively a function of the climatic conditions of the different regions, already observed of this phenomenon is the consequence of socio-economic conditions of the populations neighbouring the woodland.

By comparing the characterisation of fires during the 1980's in the Mediterranean countries of the European Community the following results are found:

- The annual frequency of FF per each square 100 km2 of forest surface is very high in Portugal (23), high in Italy (14) and in France (13), and average in Spain (3) and Greece (2).
- The annual percentage of burned forest surface turns out being very high in Portugal (2.4), high in Italy (1.9) and in France (1.2), and average in Spain (0.9) and in Greece (0.9).
- The average size of fires in hectares tends to invert the resultant order in the previous cases: very high in Greece (44), high in Spain (32), average to high in Portugal (15) and average to low in Italy (11) and in France (10).

2.1.2.2 Analysis of the socio-economic factors that influence the evolution of forest fires

The actual situation in the European Mediterranean countries is characterised by an abrupt change of the socio-economic rural setting: depopulation of rural areas, abandonment of traditional uses of the rural environment, decline of the economic function and labour in the woodland, the conversion of the traditional uses into marginal uses, increase of recreation, the woodland urban interface and other factors of socio-economic nature that result in an important variation tested in the typography of FF.

This phenomenon results in a change in the concrete actions that determine the appearance and seriousness of the FF.

Three types of conflicts are distinguished in which the socio-economic variables of major influence are mentioned.

- Conflicts in the rural interface

a) . Employment of fire as a cultural instrument to convert forest areas into agricultural areas. There exists a clear tendency towards the disappearance for the lack of present demand.

b) . Abandonment of agricultural land and the formation of thicket as a consequence of rural emigration and community policy against surplus. This conflict tends to become aggravated despite the economic incentives of the administrations for the proprietor to reduce thicket accumulation.

c) . The employment of fire for grazing purposes to maintain the herbaceous vegetation and eliminate wood. The evolution of this variable presents a dual behaviour: on one side traditional grazing is reduced in woodland, on the other side opposes a new type of grazing with proprietors of foreign livestock, a situation of major dispute and illegality.

d) . Systematic burning for the agricultural purpose of the preparation of the terrain for new sowing and the elimination of residue or thicket that hinders exploitation. This traditional conflict is valid, but policies exist that can deal with effectiveness of this type of agricultural preparation.

e) . Declaration of protected spaces with restrictions on agrarian activity which object to conflict customs and traditional uses of the area. It is concluded that this effect will have to spread.

f) . The expansion of forest cultivation in large continuous mass quantities without being subject to a correct preventative forest culture. This circumstance is in growth and should be managed with the application of known techniques and the spreading of the forest culture.

g) Conflicts in the urban interface
h) . The transformation of the forest areas to urban use is not permitted. However in the judgement of the public opinion there seems to exist a relationship between the expansion of construction areas and the appearance of FF; although, according to the author, a clear demonstration does not exist.
i) . The expansion of recreation uses such as hiking and hunting in forest areas. Their importance has increased with the passage of time yet they can be controlled by means such as education and methods of deference.
j) . The trash dumps maintained by fire are habitual in the rural environment and especially now that industrial and domestic waste is on the rise. This conflict in precise growth calls for more attention from the local authorities, who are really responsible for this problem.
k) Conflicts not directly related to the use of the land
l) . Vengeance. The vulnerability of the woodland permits the utilisation of fire as a common form of revenge against an individual or against the whole of society. It is constant but in the function of other factors it is manifested with more or less intensity.
m) . Delinquency. In this case the fire is used to conceal a crime or as an aid in realising one. This also is constant, but conditioned to other factors.

2.1.2.3 The defense policies against forest fires

The defence against FF is developed in the world along the criteria of two schools, the North American school and the Mediterranean school.

The first, known as "Fire Management", is based on admitting the existence of fire in determined areas as an element of nature, when it is originated by sun rays.

The objective of this policy would be to maintain the burned surfaces below an admissible limit for ecological conditions and the economy of the woodland.

The second, known as "Defence against Forest Fires", preaches the extinction of all fires, marking as an objective the reduction of burned surface to the possible minimum.

Before this last position, two strategies have been developed for the protection against fires:

1. Those that recognise the inevitability of fires, given the climatic and demographic characteristics of the Mediterranean.

2. Those that recognise that the worsening of the situation has a socio-economic origin.

The first are, in reality, those that have been put into practice by the suitable administrations generating the fire policy.

The second are much more wide and have already entered into the environment of the general agrarian policy, of territorial and cultural arrangement.

1. The strategies of the first group are:
a) . Reduction of the number of FF.
b) . Reduction of the damages caused.
c) . Improvement of the co-ordination between different responsible administrations.

The measures to put this into practice can be the following:
- a. Deterrent through surveillance.
a) . Increase the number of patrols.
b) . Creation of a voluntary watch group.
- b. Sensitising of the population.
a) . Differentiated sensitising campaigns for groups of the population.
b) . Information to alert the existence of danger.
c) . Application of sanctions.
- c. The practice of a preventative forest culture in places with most probability of initiation and maintenance of firelanes.
- d. Reduction of attack time on the fire.
a) . Modern systems of detection.
b) . Conditioning of infrastructures.
c) . Rearranging of the web of base areas.
d) . Conditioning of landing strips for aerial methods.
e) . Co-ordination of lines of communication.
- e. Improve co-ordination in large fires.
a) .Creation of co-ordinated aerial units and airborne units.
b) .Suitable preparation of personnel.
c) . Improvement of decision making processes.
d) . Application of computerised systems to prevent and manage means, like the PREVENTIVE PLANNING project.
e) . Monitoring of the problem of fires through suitable collection, processing and analysis of the data.

2. The strategies that follow the second group should be based on the coherent application of an agrarian policy that upgrades the social and economic utility of the wood.

2.1.3 Lekakis, Joseph N. (1993). *Social and Ecological correlates of Rural Fires in Greece*. Journal of Environmental Management. Number 43. 1995.

Starting from the fact that FF in Greece "have proliferated at alarming rates during the past two decades, seriously threatening the country's forest resources", he states the need for an operational framework of analysis able to integrate "the physical and the socio-economic environment dimensions in which rural fires occur".

His purpose is to help bridge the gap between hypotheses of fire generation and fire fighting policy.

Inspired in PYNE'S work (1968), he summarises the review of the literature in three separate but also interrelated theories of FF ignition:
- The ecological thesis, that in a good measure corresponds to our, assumes that the risk depends on particular natural dimensions and consequently there is a certain natural logic of FF; with other words, there is nothing unusual about certain FF.

Several Greek authors acknowledge the potential of this approach to explain fire generation (TRIANDAPHYLIDIS, 1959; GIANNAKOU,1982; ORFANIDIS,1991, BRIASSOULIS,1992). In this direction, KAILIDIS et al. (1975) divided Greece into four FF risk sectors.

- The cultural-institutional fire use risk. After taking a moderate methodological distance from a deterministic cultural pattern as the one held by GICAS (1978), and from some Greek stereotyped cultural attributes, he defines some concrete cultural behaviours with a real impact on FF ignition.

These dimensions, that can be integrated in our, are:

a) Urban dwellers driving to the countryside for recreation, particularly in the summer because of the tourists increasing number.
b) Fire traditional uses by farmers and livestock managers.

The author includes here as part of the Greek cultural environment, two other components: "incompetence of the administrative system, which lacks an effective regulatory mechanism for fire protection" and some "political events", namely election periods.

In our model the administrative component is considered part of the and the political event can be taken as a good indicator of social tension

- Economic development fire risk.

Even if the author speaks of an economic approach, as a matter of fact, the logic he takes is rather a sociologic one.

Instead of a cost-benefit approach to forest, he speaks about demographic migrations, forest activities abandonment, and tensions associated to the new social and economic demands for space (STAMATOPOULOS,1982); (KAILIDIS,1983); forestland has particularly to face the lack of rubbish dumps and houses.

As none of these reviewed theories seems able to offer a satisfactory explanation of FF incidence, he concludes that it is necessary to adopt a multi-factor causal approach.

Using data from 51 Greek counties over a 10-year period (1978-87), a stepwise regression procedure is employed to explain as well fires of forested land as total fires including those of non-forested land; both categories are defined as recorded by the Greek Ministry of Agriculture.

As independent variables (estimating different risk factors) are taken: population density, cars per thousand people, and clime (taking as reference July).

Two dummy variables are also constructed. One - that takes into consideration whether a national election was or was not held in a given year- is included in the model explaining fires occurrence in forested land.

The second one, used in the model explaining FF occurrence in a wider sense (including bushland and non-forested land), takes into consideration whether or not there is a degree of illegal construction above the national average.

As main contributions, "the article concludes that political events and economic development leading to increased demand for land along with some cultural and ecological phenomena are responsible for the destruction of the Greek forests".

Concrete findings are: fire risks, derived from illegal construction activities and from a loose government agencies operation during election periods, have a special weight on bushland; demographic and auto pressures, associated to the economic development, have a clear impact increasing FF risks.

This article offers a well organised work, that directly or indirectly deals with a similar central: the construction of an integral FF risk, that takes simultaneously into consideration the impact of physical factors (in this case, reduced to clime) and socio-economic factors.

It represents a first step that deserves a higher degree of theoretical development (particularly to clarify interactions), a more specific variables definition and a wider series of measurable indicators.

2.2 PUBLIC ADMINISTRATION

2.2.1 Dirección Xeral de Montes e Medio Ambiente Natural. Xunta de Galicia. *Estudio-encuesta sobre causalidad de incendios forestales*. 1991.

This work aims to be a valuation of last year's action plan or "compaign" (INFOGA).

It is designed as a survey to all direct concerned or responsible actors.

Its central point is to find out in each forest District or geographical intervention unit the main ignition causes, as attributed by FFF organisation officials.

Territorial unit or analysis: municipality.

Polled: foresters, rural Police (Guardia Civil), mayors and agrarian agents.

The following fire causes are surveyed:

- Burning to promote the natural development of pastures.
- Burning of waste and agricultural waste.
- Burning to promote hunting.
- Negligence.
- Arsonist.
- Others.

The most relevant contribution appears in the study design, structured as the organisational rational or official thinking.

Instead of summarising, as usually, the overwhelming majority of causes as arsonist or unknown, they attribute the majority of fire ignitions to cultural institutional behaviours or social tensions.

It can be said that the organisation culture is moving from a "conspiracy logic" that looked after delinquents to a socio-economic causal analysis associated to economic change and social anomie.

2.2.2 Ministerio de Medio Ambiente. Diseño y planificación de acciones de comunicación para la prevención de incendios forestales. Fab Consultores, S. A. Madrid, 1997.

2.2.2.1 Main assumption

The main reason to analyse this work is the following presumption: “one may predict that an informed public opinion creates a greater consciousness regarding the forest fire problem.

Consequently informed public opinion represents an essential mean to obtain the best fire prevention: the prevention by the general public”.

In other words the Ministerio de Medio Ambiente assumes that continuous education of the general public about forestry issues and particularity about fire risks, stands as one of the best instruments for fire prevention.

Given the fact that "the information concerning FF ... is not processed according to degree of complexity" and that at the same time it is a strategic weapon in any prevention program, it is necessary to analyse the way that mass-communication deals with these issues.

2.2.2.2 Objectives

- The program’s purpose is "to design and plan communication actions for the purpose of forest fire prevention". At the operational level, it defines five goals:

. the persons responsible for the FF information.
. the definition of the mass-media’s (MM) dominant ideas and beliefs concerning FF.
. data needed and sources used.
. technological means and organisational structure for a correct information transfer from Forest Services to the MM.
. to define proposals and a communication plan for the Forest Service.

- The authors add two other objectives; which are technical means, namely:

. a MM analysis
. a survey of journalist opinions.

Beyond the above goals, the study focuses on uncovering bias in the circulation of FF news.

2.2.2.3 Methodology

In this point the study shows a certain weakness. It lacks a clear theoretical frame of reference concerning forestry logic.

Consequently the methodology is confused with the techniques, and the questionnaires are poor.

A Delphi is used to collect information for the five main objectives.

A seven question survey is applied to a 216 journalist sample, to assess their knowledge about FF and their opinion concerning National and Regional Forest Service actions.

The bulk of the study is concerned with a MM content analysis, of 1,404 press references, taken from national, regional and local journals during the summer period of the years 1993 through 1996.

The data collected refer to FF identification as well as the journal’s formal characteristics, and a descriptive analysis is conducted using a computerised data base that allows one to know the way in which the MM inform us about FF. After a series of conclusions that summarise the main findings, and take as models the recent experiences of Andalucía, Catalonia and Valencia, a proposal is made for an Organisation attempting to develop a FF Prevention Communication Program.

2.2.2.4 Data and findings

The Spanish MM information concerning FF is poor and biased. It is seasonal and basically sensationalised. FF are presented as catastrophic events that allow political criticism of the ideological leadership of some ecological organisations. This dominant behaviour and the lack of professional journalist expertise in these matters (as well as an absence in most MM of an appropriate organisational structure to follow up the FF problem and the environmental issues), develop a mistrust regarding the official press departments of the concerned ministries and the regional administrations.

Only in the most serious fires, are the MM obliged to regularly seek information in these public agencies.

Most journals do not have a special section to handle these issues and their information reflects a clear ignorance of the FF logic, particularly, of what concerns the different kinds of risks and flow they interact.

Consequently, the lack of well documented comments about of the sensationalistic dimensions contribute to increased confusion on FF issues, instead of contributing to a well informed public opinion.

In regards to the Communication Program or Prevention Actions, the proposal of setting up an information network led by the Environmental Ministry (MAM) is not only suitable but essential as well, even in light of the fact that the model designed may appear to be too centralised.

2.2.2.5 Comment

The completed research has uncovered a crucial and strategic problem that can successfully help to fight and prevent forest fires.

It is difficult to understand why, for so many years, the authors used arson as. the main explanatory cause and there was not designed and implemented a long term information program.

It is nevertheless surprising that the study ignores the work done over the last twenty years, particularly in the Nordic Countries and Central Europe, as well as important research conducted in Spain during the last decade.

To have taken into consideration the contribution of such research could have helped to build a richer theoretical frame, design a more precise questionnaire, and avoid repetition and certain corporatist bias, which accepts as fact the given answers. In fact this research does not bring out new evidence.

However it does raise to the awareness in the Ministry for Environmental Issues -funding source of this research- of the sensationalised, seasonal, politised nature of FF public information.

Moreover it recognises the need of a professional communication program in order to create and disperse a successful forest culture.

2.2.3 Alamo Jiménez del, C. *Algunos conceptos para una Política Forestal versus Conservación de la Naturaleza*. MAM-Fundación para el Análisis y los Estudios Sociales. Unpublished Document. Madrid, 1977.

This document written by the former General Director of the Conservation of Wildlife a branch of the MAM, and Minister of the Environment of the present government of Galicia, earned special recognition for three main reasons.

First, enacts a model, not common in Spain, of negotiations with social organisations in the process of amending the currently pending Forestry Law.

Secondly, poses an institutional viewpoint and a wide array of the forestry problems and, in particular, the problem of FF, taking into account the logic of the socio-economic risk factors.

This fact have a special importance because currently, the author is the head of the institution that constitutes one of two users of the model PREVENTIVE PLANNING.

His recent appointment to the Ministry of forest fire fighting and prevention has seemed to exude a certain endorsement of his most current proposals in this field.

Due to the limited research resources for studying FF risk, "we only really know that the forest (los montes) burn".

But we fail to understand the exact reasons why this occurs so frequently.

"Are forests subject to a similar risk than are other useful or profitable things?".

This is a perfect formulation of the FF economic risk.

The socio-demografic risk factor is defined in a similarly clear way: "In the forestry schools we learned to manage trees, but perhaps we did not learn to care about the persons in charge of their conservation.

Sociologists have reminded me that before taking care of trees it is necessary to care about the silvicultors".

The basis of this statement is the fact that the forest has millions of small owners and that if they abandon their properties -because they are neither economically nor socially viable- the forest is subject to a permanent high FF risk.

The increasing diversification of forest products and increasing social demands tend to induce a growing tension that results in an even higher risk.

Given the big number of forest owners and the growing number of social organisations interested in forest issues, as well as the more complex social demands to develop new organisational models that are successful, a sector of corporate integration has become a top strategic priority.

It is crucial to remember that biological quality can be achieved by any forest but it is a secondary question in comparison to the resource persistence and its sustained management, because if the forest is not viable, it will disappear.

By all these reasons, "it is necessary to create a forestry culture, showing that forest industries use renewable resources, and that wood consumption is far less polluting than other alternative materials.

In nature there are not good and bad trees (...) public authorities are obliged to compensate the silvicultors for any limitations they may impose on them in order to pay attention to new social demands".

Here there are some key dimensions of the cultural risk factor.

FF risk will be reduced when public opinion will share these grass-roots ideas.

2.2.4 Ait Radi, Abdallah; Guzmán Guerrero, Melchor. La profesionalización de la lucha contra los incendios forestales: la experiencia andaluza. Sevilla, 1997.

This article focuses on two main points related to forest fire risk prevention: the organisational and the cultural factors.

The analysis is referred to the Andalucian experience.

Given the fact that this model is perceived as successful and that an important region as Andalucía might be considered a PREVENTIVE PLANNING potential client, this article deserves our attention.

The authors assume that, in order to succeed in the fight against FF, a professionalized organisation is needed.

Consequently, professional standards of labour recruitment should substitute the simple and dominant employment logic, which is prominent in Andalucía. Until 1993, the Forest Fire Fighting

Organisation was considered to be one of public employment most important sources; its main aim was to offer as many positions as possible.

The increasing demands for higher standards of effectiveness result in a more professional organisation.

Professionalization implies improving technological equipment and especially setting up appropriate recruitment procedures.

In fact, in the Andalucian Model, these procedures are reduced to physical and psychological tests; no mention is made of any required forestry knowledge or culture, neither to fire management expertise.

A direct effect of these innovations, according to the author, are the reduction to half of the number of the forest fighters (not necessarily the number of hours worked), as well as an important reduction of personal injuries.

The second component is investment on human capital through a training and formation program. Surprising to note 27..% of the workers hired were illiterate.

These programs helped also to develop an organisational culture, to increase group moral and to avoid the bureaucratisation of this very special task force.

Even if the sources are practically restricted to Andalucía, there is a lack of well known references and there is no new contribution to the subject.

The very objective of this work is to show how the demand to use such advanced tools as the PREVENTIVE PLANNING Model is growing among Forest Services.

2.3 OTHER

2.3.1 GARCÍA TAIBO, R.; Dans del Valle, F.; GARCÍA, A.; PÉREZ VILARIÑO, J.; ROMERO GARCÍA, A. *Viabilidad del asociacionismo forestal en la Comarca de Mahía-Barcala*. Xunta de Galicia. Santiago de Compostela, 1985.

This is a preliminary research project designed by an interdisciplinary team of engineers and sociologists, taking a socio-economic assumption as a common starting point.

The basic FF risk was associated with a high level of landownership fragmentation, a low level of profitability, and a process of forestland abandonment along with a dense ageing population.

In such an environment, forests with a high level of fuel, because of a very favourable season, will be periodically subject to fire during the dry and hot months.

Given the special seasonal conditions (high humidity and a hot and dry Mediterranean summer), the structural main risk factor is social disorganisation.

Consequently, only through property reorganisation is it possible to build forest units that can be technically managed and protected.

That used to be the logic of the "concentración parcelaria" or property merging policy.

The main contribution of this experimental research is to show that it is possible to apply alternative viable techniques to a previous one, that had clearly appeared to be too conflictive, expensive, time consuming, and finally not viable.

This new strategy sets up a system where in joint ownership of land can be established.

In order to demonstrate that it is feasible to implement this model, two pilot groups were set up, one composed by 24 owners of 6.7 ha. and the other one by 12 owners of 5.2 ha. The first one has been planted with pine trees and the second with Eucalyptus.

After 12 years, no fire has started in either of them, even if surrounded by FF.

Even more, around each one of the associated groupings a diffusion effect has spread, increasing the FF prevention in the area.

As a result of this experiment, five conditions are described under which it is feasible to build new groupings.

A second by-product was the constitution of the Asociacion Forestal de Galicia, that became a founding member of the Confederacion de Asociaciones de Silvicultores de España (COSE) and the South European Forest Association (USSE), whose FFF model deserved an official Award of the European Commission.

In this joint venture, Engineers and Sociologist contend that an appropriate organisation -able to solve social tensions and lead a successful forest management-is a key strategic factor to prevent FF.

2.3.2 Pérez Vilariño, J. *Economía Polílitica Forestal y Estrategia Asociativa*. Agricultura y Sociedad. Number 51. pp. 177-203. Madrid, 1989.

This article summarises the main sociological findings concerning the interdisciplinary research. It represents the first empirical approach of a Spanish sociologist to forest issues.

Particular stress is put on the importance of the organisational weapon in a growing corporate society.

Without some organisational tool to help integrate the thousands of small forest owners it is impossible to prevent FF risk.

The author contends that this is due precisely to the imbalance between highly organised cities and big industrial groups and small scale dispersed landowners.

The author presents a model that has shown to work under five feasible conditions.

He also notes that property division or even distribution has being one of the major western innovations that has allowed the huge development of modern corporate societies; distributed properties may be managed in an associated way.

By this reason, the old and costly landmerging policy should be substituted by the promotion of silvicultor associations.

2.3.3 Pérez Vilariño, J. *Por qué arden los montes*. Actualidad Forestal de Galicia. Number 111-112. January-June 1989.

"Forests burn because they can burn.

And they can burn, because in the present conditions they are not profitable".

This is a concise and first definition of the FF economic risk.

It is a simple adaptation of the most elementary logic: things that have or have not lost their value become garbage.

And final garbage should be burnt.

As long as many forests are converted into uncontrolled garbage collectors, as it still occurs frequently in Galicia and other Southwest European regions, FF risk is maximum.

Following this economic logic, the best way to prevent FF or to reduce FF risk is to make forests economically profitable or socially useful.

If forests are profitable for their owners, they will have an incentive to care about them.

On the contrary, they will abandon them, especially if parcels are too small.

Social utility is a more complex phenomenon, and consequently much more difficult to deal with.

In order to become accountable it is necessary to have a big level of collective responsibility, and in this case a high informed forest culture.

The conclusion of this work is that any efficient FF prevention system should start from this economic and social logic.

That means changing the present legal, fiscal, financial and managerial environment of the forest.

Forgetting this logic is only succeeding to increase, year after year, the FFF organisation budget.

It is irrational to spend more money fighting fires instead of taking care of and improving the forests.

ALEF; SESFOR. *Estudio de Cultura Forestal en Galicia*. Xunta de Galicia. Santiago de Compostela, 1991.

2.3.3.1 Purpose

This sociological research was designed to offer a substantial contribution to the Galician Forest Plan (a very ambitious interdisciplinary project in which more than sixty experts of different countries participated).

A long term Forest Planning needs not only to be technologically up-to-date and economically efficient, it also needs a high degree of social legitimacy in order to get the necessary political and economic support.

Such a goal is required as an unavoidable condition to audit the new social demands concerning forest services and products.

2.3.3.2 Content

It includes an analysis of the Galician forest culture, central topics and the main social demands.

Data were collected through a survey to a sample of 2,400 people, representative of the general population, stratified by forestry districts.

Several professional groups were also surveyed using specific mail questionnaires.

This data-base was completed with a content analysis of a sample of school textbooks and daily journals, in order to know how new generations and general opinion are being informed about forest issues.

As a whole, it represents the most ambitious sociological study on forest issues ever conducted in Spain.

2.3.3.3 Findings

Data consistently show that there is a large social consensus on several main topics:

- The compatibility of the three main forest functions, namely the economic, recreational and environmental functions.
- The need for an industrial development associated to the forest. Many people said they were ready to invest in their forest, but under the condition that FF was controlled.
- Consequently, their most urgent demand was a public investment in an efficient FFF organisation.

But another set of data brought out the existence of a an acute tension between groups that fight for leadership.

The professional discourse is, in a good measure, “kidnapped” by a controversial one, that tries to establish a dualistic vision opposing "good" to "bad' or autochthonous to alochtonous species.

This tension seems to increase FF risk and to discourage forest investments.

Regarding FF, the most salient contribution of this research is to try to substitute the traditional model of analysis, that reduces causality to arsons, by a multifactor model that defines structural risk factors.

2.3.4 PÉREZ VILARIÑO, J. *Cultura Forestal y Diferenciación Profesional*. Revista Española de Investigaciones Sociológicas. Number 59. pp.: 89-120. Madrid, 1992. *El Monte y la Construcción Social del Bosque*. Agricultura y Sociedad. Vol. 1. 1998.

Generalisation of FF is considered to be a clear indicator of social anomie, associated with a deep change in forest land uses and a growing complexity of social demands.

The new environmental dimension attributes to forests a symbolic value that, used as a political weapon, has spread severe conflicts.

Small forest owners consider these tensions as a threat that reduces long term profit rates.

Consequently they lose interest in caring about their lots.

This logic resumes the need to develop a socio-economic risk model.

According to the evidence offered by a survey, small landowners (who are the majority) are on the limit of profitability and therefore hesitate to take care of their forests, until FF risk will be under control.

In this way, the obliged first step, or zero point, should be to build up an effective FFF organisation.

The author offers a quantitative estimate of the surprising effectiveness of the new Galician professional FFF organisation, created in 1990.

Avoiding that FF could reach a catastrophic level (even if the number of ignition points continues to grow due to greater demographic pressure and social complexity), the new organisation is helping people believe that it is feasible to effectively control FF.

This evidence helped to extend to FFF strategies and the contributions of the organisational culture.

It assumes that it is urgent to develop a forest culture able to reduce tensions and to substitute the polemic discourse by a more professional one.

In order to understand FF, as well as forests, studies and future research must include more than an analysis of physical events and social factors.

Furthermore, it is also important to collaborate with supporters and common users of forest resources (and fires) in order to establish better preventative measures for fighting FF.

Obviously forest land-owners comprise a vast majority of FF supporters, however other social organizations and the general public should become supporters as well.

Their contribution is the only way to shift from the present political logic of the war on FF, to an necessitated economic logic of the efficiency, based on cost-benefit analysis.

The budget for FFF can not continue to grow as it has done during the last decade (around 900% in an 8 years period).

The bureaucratic inertia can induce the FFF Administrative Agency to substitute the FFF policy to the Forest Policy.

If a technical silviculture and a proper management is the best-long-term prevention system, credit should be given to these actions.

Taking these insights and the evidence brought by the above empirical research as a frame of reference, a socio-economic FFF theoretical model is built that includes four risk factors:

1) Forest economic value and profitability.
2) Socio-demographic pressure or tension.
3) Forest culture.
4) Organisational logic.

The author contends that there is a surprising contradiction in the FFF logic.

During these last years the socio-economic logic is gaining space, but is still only functional as an organisation remodelling.

2.3.5 PINAUDEAU, Ch. L'Organization de la lutte contre les incendies de forêt en Aquitaine. I Jornadas sobre Incendios Forestales. Mariñán (Coruña).1989. Gestion globale des risques, protection de l'environnement et dévéloppement du territoire. Agricultura y Sociedad. Vol. 1. 1998.

The French Southwest region of Aquitaine succeed creating, out of a marshy land, the largest "productive forest" of South Europe associated to a dynamic forest industrial sector. FF was the main problem to be solved.

Since 1890, Forest Defence Unions were created by forest owners (A.S. de D.F.C.I.), reaching a high degree of efficiency with a parsimonious organisation.

Forest owners -as the first interested social agents were the leading group.

The economic logic is considered to be the obliged way to calculate and reduce FF risks.

Two main means are selected as basic strategies.

At long term and as prevention actions, a technical silviculture is developed and a series of forest infrastructures are systematically built, so that the ignition risk or, at least the catastrophic one, will be avoided or reduced.

At short term, a professional organisation is created for FF control and extinction.

It is important to underline as the key point the fact that all forest owners are involved in an institutional frame, created by their initiative and legally sanctioned.

The FFF Organisation assumes a Social growing fire risk, as forests are experimenting higher social demands, demographic pressure, traffic and visits. So, the number of fire ignition points might increase.

If forest is well managed and the Forest Fire Fighting Organisation is working correctly, the risk of a catastrophe will be minimum or null.

Hundred years of forest work has developed a deep rooted, high informed and generalised forest culture, that has become the best and decisive preventive factor.

In this environment, detection is easier, investments get social support, and social groups and general population adopt a correct behaviour regarding forest, reducing FF risks.

2.3.6 Pérez Vilariño, J.; Delgado Fernández, J. L. *Análisis del riesgo de incendio forestal en Galicia*. Agricultura y Sociedad. Number 77. October-December 1995.

The theoretical reference of this study is to consider fires as a social phenomenon.

It aims to identify the underlying risk situations that make fire occurrences possible year after year.

The article offers an analysis of the findings of a research conducted by the South European Silvicultors Union (USSE) and sponsored by the European Regional Development Centre (CEDRE) and the Regional Governments of Galicia, Basque Country and Aquitaine.

It deserved the Interregional Co-operation Award of the Evaluation Commission for the Experiences Exchange Program.

2.3.6.1 Theoretical frame and design

This research is a test of the statistical performance of the socio-economic risk model designed by SESFOR and qualitatively checked among forest owners with the collaboration of the large professional team of the USSE.

The socio-economic risk model it changes the deeply rooted “offender’s logic” that used to consider most FF as intentionally provoked.

When a problem appears with a structural regularity (and generalisation), it cannot be reduced to a deviant behaviour of some particular individuals.

The socio-economic risk model tries to uncover the social and economic determinants or factors precisely.

Three notions are specially relevant:
- Risk level, the number of fires per forest surface.
- Risk type, the internal or external circumstances that encourages fire.
- Severity, the burnt surface per forest area.

"Risk" is measured using a combined index of modified "risk level" and "severity".

The risk location and classification allows a fire to be predicted and therefore, actions can be taken to alter the circumstances.

In Galicia the most influential variables are:
- Ownership distribution and a very small size of parcels (positive correlation).
- Relative growth of population defined as population pressure (positive correlation).
- Rate of forest land owned by local Communities (positive correlation).
- Productivity of local woodlands (negative correlation).
- Extensive livestock (livestock pressure correlates positively).
- Population dispersion.
- Climatic harshness.

It considers municipality as a unit analysis.

2.3.6.2 Findings

In Galicia the most important factor that, by itself alone, explains more than half of the variance in FF is ownership distribution.

Steady population increase is the second most important factor.

The third factor with a similar importance is the upraise of rare communal property.

Lastly, an increase in extensive cattle population and the effects it has on the land has a positive correlation with FF.

It is important to note the different accuracy and reliability of the data sources.

Authors used basically census data to make this first test.

The contributions of his analysis recommend to extend the study to cultural , organisational and economic factors.

2.4 OTHER INTERESTING REVIEWS

2.4.1 SARGOS, R. Contribution à l’histoire des Landes de Gascogne. Delmas. 1949.

This work analyses the indirect reasons of fires during the period 1941-45 and it finds 5 main factors:
- Severe drought.
- An insufficient forest vigilance.
- Over extension of the forest.
- The rural exodus and deshuminization of the forest.
- Inadequate FF organisations.
- Also:
- Poor accessibility to the dampest areas.

2.4.2 BILLAND, A. *L'efficacité de la défense des forêts contre l'incendie dans le département des Landes*. Union Landaise des ASC de Défense Forestière Contre Incendies. Bordeaux, 1985.

The study analyses fire statistics from two points of view: historical evolution and geographical distribution using municipalities as units of analysis.

It makes an analysis of the FFF organisation and the overall effectiveness of this public service. It concludes:
- That hygrometry is a very relevant factor (r = 0,76) in the number of fires.
- That organisation (level of organisation) has a very strong influence on the average size of fires.
- That the communication network, tourist and urban pressures, and conditions of spatial distribution have an important impact.

2.4.3 Leone, V. *Causes socio-économiques des incendies de forêts dans la région de Bari (Poilles, Italie)*. Revue Forestier Française. Special edition 1990.

This work shows the relationship between intentional fires and the labour-force derived from the prevention or the recovery of burnt areas.

It also describes the results of an in-depth survey carried out all over Italy that confirms the socio-economic origins of fires.

The study, that uses techniques of statistical analysis (cluster analysis, principal component analysis), has allowed groups of regions of different economic development (to be set up).

In these regions excessive isolation conditions and economic drawbacks are always accompanied by the problems of intentional interesting is the possibility of an FFF organisation to become a fire risk factor in order to increase the demand for fire fighters thus making available more jobs.

2.4.4 ALEXANDRIAN, D.; GOUIRAN, D. *Les causes d'incendie: levons le voile*. Revue Forestier Française. Spécial edition 1990.

This study explains the so-called "Prometheus operation" established in 1973, which aimed to study fires in the French Mediterranean region, with the help of statistics and computer science in order to increase both the knowledge and consequently the efficiency of interested parties.

The methodology used, starts from a file of fire data, some relative to the fire (month, day, hour, location, surface, fire ignition point, accessibility) and other relative to the municipality in which the fire breaks out (main local known causes, pasture surface, number of hunting licences, tourist population, garbage dumps, etc.), and uses as a method of statistical analysis the "discriminating analysis".

From the data of 15,691 fires, 5,305 have a known cause.

This group is randomly divided, into another 2 groups; with one group the model is prepared, the other serves as a control to check its validity, ignoring the real cause that has started the fire. If the outcome is good, it is applied to the 10,386 fires whose origins are unknown.

The elaborated model has validity to find fire causes in big groups, not individually.

2.4.5 Maison de la Forêt. Donnés statistiques de DFCI. Nombre et surfaces des incendies par commune, par cause et par année. Gironde, Les Landes et Lot-et-Garonne (1986-1990)

This work makes a statistical analysis of fires per department, classifying causes into:

- Natural (lightning).
- Fixed social risk.
- Infrastructures.
- Infrastructures and accidents.
- Individuals and groups.
- Accidents.
- Negligence.
- Imprudence.
- Volunteers.
- Indeterminate social risk.
- Unknown.

As it can be observed, it already appears that the importance of the economic factor (prevention forest equipment) as well as a social factor (particular social behaviours).

2.4.6 LAGE PICOS, J. *Cultura forestal e incendios forestales en Galicia*. Actualidad Forestal de Galicia. Number 119-120. January-June 1991.

The study comments on the results of the forest culture survey carried out in 1991 by Alef-MILLWARD BROWN for the Consellería de Agricultura, Ganadería y Montes (Galician Agriculture, Livestock and Forest Administration).

2.4.7 BRIASOULIS, H. *Planning uses of fire: reflections on the Greek experience*. Journal of Environmental Planning and Management 35. pp.: 161-173. 1992.

He understands that the FF key risk lies in the unsatisfied and complex new social demands that need to be planned by means of clear and more tightened criteria.

2.4.8 LORENZO DÍAZ, Mª. DEL CARMEN. *Análise dos incendios forestais na Galiza*. 1996.

This work analyses the Galician municipalities with the highest number of forest fires and burnt areas.

2.4.9 ÁLVAREZ-MIRANDA, Berta. *Los incendios forestales en España (1975-1995)*. ASP Research Paper 14(a)- 1996. (ASP: Analistas Sociopolíticos. Gabinete de Estudios). Madrid, 1996.

The study makes a critical review of socio-economic fire causes.

It summarises the fab-consulting study on motivations:

3 REVIEWED EUROPEAN PROJECTS. SUMMARY

3.1 PROJECTS RELATED TO THE TOPIC

3.1.1 F.I.R.E.S. Forest Image processing supported by Expert System

3.1.1.1 Objective

Fires develops an expert system as a management tool to prevent the appearance of forest fires in the Mediterranean region.

It is a model that intends to explain the risk of forest fires in a determined territory in function with the existing uses of land, the proximity of the interface between the different uses and the presence of illegal construction activity in forest zones.

3.1.1.2 Composition

This expert system is fed on geographic information obtained from remote sensing, photo-interpretation and Global Positioning Signals (G.P.S.), which is applied to a Geographic Information System (G.I.S.) to be able to be managed and analysed.

It consists of the following parts:

a) An electronic data base that provides information about the forest areas: physical parameters, vegetation, uses of the land, infrastructures and socio-economic parameters.
b) Two different mathematical models developed in a parallel method, that process the information from the data base and classify the forest areas according to their level of ignition risk.
c) A visualisation system to represent the risk of ignition.

3.1.1.3 Range of application

The range of application of FIRES is bound to the European Mediterranean countries.

The research, development and validation of the model has been carried out in the region of Attica in Greece and in the Central Zone of Portugal.

3.1.1.4 Functions

The FIRES model has been designed to perform the following functions:

- To detect illegal changes in the use of the land in points with an elevated density of fires.
- To police and deduce the evolution of illegal construction activities.
- To control and protect the burned forest zones from possible illegal occupation of the land.
- The pursuit of the re-conversion of zones illegally urbanised, into forest areas.
- Identification of areas with an elevated deterioration in which urban planning measures should be taken.
- To predict the appearance of fires by the identification of housing and road construction in forest areas.

3.1.1.5 Description

The FIRES system is composed of various work units that develop a specific methodology and that are elaborated by research in different geographic territories.

Next, the five parts in which the content of the project is divided are distinguished and accompanied by their corresponding explanation:

a) Factors influencing FF in Greece, Italy and Portugal.

In the project a summary is made of the damages produced in recent years in the forests, brushwood and pastures of Greece, Italy and Portugal as a consequence of forest fires. A study is made of the most influential factors and they are classified.

b) Management of the Thematic Information stored a G.I.S.

It is sought to determine the existing correlation between ignition points (number, size and cause) and the information stored in a Geographic Information System (G.I.S.) by means of remote sensing and photo-interpretation: areas of illegal housing construction, areas with urban planning, communication lines and interface between different uses of land. This module also contributes a specific technology for the development of mapmaking subject matter about illegal housing construction. The territory employed for the implementation of this unit is the Prefecture of Attica during the period of 1985 - 1992.

c) Socio-economic Model.

This independent unit seeks to know the existing direct factors that increase the risk of fire (illegal road construction, illegal housing construction, wood cutting areas) and the real socio-economic activity that develops in the zone, providing a major understanding of the problem which permits the adoption of concrete measures for its solution. The area of implementation is the Prefecture of Attica.

d) Neural Network mathematical model.

This unit has developed with the objective of characterising the forest areas according to the potential risk of fires. This neural algorithm process is trained with a sample of areas or geographical points where collected as a dependent variable is the distinction between burned areas and non-burned areas and as an independent variable, a series of physical and socio-economic parameters.

The unit was applied to two series of data: data collected in forest areas of Portugal and data collected in forest areas of Greece.

The collected parameters in 200 points of ignition and of no ignition in Portugal are: NDVI, altitude, incline, land use, distance to the cultivation/forest interface, distance to the urban/forest interface, distance to the urban/cultivation interface, distance to the closest waste dump and population density.

The collected parameters in 200 points of ignition and of no ignition in Greece are: distance to illegal housing construction, distance to low density urban centres and distance to primary and secondary roadways.

The prediction results of the model can be summarised by the following:

In the 700 defined points in Portugal a sample of 100 points have been collected for the training, of the Neural Network.

The prediction achieved in the totality of points was correct in 68% of the cases.

In Greece, of the 200 defined points, a sample of 20 points have been collected for the training of the Neural Network.

The prediction achieved in the totality of points was correct in 90% of the cases.

e) Predictive model and explanatory regression models.

The work was developed by the National Geographic Information Centre (CNIG) in Central Portugal with the intention of predicting the occurrence of fires and the burned surface on a municipal scale.

Two principal lines of work are developed. In the first study a correlation is established between localisation of ignition points, landscape variables such as vegetation coverage and human factors such as accessibility.

The second study consists of an analysis of the relationship between natural and socio-economic factors and the burned areas on a municipal level.

Both studies are supported by spatial analysis over a Geographic Information System, using information derived from remote sensing, digital maps and a range of data in an alphanumeric base.

The methods of analysis used include exploratory spatial data analysis, univariate statistical tests, logistic regression and spatial regression analysis.

3.1.1.6 Conclusions

As far as the contributions of the FIRES system to the State of the Art Socio-economic Risk Models, the following aspects or interest can be summarised:

- It deals with an expert system that explains and predicts the appearance of forest fires in the countries of the Mediterranean.
- The procedure of analysis of correlation between forest fires and risk factors are achieved at a spatial level over a Geographical Information System (G.I.S.).
- The information from physical and socio-economic factors come from remote sensing, photo-interpretation, and Global Positioning System, which is transferred to G.I.S.
- The data base of fires should indicate the point of ignition and the surface area burned over a G.I.S.
- The methodology of correlation analysis and the mathematical models are different in each unit
- Or line of work.
- Each model designed is specific to the area, its direct application in other regions is not advisable.
- The principal factor of the study is the construction of illegal housing.

3.2 OTHER PROJECTS

3.2.1 Simulation des incendies des forêts.

Objectives: to develop behavioural models of vegetational fires adapted to European conditions.

Contents: without **socio**-economic interest.

3.2.2 Modélisation incendie et études de risques pour la valorisation de l'environnement (MINERVE).

Objectives: to develop a computer tool for risk-analysis allowing rapid fire detection by the determination of ignition possibilities and for simulation studies predicting the evolution of a FF.

Contents: without socio-economic interest.

3.2.3 Wildfire prevention through prescribed burning: prediction of effects on tree.

Objectives: to analyse the effects of prescribed burning on trees.

Contents: without socio-economic interest.

3.2.4 Reclamation of Mediterranean ecosystems affected by wildfires.

Objectives: to develop techniques for the reclamation of degraded lands in the European Mediterranean Countries.

Contents: without socio-economic interest.

3.2.5 Mediterranean forest fire fighting integrated strategic tool (MEFISTO).

Objectives: the goal of the proposed work is to develop a state-of-the art, operational and strategic decision support tool for the real-time simulation of FF in Mediterranean ecosystems.

Contents: without socio-economic interest.

3.2.6 Integrated assessment of environmental degradation connected with FF in European areas.

Objectives: to develop operational methodologies for forecasting, assessing and alleviating the effects of FF in European areas.

Contents: management of data by Land Information System (LIS).

First step: land use obtained by remote sensing data processing, climatic conditions derived from the statistical analysis of meteorological data, information of human infrastructures and FF data.

Second step: present fire events in real situations, impacts of fires (increase of soil erosion).

Final step: GIS technologies to define land suitability for different forest and non forest ecosystems in order to optimise possible actions of reforestation.

3.2.7 Management techniques for optimisation of suppression and minimisation of wildfire effects (PROMETHEUS).

Objectives: to define FF preventative planning and extinction strategies in order to optimise resource utilisation and minimise overall effects.

Contents: without socio-economic interest.

3.2.8 Knowledge-based decision support system for fire risk assessment in the Mediterranean ecosystem.

Objectives: to define and develop the prototypical components of a decision support system for fire risk studies in Mediterranean areas based on the combined evaluation of remotely sensed data and geographic information, and using dynamic modelling of the fire spread.

Contents: without socio-economic interest.

3.2.9 A new approach for forest fire risk assessment: "risk-sensor" feasibility study and related methods.

Objectives: to identify relations which link the flammability of vegetation exposed to stressful conditions and emission of essential oils.

To assess a bio-climatic risk index, combining usual methods and data with information provided by sensors based on essential oils sensing.

Contents: without socio-economic interest.

4 SOCIO-ECONOMIC FACTORS RELATED TO FOREST FIRES

4.1 DEFINITION OF SOCIO-ECONOMIC FACTORS

Social and economic growing complexity produces an array of new and frequently not easily compatible demands upon the forest.

This situation entails the appearance of a gap between the management models and the social demands.

This approach assumes that this tension is the key point of the "human" or socio-economic factor that most analysis mention as the main cause of the forest fire increase.

But in a very surprising logic there is a shortage of data on this human factor.

In all reports fires caused by negligence, deliberately started or by unknown reasons are almost the whole of the set.

This fact is the reason that compels to investigate, beyond physical conditions, in its socio-economic roots, trying to develop an explanatory model of the phenomenon.

Socio-economic impact of the forest fire risk can be grouped if five main factors:

- *Forestry profitability*: production and productivity of the forest environment.
- *Demographic pressure*: degree of human presence and evolution in forest areas.
- *Social tension*: social strain level.
- *Forestry culture*: measures forest cultural environment and public opinion.
- *Organizational logic*: preventive and fight model.

The initial exposition assumes that these five components operate everywhere increasing or reducing fire risk with possible changes in a middle or long term.

There are socio-economic determinants which acquire different weights in different societies.

In this sense it is not hazardous to formulate the following propositions:

Fire risk will be lower at the same time as:

- Forest is more profitable for its owners and socially useful for the whole population.
- There is neither a sudden demographic pressure nor a fast process of rural inhabiting and land abandonment.
- The social strain between different land uses is lower. In this field it is necessary to include particular events that generate special strains like elections, trade disputes, etc. .
- General population understand forest logic and new forest uses, developing behaviours in agreement with its increasing complexity.
- The implementation of a regional and professional organisation for fire prevention and fighting, and able to operate efficiently under a continuous assessment and with a high motivation.

The measurement of weights of every component demands the selection of a sequence of socio-economic indicators or variables that must be representatives to asses fire characteristics and tends in a specific geographical area.

These parameters have not to be the same neither in every studied area nor in the course of time, since the significance of every component can change as the structure of forest functions and the environment forest culture are modified.

At the present time, the data availability to measure the significance of every socio-economic factor is, without doubt, the main obstacle to define a solid structure of the model.

Thus, it is noted between the different countries and regions considerable variations in availability of temporal series of data.

It is noted specially in the following aspects:

- Population attitudes referring to different forest types and its functions.
- The evaluation of Public Services action in prevention and fighting against forest fires.
- The measures of forest profitability, as well as, the type of taxes, invectives and investments to forest capitalisation.
- The valorisation of social forest uses in aspects as preservation, protection, recreational and landscape.

The *Socio-economic Risk* doesn't change in a very short time.

It rather shows an evolutionary process that can be observed in a medium period of time.

The *Socio-economic Factors* define a structural risk, that presents a relatively stability, according to the characteristics of the geographic area.

The specific impact of the different factors can be observed through a comparative analysis of different areas.

The utility of this kind of analysis is mainly oriented to: prevention, planning and evaluation.

Knowing the risk factors will allow to establish a correct system of intervention in the forest fire fighting design and, particularly important, to establish the cost-benefit priorities to assign the fire resources according to social preferences.

Only through a strategic planning (with clear hierarchical priorities) the growing budget of forest fire fighting can be controlled.

At the same time the control of the fire fighting budget is the condition for a forest sustainable development.

4.2 FACTORS RELATIONSHIP SCHEME

The interactions between different factors have be taken into consideration.

First, the factors that only change in the long term are taken into consideration, next those that are modified progressively and finally, those most directly modified.

Perhaps other, more forest specific logic should be adopted: in the first place the factors with the greatest determinant weight are situated: demographics and culture.

The fundamental variable is the *demographic* component because it is a condition of all the rest.

The forest is believed to be conditioned by its surrounding population which it has to serve and which imposes its technology and demands.

Secondly, this population moves closer to the woodlands with a determined *culture*, this along, with ideas and purposes, is what will radically condition its actions.

Although modifiable, the influence of the population is fundamental and has a direct impact as much on investment decisions as on organisational form as well as the type of tensions that different demands and organisational forms can provoke.

In the third place is the *economic* factor that constitutes the basic condition of forest viability.

This can be put on the same level as culture because there is a strong interaction between the two: each managerial socio-economic model pertains to its own culture and each culture favours the appearance and development of determined economic models.

Types of investment in the forest modify the social representation over it; while the development of ideas induce preferences which consequently condition investment.

The economy acts as both a catalyst for change and as a basic restriction.

For much of the forest culture, if the forest is not economically viable or socially useful, that is if it does not and will not have possess value for the population, attempting to care for it beyond its actual value will result in a waste of energies.

Furthermore, in clear relation to demographic pressure, the forest culture and the economic value of the woodland creates the *social tension*.

The preceding factors increase and decrease the tensions over time that define diverse types of conflicts.

Yet in short, as has always been affirmed -through a causal attribution without testing, the factor or most immediate cause seams to be social order.

This design intends precisely to give reason to forest fires in terms of situation or risk structure that is foreseeable and within accessible limits, and refuses to reduce the general complexity of forest fires to a simple element of guilt or original responsibility.

Finally, the *organisational* factor is situated as being dependant on the previous four.

The organisational mode of management of the woodland and the fight against forest fires makes it possible to comprehend and anticipate the risk of fire appearance as well as estimate the potential damage.

At the same time, through this organisational model, a feasible result is to intervene in the short term which defines this last risk factor.

As being most directly related to fire management. The immediacy of this factor is what explains the success and happiness of various autonomous Spanish communities that have experimented with fire control through the creation of professional fire fighting organisations.

Curiously, at the investment in many resources to professionalise the fight (due to the urgent nature of the magnitude of catastrophe and public pressure) the fire risk is maintained in high levels.

With a relatively high budget a feasible result is to maintain a certain level of control over burned area.

However, but given the low level of capitalisation of the woodland and poor management conditions (en particular the abandonment of thousands of small silviculture) it becomes more difficult to control the appearance of fire and consequently, the number of forest fires.

4.3 OPERATIONAL APPLICATION

As it has already been exposed the socio-economic forest fire risk is established by the combined effect of five major factors: economic, demographic, social, cultural and organisational.

But at the practical level two main tasks were obliged.

The first one is to find available data source to construct each of the factors, and the second is to check the relative real weight of each factor in each one of the user's region

To achieve these two operational goals, it has been necessary to deploy a rather laborious work following a five steps strategy:

- The first one is to find the data sources for the primary data; these data are row numerical values collected from census, public statistics, user's series or own survey data.
- The second is to select and operationally define functions or indicators for each one of the variables, that are supposed to measure the main components of each factor.

For each variable several indicators can be chosen according to their reliability and the availability of primary data.

In this step variable indicators are built taking as inputs primary data.

- The third step tries to operationalise the theoretical variables, according to the indicators that had been built.

Even if the socio-economic risk is defined by socio-economic variables, some physical variables are also added in order to check the interaction between the two kind of variables included in the integral forest fire risk.

A large set of variables have been identified for each factor, even if in several cases primary data are not yet available, particularly regarding the cultural and organisational factors which are the most innovative contributions.

These not yet operative variables can be included in the algorithm by other users.

In addition, variables have been ordained by thematic groups and subgroups so that the user can adjust the model to his changing needs.

In this way, the user has at his hand an ordained file of variables with a high socio-economic significance.

- The fourth step is the most crucial one. It implies a hard theoretical and statistical work, in order to define accurate estimators that can be statistically significant.

After a variable was defined, it was necessary to test its specific effect on the dependent variable.

This task was achieved through a hard computing work accompanied by long discussions in order to understand the way each variable acts.

Result of this task is the selection, for each socio-economic factor, of the most significant estimators, that is, the ones with a higher independent contribution to the explanation of the dependent variable (the number of forest fire occurrence).

Starting from the hypothesis defined in the State of the Art, discussions were held with forest experts in order to test the correctness of the variables assignment to each factor.

This theoretical design was also continuously checked through a micro socio-economic field work in specific areas where the different factors were suppose to have an special impact.

The final result assigns a numeric value to the effect of each factor.

- The first step integrates the different socio-economic factors (demographic pressure, forestry profitability, forestry culture, social tension and organisational logic) in a mathematical function, that estimates the average socio-economic forest fire risk for a particular area (state, region, nomos, county, comarca municipality or parish).

The algorithm can be enriched as new primary data may become available (it is particularly important that users will collect and analyse cultural and organisational data, some them existent but not ready to be included in the model).

It can also be improve with a higher variable adjustment to each forest area.

It is also important to note that it seems to be necessary to take the number of fires as the first dependent variable, acting as the first link between the socio-economic risk and the physical to define the integral FF risk.

The fire number is nevertheless an elementary variable, good for a first analysis because of the data availability and the political importance attributed by users.

In order to increase efficiency it is obliged to move into a higher degree of specification.

According to the user's priorities other dependent variables can be defined, such as forest and wooded area burned.

It is also advisable to built complex variables that estimate the social, ecological and economic value of the surface burned.

In this way it will possible to establish different types of fires and also different strategies to fight them.

This is a key point to implement a efficient cost/benefit logic new variables.

5 RISK MODEL VARIABLES

In this section a set of well arranged qualities that characterise the socio-economic setting of the forest environment have been established.

Variables are selected following two criteria: the first one is the availability of data sources, and the second is the relative impact of each variable (as measured by the simple and multiple regression coefficients) upon the forest fire number.

According to the available data, the values of each variable can be estimated by different alternative indicators.

Each user shall make his most operative selection of variables and indicators.

The socio-economic variables (even some physical variables) are classified in groups and subgroups according to the thematic record or area of study to which they pertain.

Each variable will be briefly defined and assigned an identification key.

The standard nomenclature to follow can be explained in the following example:

D.1.5

where:

D : group variables key.

1 : subgroup variables key.

5 : variable key.

5.1 A. FORESTRY GROUP

It includes the subgroups of variables directly related to the forestry environment and its management.

5.1.1 A.1 Forest productivity subgroup.

It includes the variables that assess the income of the land owner or tenant derived from forest exploitation.

The returns can be measured in monetary units, in kind or as borrowed public services (when the titular is a public institution).

- A.1.1 Actual timber productivity. It measures the actual production of timber by units of area and time.
- A.1.2 Actual forest livestock productivity. It measures the actual production of meat or animal products by units of area and time. This only includes ranching in an extensive regimen (in which the livestock is supported exclusively by the forest), or proportionally in a semi-extensive regimen (in which the catering of the livestock draws on an outside nutritive supplement, non forestry related).
- A.1.3 Other productivity. It measures the actual production of other distinct forestry products from wood or livestock by units of area and time. At a macro level comes to be an auxiliary compliment of production but at a micro level can be a resource of major importance. Included in this subsection: quarrying, cork, firewood, fungus, seed, fruit, honey, resin, hunting, benefits of recreation activity, etc. If the different concepts are summarised they should utilise monetary units.
- A.1.4 Total actual productivity. It measures the sum of all of production by units of area and time. If the different concepts are summarised they should utilise monetary units.
- A.1.5 Total economic profitability. It measures the sum of benefits of all production by units of area and time.

5.1.2 A.2 Forest inventory subgroup.

It includes the variables that quantify the existence of vegetation products, heads of livestock in the forest[1], hunting specimen, estimations of the abundance of fauna and other devisable elements.

This inventory should be updated periodically.

- A.2.1 Stocks of wood. It estimates the volume or weight of wood by unit of area. On occasion the existence of wood differentiates due to arboreal species or age classes.
- A.2.2 Bovine density on the forest. It is the number of cows that graze per unit forest area.
- A.2.3 Bovine holdings density on the forest. It is the amount of bovine holdings in extensive regimen per unit forest area.
- A.2.4 Sheep density on the forest. It is the number of sheep that graze per unit forest area.
- A.2.5 Ovine holdings density on the forest. It is the amount of ovine holdings in extensive regimen per unit forest area.
- A.2.6 Goat density on the forest. It is the number of goats that graze per unit forest area.
- A.2.7 Goat holdings density on the forest. It is the amount of goat holdings in extensive regimen per unit forest area.
- A.2.8 Equine density on the forest. It is the number of horses that graze per unit forest area.
- A.2.9 Equine holdings density on the forest. It is the amount of equine holdings in extensive regimen per unit forest area.
- A.2.10 Total forest ranching density. It is the index of ranching units (1: equine/bovine; 0,5: ovine/goats) that graze per unit forest area.
- A.2.11 Livestock holding density on the forest. It is the amount of livestock holding in an extensive regimen per unit forest area.

[1] In this subgroup is only included cattle grazing in an extensive and exclusive regimen on forest land.

5.1.3 A.3 Subgroup of forest land uses.

Includes the variables that express the proportion of a type of surface in relation to the wooded or forest area.

These relationships are expressed in terms of ratio per one.

- A.3.1 Proportion of industrial forest. It is the relation between wooded forest surface and total forest area.
- A.3.2 Proportion of useful wooded surface in forest. It is the relation between forest area covert by trees able to be cut (with a minimum diameter of 15 cm.) and total forest area.
- A.3.3 Proportion of eucalyptus surface. It is the relation between area covered by Eucalyptus and total wooded area.
- A.3.4 Proportion of coniferous surface. It is the relation between area covered by coniferous trees and the total wooded area.
- A.3.5 Proportion of protected areas. It is the relation between the sum of the area publicly protected and the total forest area.

5.1.4 A.4 Subgroup of forest land use evolution.

It includes the variables that express the tendencies of land use changes per units of time and area.

- A.4.1 Increment of industrial forest.
  It measures change in the wooded surface.
- A.4.2 Increment of useful wooded land.
  It measures change in the useful wooded surface.
- A.4.3 Increment of eucalyptus land.
  It measures change in the surface dedicated to the Eucalyptus.
- A.4.4 Increment of coniferous land.
  It measures change in the surface dedicated to the coniferous species.
- A.4.5 Increment of brush land.
  It measures change in the brush surface.

5.1.5 A.5 Subgroup of hunting activity.

It includes variables related to hunting activities: hunting density, animal habitat and transit difficulty.

- A.5.1 Density of hunted wild boar.

It is an estimation of the number of hunted wild boar per season in each unit of total area.

- A.5.2 Density of other major hunting species captured.

It is an estimation of the number of other major hunting species captured per season in each unit of total area.

- A.5.3 Density of hunted rabbits.

It is an estimation of the number of hunted rabbits per season in each unit of total area.

- A.5.4 Density of hunted partridges.

It is an estimation of the number of hunted partridges per season in each unit of total area.

- A.5.5 Density of other minor hunting species captured.

It is an estimation of the number of other minor hunting species captured per season in each unit of total area.

- A.5.6 Decrease in rabbit hunting space.

It is estimated through indicators that signify harmful changes in soil use for rabbit hunting and for the existing local demand.

- A.5.7 Decrease in partridge hunting space.

It is estimated through indicators that signify the harmful changes in soil use for partridge hunting and for the existing local demand.

5.1.6 A.6 Subgroup of wild fauna damage.

It includes variables that estimate cohabitation tensions between human beings and certain wild species.

- A.6.1 Damages of wild boar on agriculture.

It is an estimate of the damages of wild boar on cropland or meadow.

- A.7 Subgroup of recreation activity.

It includes variables related to the use of the woodland as recreational area.

- A.7.1 Frequency of visits to the forest.

It is number of visits per season per unit of surface forest area.

- A.8 Subgroup of forest ownership.

It includes the variables that express the proportion or the evolution of a type of ownership or manager in relation to the forest area.

- A.8.1 Proportion of public managed forest land.
  It is the relation between forest surface managed by public entities and the total forest area.
- A.8.2 Proportion of public forest.
  It is the relation between forest surface owned by public entities and the total forest area.
- A.8.3 Proportion of vecinal forest.
  It is the relation between vecinal forest (*monte vecinal en mano común*) surface and the total forest area. Vecinal ownership is a characteristic galician type of private forest ownership belonging to primordial neighbouring groups.
- A.8.4 Increment of public managed forest.
  It measures change in the surface managed by public institutions.

5.1.7 A.9 Forestry product prices subgroup.

It includes the variables that measure the market price of forestry products.

- A.9.1 Price of wood.
  It is the average market price of wood.
- A.9.2 Yearly price variation.
  It is the relation between the price of wood between one year and the previous year.

5.2 B. LIVESTOCK GROUP

It includes the subgroups of variables related to the livestock sector, considering all cattle (in extensive and intensive regimen).

5.2.1 B.1 Livestock holdings subgroup.

It includes the variables that characterise the type of livestock holdings.

- B.1.1 Cows for meat production per holding. It is the average number of cows per holding for meat production.
- B.1.2 Sheep per holding. It is the average number of sheep per holding.
- B.1.3 Goats per holding. It is the average number of goats per holding.
- B.1.4 Sheep + goats per holding. It is the average number of sheep and goats per holding.
- B.1.5 Cows for milk production per holding. It is the average number of cows for milk production.
- B.1.6 Heads of cattle in non-intensive regimen per holding. It is the average number of cattle in extensive and mixed regimen per holding.

5.2.2 B.2 Livestock population density subgroup.

It includes the variables that indicate the number of existing heads of livestock in relation to the total area.

- B.2.1 Bovine density for meat production. It is the number of registered bovine cattle for meat production per unit area.
- B.2.2 Ovine density. It is the number of registered sheep per unit area.
- B.2.3 Goat density. It is the number of registered goats per unit area.
- B.2.4 Sheep + goat density. It is the number of registered sheep and goats per unit area.
- B.2.5 Density of sheep and goats in flocks of more than 9. It is the number of registered sheep and goats belonging to flocks of more than 9 heads per unit area.
- B.2.6 Density of sheep and goats in flocks of more than 49. It is the number of registered sheep and goats belonging to flocks of more than 49 heads per unit area.
- B.2.7 Density of sheep and goats in flocks of more than 99. It is the number of registered sheep and goats belonging to flocks of more than 99 heads per unit area.
- B.2.8 Density of sheep in flocks of more than 9. It is the number of registered sheep belonging to flocks of more than 9 heads per unit area.
- B.2.9 Density of sheep in flocks of more than 49. It is the number of registered sheep belonging to flocks of more than 49 heads per unit area.
- B.2.10 Density of sheep in flocks of more than 99. It is the number of registered sheep belonging to flocks of more than 99 heads per unit area.
- B.2.11 Density of goats in flocks of more than 9. It is the number of registered goats belonging to flocks of more than 9 heads per unit area.
- B.2.12 Density of goats in flocks of more than 49. It is the number of registered goats belonging to flocks of more than 49 heads per unit area.
- B.2.13 Density of goats in flocks of more than 99. It is the number of registered goats belonging to flocks of more than 99 heads per unit area.
- B.2.14 Bovine density for milk production. It is the number of registered bovine cattle for milk production per unit area.
- B.2.15 Livestock population density in non-intensive regimen. It is the amount of cattle in extensive and mixed regimen per unit area.

5.2.3 B.3 Livestock evolution subgroup.

It include the variables that express the tendencies of change in cattle raising over units of time and area.

- B.3.1 Increase in cattle population in non-intensive regimen. It measures the change in the number of units of cattle.
- B.3.2 Increase in cattle population in non-intensive regimen per holding. It measures the change in the average number of units of cattle per holding.
- B.3.3 Increase in the bovine population for meat production. It measures the evolution of the number of cows for meat production.
- B.3.4 Increase in the ovine population. It measures the evolution of the number of sheep.
- B.3.5 Increase in the goats population. It measures the evolution of the number of goats.

5.3 C. AGRICULTURE GROUP

It includes the subgroups of variables related to the agriculture sector.

Variables or subgroups in this category have not been described.

5.4 D. LAND USES GROUP

It includes the subgroups of variables related to area and distribution of each type of land use.

5.4.1 D.1 Typology land of uses subgroup.

It measures the proportion of area dedicated to each defined land use category with respect to the total geographical area.

- D.1.1 Proportion of cropland.
  It includes all types of agricultural cultivation, herbaceous dry farming, herbaceous irrigated farming, large market crops, fallow land, orchards, olive groves, vineyards, etc. This does not include meadows.
- D.1.2 Proportion of meadowland.
  It includes artificial grassland, permanently irrigated grassland and those cultivated seasonally in dry zones, used for harvest and/or grazing. This land use is more characteristic of humid Mediterranean climates (Galicia).
- D.1.3 Proportion of agricultural land.
  It includes the sum of cropland and meadowland. (It corresponds to D.1.1 plus D.1.2). It includes:
  a. Areas farmed on a yearly basis (or with alternate yearly “rest” intervals)
  b. Fields cultivated on a non-regular basis but at least once per 5 years
  c. Irrigated lands
  d. Orchards, olive groves, vineyards, etc.
  e. Fields that were uncultivated for sometime, probably with some shrubs, but showing signs of earlier cultivation

- D.1.4 Proportion of grazing land.
  It includes:
  a. Grass meadows at high elevations, without trees
  b. Grass areas at the edge of forests or within forests. Tree cover is <10%
  c. Denuded areas, previously used for agriculture and now abandoned, generally on steep slopes, and heavily eroded
  d. Heavily degraded maqui or phrygana areas (generally evergreen shrubs) with low shrub cover (generally < 10%)

  Normally this is used for grazing, although natural grassland permits the possibility of harvest. This land use is more in dry Mediterranean climates (Greece).
- D.1.5 Proportion of brush land.
  It includes the species of shrubbery that form woody masses of more than 10% area coverage, where the dominant genus are: *Cistus*, *Ulex*, *Erica*, Retama, etc. Also included is the natural regeneration of wooded area. The wooded area coverage is not greater than 10%.
- D.1.6 Proportion of wooded land.
  It includes the woody formations formed by tree species whose tops cover more than 10% of the forest area. Also included in this category forested and cut areas.
- D.1.7 Proportion of forest land.
  It includes the sum of wooded and brush surface:
  a. Parcels having an area of at least 0,5 ha. or strips 30 m. wide with tree crowns covering at least 10% of their area, or areas that carry at least 250 trees at regeneration stage per ha., not being used for other land uses and capable of producing timber or other forest products
  b. Areas from which trees have been removed, leaving less than 10% tree cover, and which have not been given to another use
  c. Reforest areas
  d. Evergreen shrub areas (generally with shrub cover >10%)
- D.1.8 Proportion of rocky land.
  It includes areas with minimal or no vegetation with at least 50% of bare rock or gravel exposed.
- D.1.9 Proportion of urban and industrial areas.
  It includes villages, towns, cities and the industrial areas around them (all types of buildings) plus the roads.
- D.1.10 Proportion of wetland.
  It include the areas that are permanently covered by water (natural and artificial lakes, rivers, water tanks, swamps).

5.4.2 D.2 Exploitation structure subgroup.

It measures the average area per holding of each type of land use.

- D.2.1 Area of cropland per holding. It indicates the average area of terrain dedicated to crops.
- D.2.2 Area of meadowland per holding. It indicates the average area of terrain dedicated to grassland harvesting and/or grazing.
- D.2.3 Area of agricultural terrain per holding. It indicates the average area of terrain dedicated to the exploitation of agricultural crops and meadows.

5.4.3 D.3 Land use evolution subgroup.

It includes the variables that express the tendencies of change in land use over the units of time and area.

- D.3.1 Increase in cropland. It measures the change over time of the area dedicated to crops.
- D.3.2 Increase in the area of cropland per holding. It measures the change over time of the average area dedicated to the exploitation of agricultural crops.
- D.3.3 Increase in meadowland. It measures the change over time of the area dedicated to artificial grasslands complementary to cattle-raising exploitation.
- D.3.4 Increase in the area of meadows per holding. It measures the change over time of the average area dedicated to exploitation of meadows.
- D.3.5 Increase in agricultural terrain. It measures the change over time of the area dedicated to meadows.
- D.3.6 Increase in the area of agricultural terrain per holding. It measures the change over time of the average area dedicated to the exploitation of agricultural crops and meadows.
- D.3.7 Increase in pastures. It measures the change over time of the area dedicated to grazing.
- D.3.8 Increase in brush land. It measures the change over time of the area covered by bush.
- D.3.9 Increase in wooded area. It measures the change over time of the area covered by trees.
- D.3.10 Increase in forest area. It measures the change over time of the area covered by bush and trees.

5.4.4 D.4 Relations between land uses subgroup.

It includes the variables formed through combinations of variables of basic land use.

Only the combinations that have a high correlation with the appearance of forest fires should be selected.

- D.4.1 Meadowland / cropland ratio. It is the relation between area of meadowland and area of cropland.
- D.4.2 Cropland / forest ratio. It is the relation between the area of cropland and the forest area.

5.4.5 D.5 Distribution of land use subgroup.

It includes the variables that explain the degree of division, complexity or mixture of land use.

- D.5.1 Interface between agricultural cultivation and forest areas. It measures the length of the boarder between agricultural cultivation and forest areas per unit area.
- D.5.2 Expansion of isolated housing in the forest. It estimates the degree of presence of isolated housing in forest areas.
- D.5.3 Interface between urban and forest areas. It measures the length of the boarder between urban and forest land per unit area.

5.4.6 D.6 Land ownership subgroup.

It includes the variables that characterise the proportion of distinct types of owners and land tenants.

- D.6.1 Private ownership density. It measures or estimates the number of forest owners per surface unit.
- D.6.2 Proportion of vecinal ownership. It is the relation between vecinal ownership (*monte vecinal en mano común*) and the total area. (Vecinal ownership is a characteristic galician type of private forest ownership belonging to primordial neighbouring groups).
- D.6.3 Proportion of public ownership. It is the relation between public ownership (state, commune ...) and the total area.
- D.6.4 Proportion of public managed land. It is the relation between publicly managed land and the total area.

5.4.7 D.7 Land fragmentation subgroup.

- D.7.1 Degree of agrarian property division. It is the number of agrarian plots per total area or agrarian surface. (Agrarian area includes: agricultural land, grazing land and forest land).
- D.7.2 The presence of an agrarian plot concentration process. It is a binary variable that indicates the presence or not of a land concentration process in a given area.
- D.7.3 Fragmentation of agrarian activity. It measures the average number of agrarian plots per holding.
- D.7.4 Increase of agrarian fragmentation activity. It measures the change over time of the average number of agrarian plots per holding.
- D.7.5 Agrarian holdings density. It measures the average amount of agrarian holdings per unit area (total or agrarian).
- D.7.6 Agrarian holdings area. It measures the average surface size of agrarian holdings. This is the inverse of D.8.3.
- D.7.7 Increase in the amount of agrarian holdings. It measures the change over time of the number of agrarian holdings in reference to a unit of area.
- D.7.8 Number of holdings per agricultural area. It measures the average amount of agrarian holdings per unit of agricultural terrain (cropland + meadowland).

5.4.8 D.8 Agrarian production subgroup.

- It includes the variables that measure the total productivity of the agrarian sector: agricultural, cattle-raising and forestry.
- D.8.1 Potential agrarian productivity index. It is a index that measures the agrarian productivity capacity of a territory by climatic and topographical parameters.

5.5 E. SOCIO-DEMOGRAPHIC GROUP

It includes the subgroups of variables related to the human community of the study territory.

5.5.1 E.1 Population density subgroup.

It includes the variables that measure the number of inhabitants per unit area.

- E.1.1 Total population density. It is the total number of inhabitants per unit area.
- E.1.2 Density of national tourists. It is the number of national tourists per unit area.
- E.1.3 Density of foreign tourist. It is the number of foreign tourists per unit area.

5.5.2 E.2 Population characterisation subgroup.

It includes the variables that measure the proportion of a determined demographic characteristic.

- E.2.1 Proportion of old population. It is the proportion of inhabitants older than 65 with respect to the total population.
- E.2.2 Proportion of youth population. It is the proportion of inhabitants younger than 20 with respect to the total population.
- E.2.3 Proportion of active population. It is the proportion of inhabitants within working age with respect to the total population.
- E.2.4 Proportion of employed population. It is the proportion of employed with respect to the active population.
- E.2.5 Proportion of unemployed male population. It is the proportion of unemployed males with respect to the male active population.
- E.2.6 Proportion of industrial employees. It is the proportion of inhabitants who work in the industrial sector with respect to the total employed population.
- E.2.7 Proportion of construction employees. It is the proportion of inhabitants who work in construction with respect to the total employed population.
- E.2.8 Proportion of service employees. It is the proportion of inhabitants who work in the service sector with respect to the total employed population.
- E.2.9 Proportion of agricultural employees. It is the proportion of inhabitants who work in the agrarian sector with respect to the total employed population.
- E.2.10 Proportion of active rural population. It is the proportion of inhabitants employed in the rural areas with respect to the total rural population.
- E.2.11 Proportion of rural population. It is the proportion of inhabitants who live in the rural areas with respect to the total population.

5.5.3 E.3 Population evolution subgroup.

It includes the variables that express the tendencies of population change related to the units of time and area.

- E.3.1 Population increase. It measures the change of the number of total inhabitants related to the units of time and area.

- E.3.2 Migratory balance. It measures the difference between the number of immigrants and the number of emigrants related to the units of time and area.

5.5.4 E.4 Subgroup of geographical distribution of population.

It includes the variables that explain the form in which housing is distributed in a determined territory.

- E.4.1 Disseminated housing. It is the degree of housing spread outside urban centres per unit area.
- E.4.2 Disseminated housing evolution. It measures the expansion of housing dissemination.
- E.4.3 Population entities density. It is the number of existing population centres per unit area.
- E.4.4 Population entities per parish. It is the number of existing population centres per parish.
- E.4.5 Proportion of secondary housing. It is the relation between the amount of second residence housing and the total amount of housing.

5.5.5 E.5 Subgroup of characterisation of administrative units.

It includes the variables that describe the average extension occupied by territorial units delimited by public administrations. The church or neighbouring communities.

- E.5.1 Density of municipalities. It is the number of municipalities per unit area.
- E.5.2 Municipal area. It is the average area occupied by municipalities in a determined territory. This is the inverse of E.5.3.

5.5.6 E.6 Level of income subgroup.

It includes the variables that estimate the economic level of life.

- E.6.1 Per capita income. It is the total value of all good and services produced in one year divided between the total population.
- E.6. 2 Evolution of the income level. It measures the change over time of the average level of income.

5.5.7 E.7 Infrastructures subgroup.

It includes the variables that measure the density of communication networks in a territory.

- E.7.1 Density of main roads. It is the relation between the total length of main roads (freeways, highways, national roads) and the area of the territory.
- E.7.2 Total roadway density. It is the relation of the total length of roads and railways and the area of the territory.

5.6 F. GROUP OF SOCIO-POLITICAL TENSION AND FORESTRY CULTURE

Includes the subgroups of variables that characterise the state of the political and social tension related to the forest, as well as the main components of the prevailing forestry culture, namely the general values, norms and behaviours regarding the forest and the forestry activities.

Given the lack of systematic data, some fictitious indicators are used.

5.6.1 F.1 Social tension subgroup.

It includes the variables that estimate the level of tension between a social group and the government, or the tension between different social groups.

- F.1.1 General level of social tension. It estimates the level of social tension in a general environment.
- F.1.2 Presence of elections. It is a binary variable that indicates the existence or not of an electoral period.
- F.1.3 Conflicts over land use. It is a variable that indicates the degree of conflict in the interface of different types of land use.
- F.1.4 Conflicts over opposing uses of the forest. It is a variable that indicates the degree of conflict because of divergent forestry uses, the absence of a land use planning or because of illegal land use.

5.6.2 F.2 Legislation subgroup.

It includes the variables that describe the legal framework that affects the woodland and the employment of fire.

- F.2.1 Legal restrictions on selviculture. It estimates the severity of limitations on improvement operations or on forestry use.
- F.2.2 Legal restrictions on the use of fire. It estimates the severity of seasonal or spatial limitations on the employment of prescribed burning in forestry, livestock or agriculture exploitation.
- F.2.3 Sanctions on the illegal use of fire. It estimates the severity of administrative or judicial penalisations or sanctions on illegal fire use.

5.6.3 F.3 Fiscal politics and subsidies subgroup.

It includes the variables that describe economic compensations granted by public administrations to forest owners.

- F.3.1 Incentives to the forestation of agricultural terrain. It measures the amount of economic subsidies aimed at the conversion of agricultural land into forest areas.
- F.3.2 Incentives to forest improvement. It measures the amount of economic subsidies and fiscal benefits destined to improve the production and environmental quality of the forests.
- F.3.3 Incentives for the prevention of forest fires. It measures the amount of economic subsidies dedicated to the prevention of forest fires.

5.6.4 F.4 Forestry culture subgroup.

It includes the variables that describe the setting the prevailing forestry cultural system, the main values, norms and behaviours.

- F.4.1 Forestry culture consistency. It measures the degree of consonance or tension between the different forest functions as experienced by a population in a given time and area.
- F.4.2 Forestry culture. It measures the degree of relative public esteem of the forestry resources.
- F.4.3 Public valuation in forest production. It measures the relative value accorded to the wood production.

- F.4.4 Public valuation in the recreation function. It measures the relative value accorded to the forest recreational function.
- F.4.5 Public valuation in the environmental function. It measures the relative value accorded to the forest environmental function.
- F.4.6 Public valuation concerning forest fires problem. It measures the importance accorded to the FF problem and estimates the degree of approval of public expenditures in FFF.
- F.4.7 Level of established use of fire. It measures how rooted is the cultural use of fire and estimates the risk factors of this practice.
- F.4.8 Forestry association index. It measures the horizontal level of organisational integration of the silvicultors.
- F.4.9 Level of corporate integration of the forest sector. It measures the level of vertical integration of the forest actors and the institutional level or articulation.
- F.4.10 Level of forest professionalization. It measures the level of forest activities professionalization (the most important being: silvicultors, private forest management, forest fire fighting and a correct forestry culture diffusion).

5.6.5 F.5 Local conflict subgroup.

It includes the variables that measure the impact of a specific detected conflict on a local area.

- F.5.1 Impact of arsonists. It estimates the existence of a general belief that there are (identified or unidentified) arsonists within the local communities.
- F.5.2 Impact of a holiday. It measures the fire occurrence during particular holidays.
- F.5.3 Impact of a rubbish dump. It measures the number of uncontrolled rubbish dumps in the forest.
- F.5.4 Other impacts.

5.7 G. ORGANIZATIONAL GROUP

It includes the subgroups of variables that describe the organisational weapon employed in the defence (prevention and fight) against forest fires.

5.7.1 G.1 Subgroup sources of fire fighting resources.

It includes the variables that measure the quantity or proportion of the budget contributed by each organisation: European Commission, the State, Autonomous communities, local entities, private, voluntary, etc.

5.7.2 G.2 Subgroup of type of fire fighting resources.

It includes the variables that measure the quantity or proportion of the budget dedicated to each resource: salaries, equipment, machinery, infrastructure, technical assistance, disclosure, etc.

5.7.3 G.3 Subgroup of stability of fire fighting resources.

It includes the variables that measure the seasonal or stable character of the resources.

5.7.4 G.4 Subgroup of recruitment and contractual system of fire fighting resources.

It includes the variables that describe the procedure followed by Defence Services Against Forest Fires and the social demand to participate in this contraction.

- G.4.1 Social demand for employment as fire fighters.
- G.4.2 Type of working contract.

5.7.5 G.5 Subgroup of forest fires fighting organisation.

It includes the socio-economic variables that describe the function and level of effectiveness of the Defence Service Against Forest Fires.

- G.5.1 Degree of professionalization and level of equipment.
- G.5.2 Level of bureaucratisation.
- G.5.3 Degree of silvicultors co-operation.
- G.5.4 Intervention time.
- G.5.5 Cost-benefit analysis of the FF interventions.

5.8 H. STRICTLY PHYSICAL VARIABLES GROUP

It includes the subgroups of physical variables that are independent of human activity.

5.8.1 H.1 Clime subgroup.

It includes the variables related to meteorological measurements.

- H.1.1 Hydric deficit. It estimates the average value of the total hydric deficit of the soil in a determined period.

5.8.2 H.2 Physical geography subgroup.

It includes the variables related to relief, orientation, incline and altitude.

5.8.3 H.3 Vegetation subgroup.

It includes the variables related to the type of potential vegetation (without human intervention).

- H.3.1 Proportion of low elevation forest. It is the relation between area covered by low elevation species and the total forest area.
- H.3.2 Proportion of mid-elevation forest. It is the relation between area covered by mid-elevation species and the total forest area.

5.9 I. FIRE GROUP

It includes the subgroups of variables obtained through the historical fire data base.

5.9.1 Subgroup of Fire annual characteristics.

It includes the variables related with the FF frequency and the characteristics of the burned areas in a particular area and year.

They define the dependent variables of the risk models.

- I.1.1 Number of fires per unit of forest area and year.
- I.1.2 Number of fires per unit of total area and year.
- I.1.3 Burned area per unit of forest area and year.
- I.1.4 Burned area per unit of total area and year.
- I.1.5 Average fire size.
- I.1.6 Percentage of burned wooded surface.

- I.1.7 Sum of the 10 largest fires. Wooded surface.
- I.1.8 Sum of the 10 largest fires. Bush surface.
- I.1.9 Percentage of fires smaller than 1 hectare.
- I.1.10 Percentage of publicly managed burned wooded area.
- I.1.11 Percentage of publicly managed total burned area.
- I.1.12 Wooded area burned per unit of wooded area and year.
- I.1.13 Area of bush burned per unit area of brush land and year.
- I.1.14 Publicly managed area burned per unit publicly managed forest area and time.
- I.1.15 Percentage of burned forest area.

5.9.2 I.2 Subgroup of seasonal incidence

Includes the variables related to fire occurrence distribution throughout the year.

5.9.3 I.3 Subgroup of Fire Monthly characteristics.

It includes the variables related to fire frequency and the characteristics of the burned area within a determined area and temporal marker for each month.

These are parameters that may be used as dependent variables in risk models.

5.9.4 I.4 Burned vegetation subgroup

It includes the variables related to the type of burned vegetation.

This can be the species or type of plant formation (brush land, meadow, etc.).

5.9.5 I.5 Attributed cause subgroup

It includes the variables related to the typology of causes defined in the fire report.

5.10 J. GROUP OF OTHER VARIABLES

It includes the subgroups of variables that are not classified in any specific group.

5.10.1 J.1 Complex variables subgroup.

It includes the variables formed by combinations of variables of different groups.

5.10.2 J.2 Other variables subgroup.

It includes variables not identified in any previous class.

6 FACTOR ESTIMATORS: VARIABLES ASSIGNED TO EACH FACTOR

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In this section a criterion is established to measure the impact of each factor on the appearance of forest fires.

This objective succeeds in associating with each factor a group of variables with direct impact (positive or negative) over its value.

It is normal for the variables that compose this group to have strict relations of dependency.

Therefore, to estimate the impact of each factor one should specifically select the most appropriate variables in the application zone of the model.

A variable is considered good the more it contributes to the explanation of fire risk variation and if it is independent from the rest of the variables in the group.

However, the principal limitation come selection time is the existence of suitable indicators to measure the variable.

The variables that form part of the risk formula, in representation of a factor, will be the components of the so-called factor estimator.

The factor estimator is a function formed by a combination of variables obtained by theoretical investigation and practice in pilot regions.

Current knowledge in this area is clearly insufficient. Yet, being able to adopt provisional functions will permit the orientation of the Socio-economic Risk Model design.

Next, a listing of dependent variables for each factor is explained, which can contribute to the estimation of the weight or impact on the appearance of forest fires.

6.1 ESTIMATION OF THE DEMOGRAPHIC PRESSURE FACTOR

Human pressure on the forest environment is normally the greatest deciding factor in the determination of fire risk.

The more interaction that exists between man and forest areas the more probable is the appearance of fire.

This factor is the risk matrix component that conditions the impact of the rest of the defined factors.

The impact of this factor depends principally on the density of inhabitants and their proximity to the forest.

Yet, also influential is the typology of this population; economic characteristics, age, presence of tourists, communication infrastructures, etc.

The following variables are suggested to measure this factor:

- E.1.1 Total population density.
- E.1.2 Density of national tourists.
- E.1.3 Density of foreign tourist.
- E.2.1 Proportion of old population.
- E.2.2 Proportion of youth population.
- E.2.5 Proportion of unemployed males population.
- E.2.9 Proportion of agricultural employees.
- E.2.10 Proportion of active rural population.
- E.2.11 Proportion of rural population.
- E.3.1 Population increase.
- E.4.3 Population entities density.
- E.7.1 Density of main roads.
- E.7.2 Total roadway density.

6.2 ESTIMATION OF THE FOREST PROFITABILITY FACTOR

It is assumed that the risk decreases if the forest land has a high degree of productivity, on the contrary, it is easier to burn if it is abandoned.

The economic profitability to forest owners is related to the existence of a stronger and more deeply rooted forest sector.

The maintenance of an active selviculture that assures the future of forest products and the development of a transformation industry are the best guarantees for the protection of the forests against fires.

Also, the increasing valuation of environmental and recreational uses understood from a reasonable and realistic perspective becomes a source of income or social benefit, generally in woodlands of public ownership.

As the utility of the forest for proprietors and society grows, more will be invested in its conservation and defence against forest fires.

Furthermore, rural emigration to the city will decrease and a social setting that includes the sensible use of the forest will be created.

The following variables are suggested to measure this factor:

- A.1.1 Actual timber productivity.
- A.1.2 Actual forest livestock productivity.
- A.1.3 Other productivity.
- A.1.4 Total actual productivity.
- A.1.5 Total economic profitability.
- A.2.1 Stocks of wood.
- A.3.1 Proportion of industrial forest.
- A.3.2 Proportion of useful wooded surface in forest.
- A.9.1 Price of wood.
- H.3.1 Proportion of low elevation forest.
- H.3.2 Proportion of mid-elevation forest.

6.3 ESTIMATION OF THE SOCIAL TENSION FACTOR

This factor indicates the degree of presence of opposing land use, illegal exploitation, wrongful fire use, and all types of conflicts that effect forest terrain and its periphery.

This factor has the closest relationship with the causes of fire appearance but is generally based on average variables in an objective manner.

In other words, without any subjective attribution of the cause.

The following variables are suggested to measure this factor:

- A.2.2 Bovine density on the forest.
- A.2.3 Bovine holdings density on the forests.
- A.2.4 Sheep density of sheep on the forest.
- A.2.5 Ovine holdings density on the forests.
- A.2.6 Goat density on the forest.
- A.2.7 Goat holdings density on the forests.
- A.2.8 Equine density on the forest.
- A.2.9 Equine holdings density on the forests.
- A.2.10 Total forest ranching density.
- A.2.11 Livestock holding density on the forests.
- A.5.6 Decrease in rabbit hunting space.
- A.5.7 Decrease in partridge hunting space.
- A.6.1 Damages of wild boar on agriculture.
- A.7.1 Frequency of visits to the forest.
- A.9.2 Yearly price variation.
- B.1.3 Goats per holding.
- B.1.4 Sheep + goats per holding.
- B.1.5 Cows for milk production per holding.
- B.2.3 Goat density.
- B.2.5 Density of sheep and goats in flocks of more than 9.
- B.2.6 Density of sheep and goats in flocks of more than 49.
- B.2.7 Density of sheep and goats in flocks of more than 99.
- B.2.14 Bovine density for milk production.
- D.1.1 Proportion of cropland.
- D.1.2 Proportion of meadowland.
- D.1.3 Proportion of agricultural lands.
- D.1.4 Proportion of grazing land.
- D.1.9 Proportion of urban and industrial areas.
- D.5.1 Interface between agricultural cultivation and forest areas.
- D.5.2 Expansion of isolated housing in the forest.
- D.5.3 Interface between urban and forest areas.
- D.7.1 Degree of agrarian property division.
- D.7.2 The presence of an agrarian property division.
- D.7.3 Fragmentation of agrarian activity.
- D.7.4 Increase of agrarian fragmentation activity.
- D.7.5 Agrarian holdings density.
- E.4.1 Disseminated housing.
- E.4.2 Disseminated housing evolution.
- F.1.1 General level of social tension.
- F.1.2 Presence of elections.
- F.1.3 Conflicts over land use.
- F.1.4 Conflicts over opposing uses of the forest.

6.4 FORESTRY CULTURE ESTIMATION

Forestry culture is the symbolic system of collective representations concerning the forest and the derived products and services. It establishes a value hierarchy and norms, as well as the expected social behaviour and discourse regarding forests.

The relevant point is how much value a society attributes to their forests and how compatible these values are: values associated with the forests: economic, recreational, environmental; legal code (fiscal incentives. legal restrictions), discourse: how text books, mass media, etc. speak about forests, social behaviour in relation to forests (such as visiting, camping, etc.) that might prevent or increase fire risk.

- F.4.1 Forestry culture consistency.
- F.4.2 Forestry culture.
- F.4.3 Public valuation in forest production.
- F.4.4 Public valuation in the recreation function.
- F.4.5 Public valuation in the environmental function.
- F.4.6 Public valuation concerning forest fires problem.
- F.4.7 Level of established use of fire.
- F.4.8 Forestry association index.
- F.4.9 Level of corporate integration of the forest sector.
- F.4.10 Level of forest professionalisation.
- F.4.3 Public valuation in forest production.
- F.4.4 Public valuation in the recreation function.
- F.4.5 Public valuation in the environmental function.
- F.4.6 Public valuation concerning forest fires problem.
- F.4.7 Level of established use of fire.
- F.4.8 Forestry association index.
- F.4.9 Level of corporate integration (horizontal and vertical) of forest sector.
- F.4.10 Level of professional selviculture and forestry.

6.5 ORGANIZATIONAL LOGIC ESTIMATION

Given the growing complexity of social demands upon the forest and also the continual depopulation of forest area, a new and more complex organisation model is needed to manage forest diversity as well as to protect them from FF.

Organisation has become the most important weapon.

Two main dimensions should be considered.

The first one aims at structural prevention through correct management.

The second is the FFF organisation.

In both cases effectiveness, efficiency and legitimacy should be checked.

- F.2.1 Legal restrictions on selviculture.
- F.2.2 Legal restrictions on the use of fire.
- F.2.3 Sanctions on the illegal use of fire.
- F.3.1 Incentives to the forestation of agricultural terrain.
- F.3.2 Incentives to forest improvement.
- F.3.3 Incentives for the prevention of forest fires.
- G.4.1 Social demand for employment as fire fighters.
- G.5.1 Degree of professionalisation and level of equipment.
- G.5.2 Level of bureaucratisation.
- G.5.3 Degree of silvicultors co-operation.
- G.5.4 Intervention time.
- G.5.5 Cost-benefit analysis of the FF interventions.

7 CONCLUSIONS

7.1 GENERAL CONCLUSIONS

The analysis of the relationship between FF and their environment can currently be synthesised in three circles.

- The first and most immediate, establishes a causal relationship between fire and a human agent.
- The second looks for personal motivations that induce individuals to start fires.
- The third, searches for underlying structural, economical, social, historic, cultural and organisational factors of forest fires. It is based on the relationship between fire and society.

This third field defines the essence of preventive planning of forest fires.

In the forestry bibliography, no more than 2% of documents classified in scientific magazines make reference to the issue of "fire" and only 0.03% refer to its causes.

Finally references relative to "fire and socio-economic and cultural factors" are extremely limited (LEONE, VÉLEZ, LEKAKIS, PÉREZ VILARIÑO, FIRES PROJECT).

Studies carried out follow two basic methods; those based on qualitative analysis and those based on classic statistical analysis.

Among the first, are the works of LEONE E VITA (1982) and VÉLEZ (1986).

These studies made a compilation of data of geographical areas differentiated from fire and socio-cultural spheres, and they try to explain the different behaviours in each region.

They explain the interaction of those social factors considered being determinant -economic, demographic, social and cultural.

As for statistical methods, the following are proposed as suitable for the scope of the work done:

- Multiple regression, the fixed variable being a fire characteristics and the unfixed variable, characteristics of a socio-economic character. For PÉREZ VILARIÑO (1995) the fixed variable is the product of the "risk level" for "risk seriousness" and the significant unfixed variables are land division, the type of ownership, population tendencies, and conflicting land uses. According to LEKAKIS (1993) the fixed variable is the risk level and the chosen unfixed variables are the population density, number of cars, political conflicts and illegal buildings.
- The factorial analysis. A socio-economic data bank about fires in the studied area is produced making reference to the geographical unit of analysis (communes, municipalities) and also to a specific period of time. These data are both from internal characteristics of fires and environmental conditions.

A complete discriminatory analysis is applied to the French Provence-Alps-Blue Coast Region to obtain a fire behaviour model (ALEXANDRIAN - GOUIRIAN, 1990).

The analysis starts from data of half of 5,305 fires whose circumstances are well known, including its causes and motivations.

The analysis is then tested with the other half of the well-known fires and is applied to the total number of fires.

The advantages of the model consists in its validity to explain fires that happen in specific circumstances; the disadvantage, however is the deficiency to determine the cause of one particular fire.

In Italy (LEONE, V. et all., 1989) the studied area is extended to all regions and the data bank is obtained starting from in-depth surveys.

The methods of analysis used are cluster and main components.

7.2 CONCLUSIONS ABOUT MODELS

Once the contents of the different publications and projects have been reviewed, the importance of the contributions to the design of the socio-economic risk models are summarised.

- Identification of factors: very important. Especially as far as economic, demographic and social factors are concerned.
- Classification of factors: average importance. Opinions are diverse and somewhat controversial.
- Sources of socio-economic data: average to low importance. Although abundant there is a lack of specific information, which permits direct application. For this, it will be necessary to produce changing variables and turn to indirect.
- Selection of indicators: average importance. The use of few indicators with a simple elaboration, applied to very heterogeneous territories is opted for. It is necessary however; to adopt a strategic position directed to the choice of significant and not too costly indicators. The aim is to create an open model which will allow the introduction of refinement, if appropriate information is obtained.
- Fields of study: average importance. In qualitative analysis it is observed important advances in the differentiation of historic periods and in the delimitation of geographic areas in which homogenous characteristics can be observed. In quantitative analysis detailed studies applied to very specific geographical areas have been obtained. However generalised models have been approached in an over simple way without stratification according to physical and economic characteristics of the territory.

- Methodology of design: low importance. The used methods are satisfactory in limited fields action. The needs of users require general models that can be applied on a full scale to a great range of regions and at the same time be adjusted to the specific needs of each one. For this, it is essential to create a new methodology with a wider spectrum and functioning, even if it is (in part) inspired by methods adopted in other works.
- Techniques of analysis: average importance. Modern statistical methods based on the use of computer programmes offer the guarantee of accurate data processing. The reviewed reports comply with this aim through different procedures. The merger between techniques of qualitative analysis and those of statistic analysis to clarify gaps caused by the lack of socio-economic data in certain sectors is missed.
- Analysis of results: high importance. The possession of several reports studying different geographical areas and periods, gives us firstly the identification of the most influential socio-economic factors in each area and at each time. These results must be considered when the model is being designed so they can serve as a guide in the elaboration of hypothesis and to their subsequent proof. In this way, efforts will be aimed towards the understanding of the incidence of the diverse socio-economic settings in the generation of a forest fire.

As a final conclusion of this review of the State of the Art, it could be said that the need to move from these exploratory studies (based on one or more predominant factors), to a more complex design, capable of adapting to various socio-economic settings, and of understanding the concrete impact of different factors, is reflected.

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