ID=2439846

EUROPEAN COMMISSION
DIRECTORATE GENERAL
Joint Research Centre

Deliverable 1.1

Cemagref
Sciences, eaux & territoires

Determination of forest fire causes and harmonization of methods for reporting them

Contract number: 384 340

Deliverable 1.1. State of the art (Draft)

Due date of draft: Month 6 Actual submission date: 29/07/09

Start date of project: 4th December 2008 Duration: 24 months

Organisation name of lead contractor for this deliverable: *Cemagref* (P1)

Members of the Consortium: *Cemagref* (P1), ONF (P2), Fraunhofer-IAIS (P3), IBIMET CNR (P4), FRI/IBL (P5), NICIF (P6), SFI/GIS (P7), GMV (P8)

Office National des Forêts Fraunhofer IAIS Institut Intelligente Analyse- und Informationssysteme Ibimet gmv INNOVATING SOLUTIONS IBL Gozdarski inštitut Slovenije Slovenian Forestry Institute

This document must be cited:

GANTEAUME A., JAPPIOT M., LONG M., LAMPIN-MAILLET C., DUCHE Y., SAVAZZI R., BONORA L., CONESE C., PIWNICKI J., UBYSZ B., SZCZYGIEL R., GALANTE M., FERREIRA A., SUAREZ-BELTRAN J., 2009. State of the art (Draft). Deliverable D 1.1. Contract number 384 340 "Determination of forest fire causes and harmonization for reporting them". European Commission-JRC, p 220.

Background

The European Community, represented by the Commission of the European Communities, represented by the Director of the Institute for Environment and Sustainability (IES) of the Joint Research Centre (JRC), and Cemagref, a French public institution, in consortium with:

- Office National des Forêts (ONF),
- Fraunhofer Gesellschaft zur Förderung der angewandten Forschung-IAIS,
- Consiglio Nazionale delle Ricerche, Istituto di biometeorologia (IBIMET CNR),
- Forest Research Institute – Instytut Badawezy Lesnictwa (FRI/IBL),
- Núcleo de Investigaçao Cientifica de Incêndios Florestais (NICIF),
- Slovenian Forestry Institute - Gozdarski inštitut Slovenije (SFI/GIS),
- GMV Aerospace and Defence SA,

following the call for tender N°IES/H/2008/01/153999/OC of 05/06/2008 and the contractor's tender, have entered a contract, the subject of which is a service on " Determination of forest fire causes and harmonization of methods for reporting them".

The contract was signed on 04/12/2008.

The present document is the deliverable D1.1 State of the art (Draft).

ACKNOWLEDGEMENTS

The Consortium wishes to thank the following persons for their advice and contribution to this deliverable:

EFFIS Forest Fire Experts

- Franz Humer (Austrian federal Fire Brigade Association, Austria)
- Vladimir Konstantinov (State Forestry Agency, Bulgaria)
- Marco Conedera (Swiss Federal Research Institute, Switzerland)
- Boris Pezzatti (Swiss Federal Research Institute, Switzerland)
- Costas Papageorgiou (Ministry of Agriculture, Department of forest, Cyprus)
- Diethelm Witthoff (Landesfeuerwehrschule Land Brandenburg, Germany)
- Nikula Alpo (Ministry of the Interior, Finland)
- Theodoros Pallas (Ministry of rural development and foods, Greece)
- Alfredo Milazzo (Corpo Forestale dello Stato, Italy)
- Zbignev Glazko (Ministry of Environment, Forest department, Lithuania)
- Agris Sumanis (State Forest Service, Latvia)
- Marian Proorocu (Regional Environmental Protection Agency, Romania)
- Elsa Enriquez (Ministry of Environment, Spain)
- Leif Sandahl (Swedish Civil Contengencies Agency, Sweden)
- Jonathan Taylor (International Forest Policy, UK)
- Robert Aleksis (UNDP, Montenegro)

Other Forest Fire Experts

- Mike Flannigan (Ministry of natural Resources, Canadian Forest Services, Canada)
- Martin Alexander (Ministry of natural Resources, Canadian Forest Services, Canada)
- Brian Stocks (B.J. Stocks Wildfire Investigations Ltd., Canada)
- Daniel Alexandrian (MTDA, France)
- Gavriil Xanthopoulos (National Agricultural Research Foundation, Greece)
- Amato Patrone (Corpo Forestale dello Stato, Italy)
- Mara Septimius (Ministry of Environment, Romania)
- Marija Kolsek (Slovenia Forest Service, Slovenia)
- Klemen Gorse (Civil Protection and Disaster Relief, Slovenia)
- Neels Deronde (SFS, South Africa)
- Colin McIntyre (Swedish Civil Contengencies Agency, Sweden)
- Salim Zahoueh (FAO, Syria)
- Hamza Bozada (French Ambassady, Turkey)
- Rob Gazzard (Forestry Commission, UK)

TABLE OF CONTENTS

D 1.1 STATE OF THE ART

1. Introduction

A database listing precisely and systematically the number of fires and their causes each year is necessary to manage an efficient programme of fire prevention. However, statistics on fire causes in the Mediterranean region, but also in the other European regions, are far to be complete. Some countries do not have fire statistics (Malta, Egypt for instance), especially if the forest area is small or if the forest fires are not frequent. Most of the time, the record of the number of fires differ from one country to another as the definition of forest fires is different. In Cyprus for instance, the fires recorded are only those occurring in state-owned forests, at less than 1km from the edge. In Greece, a wildland fire concerns all kind of vegetation except the agricultural vegetation (Colin *et al.*, 2001). Sometimes, several databases exist for a same country and are not built in the same way because they result from different institutions, often at national and regional levels.

Forest fire causes are numerous and various. They depend on the climatic conditions, for the natural causes, and also mainly on the socio-economic context, for the human-induced causes. They differ from one country to another but also at regional scale in a same country. In the Mediterranean region, the forest fires are mainly human-induced (90%). Natural causes as lightning can be very destructive but the number of fires they provoke is much lesser in the Mediterranean region (1 to 5%) and in the rest of Europe than in North America, maybe due to the lack of dry storms. The human causes can be related to activities such as agriculture and forestry operations, garbage dumps, power lines, accidents, etc, or to man behaviour (recreation, delinquency, unawareness, smoking, etc.). Moreover, important indirect causes affecting the occurrence, behaviour and effects of wildfires are related to climatic factors such as temperature or moisture acting on plant physiology or wind acting of fuel combustion and fire propagation.

The situation in the southern Mediterranean woodlands is characterized by a depopulation of rural area, an abandonment of traditional uses in rural environments as a result of depopulation, such as grazing and firewood use of wildland, a continuous growth of the forest urban interface, etc. The overall involves conflicts between people in which fire has become a violent means. Other conflicts and causes are not directly related to the use of land but rather to human behaviour (revenge, delinquency and pyromania) or improper management (military exercises, public works with explosives, badly maintained power lines, etc.). Conflicts at the wildland/rural interfaces are mainly related to rural abandonment, inconsistent policies on land management (fire use and grazing) and the designation of protected areas for nature conservation. They are also related to increased and uncontrolled urbanization in wildland areas, recreational use and poor waste management practices are also significant (EFIMED, 2009).

Fire causes and consequences in temperate and boreal Europe and Asia can be extremely different because of a great cultural diversity and of a large range of socio-economic and environmental conditions. In the industrialized countries with a high density of population, most forested and non-forested areas supposed to be at risk are under intensive management practices (forestry, agriculture, pasture) or protected areas.

The objectives of this deliverable are to collect and analyze literature on fire ignitions and so:
- to collect scientific literature world wide,
- to draw a specific review of the studies reporting on fire causes in the European countries during the last 20 years,
- to write a state of the art in the field of fire causes, main driving factors of ignition and related modelling works. A synthesis for the southern most affected country concerning the causes has been carried out as far as possible.

After an account for the data collection, follows a part concerning the review of fire causes, mainly based on technical studies, contacts with fire experts and analysis of fire causes databases.
With respect to the forest fire causes while European countries are maintaining their own schemes for classifying forest fire causes, the EU proposed a classification scheme for fire causes that was adopted when the common core fire database was established, in this scheme four categories of fire causes are considered:

(i) Fires of unknown origin, (ii) fires of natural origin, (iii) fires of accidental origin or due to negligence i.e. linked to human activities, but without there having been any intention to destroy a forested area, (iv) fires of deliberate origin i.e. linked to the will to destroy a forested area for various reasons.
In the review of fire causes in each country, these four categories have been used for more coherence with the European classification. This implies that, sometimes, different types of causes all related to negligence or accident were merged in the unique category "Negligence" as it is sometimes the case for "Agricultural burning" for instance.

Then, come the parts concerning the main driving factors and the modelling works mainly based on scientific papers worldwide. At last, an appendix gathering additional information for certain countries can be found at the end of this report.

2. Data collection

2.1. Sources of data

Data on the different countries needed in order to complete the state of the art on forest fire causes, main driving factors of ignition and modelling works were collected by different means: *Cemagref*'s bibliographical database, scientific international bibliographical databases on the Web (ISI Web of Knowledge, etc.), contacts with EFFIS Fire Experts, contacts with other international Fire Experts, contacts with national and international institutions (Forest, Agriculture, Suppression services, FAO, etc.), International Forest Fire News (IFFN) reports, EU dataset extracted from the reports "Forest fires in Europe" available from 2001 to 2007 and UNECE dataset extracted from the "Timber Bulletin" available from 1994 to 2001. For certain countries, from 2002 to 2005, data have been prepared for theUNECE bulletin and computed by JRC using the EFFIS fire database. Results from previous national and European Programmes or networks (FIRE PARADOX, EUFIRELAB, PHEONIX, SPREAD, etc.) were also used (Table 1, figures 1, 2 and 3).

Table 1: Countries in which data have been collected and data sources (Timber Bulletin TB: 1994-2001, Forest Fires in Europe FFE: 1977-2007, IFFN reports: 1990-2006, FAO report: 2001, *ND*:No Data).

code ISO 3166	EU Countries	EFFIS member	Source
AT	Austria	x	TB/IFFN/fire expert
BE	Belgium		TB
BG	Bulgaria	x	FFE/TB/IFFN/Fire expert
CY	Cyprus	x	FFE/TB/IFFN/Fire expert
CZ	Czech Republic	x	FFE/TB
DK	Denmark		TB
EE	Estonia	x	FFE / TB /IFFN
FI	Finland	x	TB/FFE /IFFN/Fire expert
FR	France	x	TB /IFFN/ONF/ARDFCI/CNRS/*Cemagref* reports
DE	Germany	x	FFE / TB /IFFN/ Fire expert
GR	Greece	x	TB /IFFN/Biblio DB/Fire experts
HU	Hungary	x	TB/FFE /IFFN
IE	Ireland		TB
IT	Italia	x	FFE / TB /IFFN/Consortium/ Fire expert
LV	Latvia	x	FFE / TB /Fire expert
LT	Lithuania	x	FFE / TB /IFFN/Fire expert
LU	Luxembourg		TB
MT	Malta		*ND*
NL	Netherlands		TB
PL	Poland	x	FFE / TB /IFFN/Consortium
PT	Portugal	x	FFE / TB /FAO/Biblio DB

RO	Romania	x	FFE/ TB /Fire expert
SK	Slovakia	x	FFE /TB
SI	Slovenia	x	FFE / TB
ES	Spain	x	TB /IFFN/Biblio DB
SE	Sweden	x	TB /IFFN/Fire expert
GB	United Kingdom	x	FFE /Fire expert/Internet
EU new	**candidates**		
TR	Turkey	x	FFE / TB /IFFN/FAO/Ministry of environment and forest/ *Cemagref* report
HR	Croatia		FFE / TB /IFFN
MK	FYROM	x	TB /IFFN
ME	Montenegro	x	Fire expert
	EFTA countries		
IS	Iceland		*ND*
LI	Liechtenstein		*ND*
NO	Norway		TB /IFFN
CH	Switzerland	x	TB /Biblio DB/Fire expert/SPREAD/Fire Danger book
Other	**UNECE countries**		
AL	Albania		TB /IFFN
AD	Andorra		*ND*
AM	Armenia		TB
AU	Australia		IFFN/Biblio DB
BY	Belarus		TB /IFFN
BA	Bosnia		TB
CA	Canada		IFFN/SOPFEU/Ministry natural resources/Biblio DB/Experts
CL	Chile		IFFN/FAO
GE	Georgia		TB
IL	Israel		TB /IFFN
MC	Monaco		*ND*
MD	Moldova		TB
RU	Russian Federation		TB /IFFN
SM	San Marino		*ND*
RS	Serbia		TB
UA	Ukraine		TB
US	USA		IFFN/Biblio DB
	other countries		
DZ	Algeria		IFFN
AR	Argentina		IFFN/Biblio DB
LB	Lebanon		ONF
MA	Morocco		IFFN/FAO/ *Cemagref* report
ZA	South Africa		IFFN
SY	Syria		FAO/*Cemagref* report
TN	Tunisia		FAO/ *Cemagref* report

The data collection encountered different problems. The first of all was the scarcity of scientific papers or technical reports especially concerning forest fire causes *sensus stricto*, in most countries. In order to fill this gap, data were searched in Forest Fires in Europe (EFFIS) or Timber Bulletin (UNECE) datasets but they were often partial and the temporal series often incomplete (especially concerning the recent data). There are no data at all available in some countries mainly because of the almost-lack of forest (Malta, Iceland, for instance).

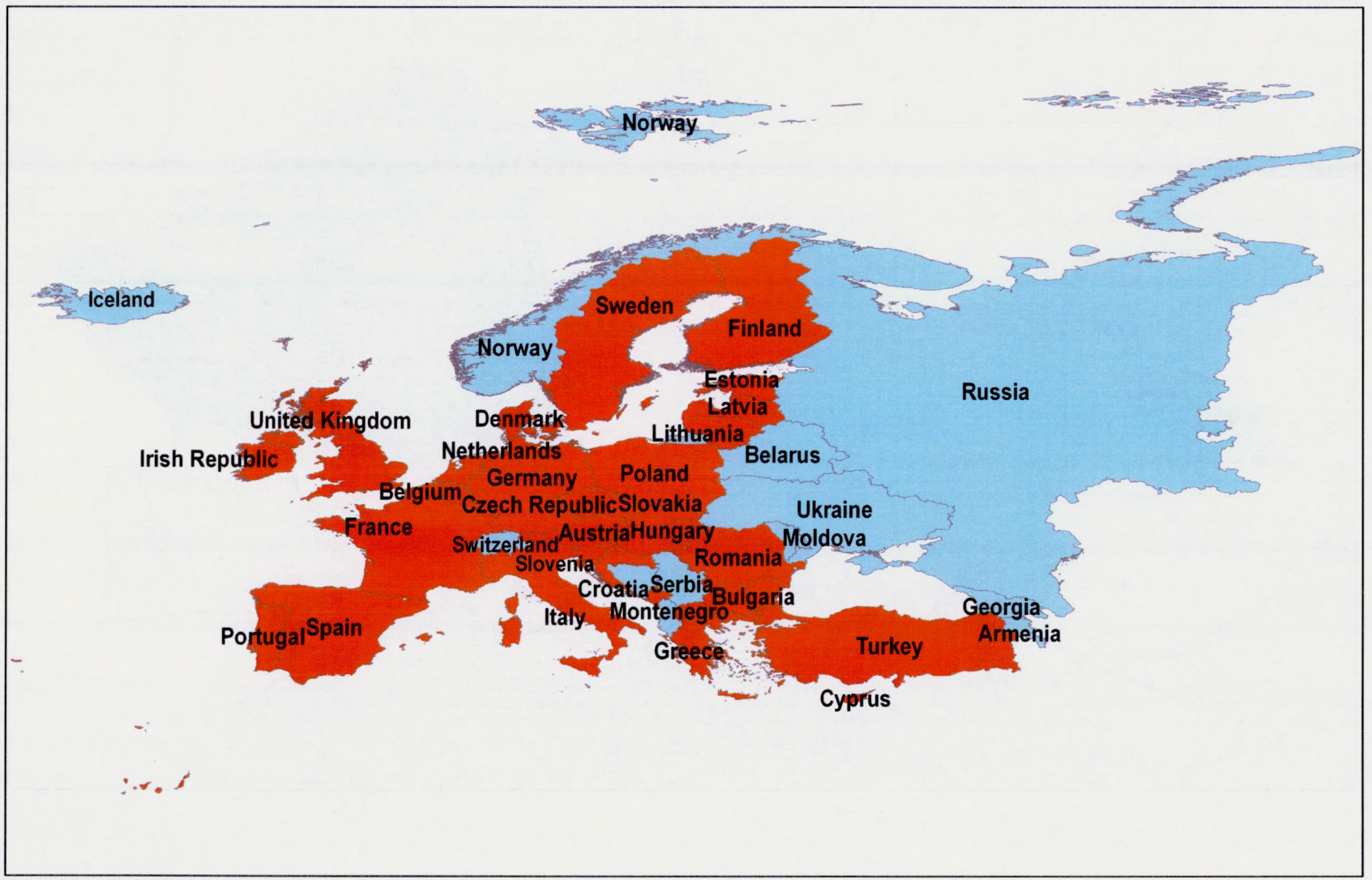


Figure 1. : EU members, new candidates (in red) and other European countries (in blue) *(Source: ESRI Europe Countries 2002).*

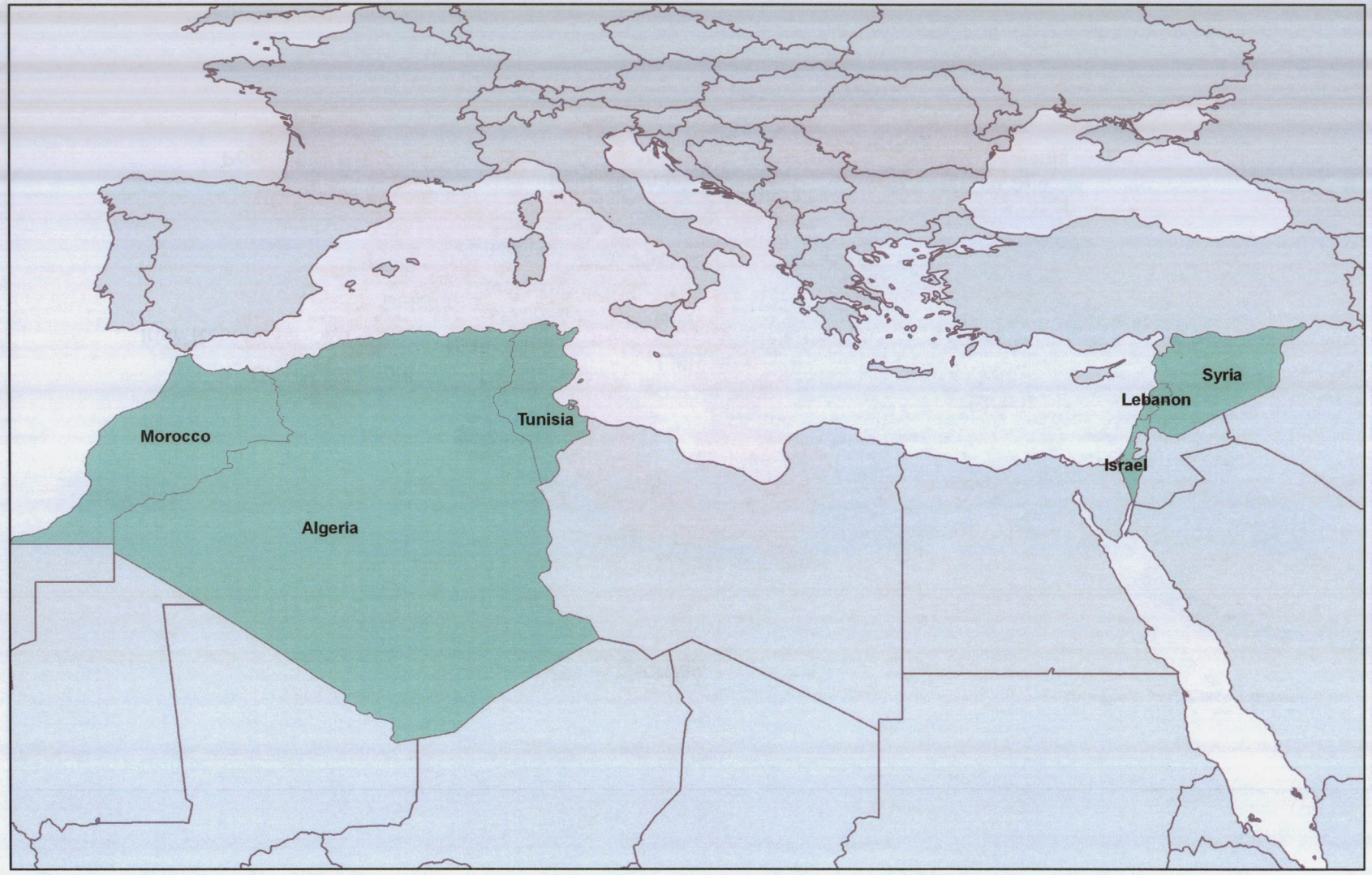


Figure 2. : Data available in countries of the southern Mediterranean basin (in green) *(ESRI World Countries 1996-2002).*

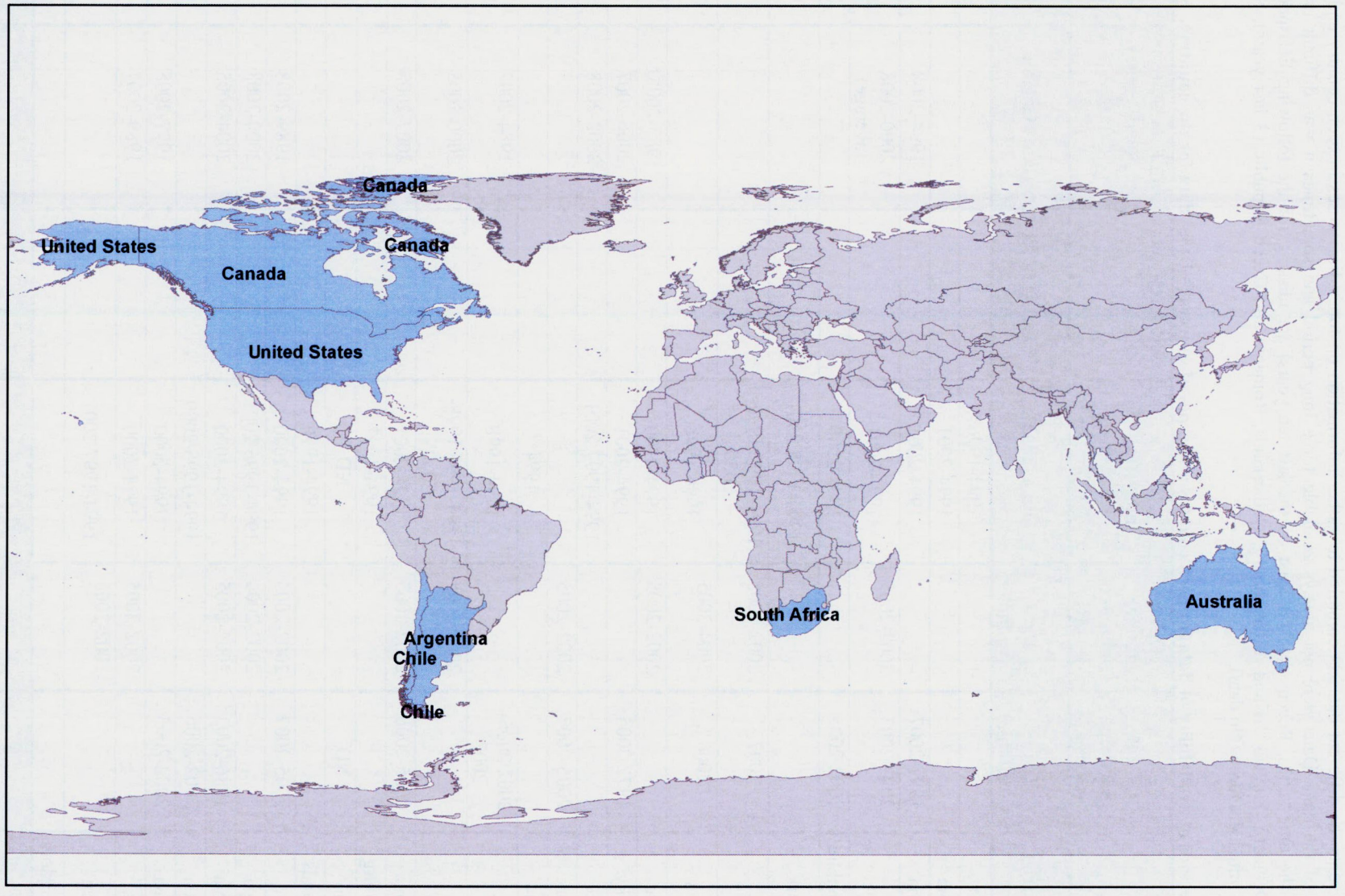


Figure 3. : Data available in other countries elsewhere in the world (in blue):. *(ESRI World Countries 1996-2002).*

2.2. Types of datasets

Table 2 presents the different datasets compiled to gather information on forest fire causes in each country and the periods of availability of the data. Data were not always available for a long period and sometimes it was difficult or impossible to reconstruct the time series. Recent data (at least on the last ten years) are missing for the following EU members: Austria, Belgium, Denmark, Finland, Ireland, Luxembourg, Netherlands, Romania and Czech Republic (3 last years), Slovakia (2 last years) and United Kingdom (No data).

Table 2: Periods of availability of data for each country and types of sources (ND: no data for the country).

	Forest fires in Europe dataset	Other datasets computed by JRC	Timber Bulletin dataset	IFFN Reports	Ministry/State or regional Agency datasets	
EU Countries	**Data available**	**Data available**	**Data available**	**Data available**	**Data available**	**No Data**
Austria			1994-1996			**1997-2008**
Belgium			1994-2001			**2002-2008**
Bulgaria	1997-2007		1994-2001		1994-2008	
Cyprus	2002-2003	2002-2005	1994-2001		2000-2008 (average)	**2006-2008 by year**
Czech Republic	2002-2005		1994-2000			**2001/2006-2008**
Denmark			1994-1998/2001			**1999-2000/2002-2008**
Estonia	2007	2002-2005	1994-1997/1999-2000			**2001/2006/2008**
Finland	2006	2004-2005	1996-1998			**1999-2003/2007-2008**
France		2002-2005	1994-2000		1983-2008*	
Germany	1977-2005		1994-2001		2006-2007	**2008**
Greece			1994-1997/2001		2002-2008	**1998-2000**
Hungary	2005-2007	2002-2005				**<2005/2008**
Ireland			1994			**1995-2008**
Italy	2002/2006-2007		1994-1998		1984-2007	**2008**
Latvia		2002-2005	1994-1996/1998-2000		2000-2008	
Lithuania	2005-2006	2002-2005	1994-2001		2007-2008	
Luxembourg			1994-1997			**1998-2008**
Malta	ND		ND			**ND**
Netherlands			1994-1996			**1997-2008**
Poland	2005-2007	2002-2005	1994-2000		1989-2008	
Portugal		2002-2004	1994-1996/2001		2000-2008	
Romania	1986-2003	2002-2005	1994-2000		2004-2005	**2006-2008**
Slovakia	2002-2006		1994-1998/2000			**2001/2007-2008**
Slovenia	2002-2005		1994-2000		1997-2008	
Spain		2002-2005	1994-2000		1989-2007	**2008**
Sweden		2002-2005	1994-1997/2001			**1998-2000/2006-2008**
United Kingdom						**<2008**
EU new candidates						
Turkey	2003	2002-2005	1994-2001		1997-2006	**2007-2008**

Croatia	2006	2002-2005	1994-2000			**2001/2007-2008**
FYROM			1994-2000		2002	**2001/2003-2008**
Montenegro						**2006-2008**
EFTA countries						
Iceland	*ND*	*ND*	*ND*	*ND*	*ND*	***ND***
Liechtenstein	*ND*	*ND*	*ND*	*ND*	*ND*	***ND***
Norway		2002-2005	1994-2000			**2001/2006-2008**
Switzerland		2002-2005	1994-2000		1990-2008	
Other UNECE countries						
Albania			1994	1988/1996-2001/2001-2004 (average)		**1995-2008 by year**
Andorra	*ND*	*ND*	*ND*	*ND*	*ND*	***ND***
Armenia			1995-2000			**2001-2008**
Australia				1976-1996		**1997-2008**
Belarus			1994-2000			**2001-2008**
Bosnia			1994-1995/1998			**1996-1997/1999-2008**
Canada					1999-2008	
Chile				1990-1999		**2000-2008**
Georgia			1995-1997			**1998-2008**
Israel			1994-1996	1987-2002		**2002-2008**
Monaco	*ND*	*ND*	*ND*	*ND*	*ND*	***ND***
Moldova			1994-1995/1998			**1996-1997/1999-2008**
Russian Federation			1994-2000	1986-1997		**2001-2008**
San Marino	*ND*	*ND*	*ND*	*ND*	*ND*	***ND***
Serbia-Montenegro			1999-2001			**2002-2008**
Ukraine			1994-2001			**2002-2008**
USA					1990-1997	**1998-2008**
other countries						
Algeria				1907-1957/1977-1991		**1992-2008**
Argentina				1992-1999		**2000-2008**
Lebanon						**<2008**
Morocco				1998		**1999-2008**
South Africa				2003		**<2008**
Syria					1987-1998	**1999-2008**
Tunisia				1985-19987		**1999-2008**

*: For the Prométhée database.

The classification of the forest fire causes differs depending on the countries (different levels, different numbers of causes recorded, different types of causes, etc., e.g. Deliverable 2.1.) and on the types of dataset. In order to keep a coherent description of the fire causes in each country, the choice was made to present, as far as possible, the evolution in time of four groups of causes used in the European classification: (i) natural causes (lightning), (ii) causes due to negligence and accident (unintended causes and accidental causes), (iii) causes due to arson (intentional or intended causes) and (iv) unknown (dubious, doubtful) causes. Sometimes, when the information allowing the differentiation between negligence and arson was missing, both were merged in a same group, the human causes. For some countries, details on the different types of causes (motivations) were available, especially for the causes due to negligence and accident but sometimes also for the intentional causes.

3. Synthesis on fire causes

At first, a synthesis on fire causes is given, comparing Northern and Southern Europe, and Europe to Canada. Then, a synthesis for each country (in Europe and elsewhere in the world) is presented. Addidional details for each country are given in the appendix.

3.1. Comparison Northern Europe and Southern Europe and comparison Europe and Canada

Synthesis on fire causes in Northern Europe and Southern Europe but also comparisons between these two parts have been made using all the datasets available (average data per country), focusing on the most recent and stable periods. Tables 3 and 4 present the main cause of forest fires and its percentage recorded for each country in Northern and Southern Europe over a period corresponding to the last years where the data were most stable. Southern Eurpore gathers the countries located on the Northern rim of the Mediterranean Sea. For each country, the mean number of fires by year has been calculated on the same period than for the main cause. This number of fires varies greatly between the countries, depending on different parameters as the forested area of the country. Combined with the proportion of the main cause, it gives an idea of the reliability of the record.

Table 3: Main cause of forest fires, its percentage and mean number of fires/year for each country in Northern Europe.

Country	Period	Main cause	%	Fires/year
Armenia	1995-2000	Negligence	99	11
Austria	1994-1996	Negligence	42	62
Belarus	1994-2000	Negligence	67	2757
Belgium	1994-1999	Negligence	51	43
Bulgaria	2003-2005	Unknown	66	329
Czech Republic	2002-2005	Negligence	64	963
Denmark	1994-1997	Unknown	43	8
Estonia	2002-2005	Negligence	57	65
Finland	1995-2001	Negligence	65	2496
Georgia	1995-1997	Negligence	100	6
Germany	2002-2007	Unknown	44	1040
Hungary	2002-2007	Unknown	61	262
Ireland	1994	Negligence	79	149
Latvia	2002-2008	Negligence	97	958
Lithuania	2002-2008	Negligence	83	736
Luxembourg	1994-1997	Unknown	74	4
Moldova	1994-1997	Negligence	100	15
Netherlands	1994-1998	Unknown	50	69
Norway	2002-2005	Unknown	94	163
Poland*	2002-2008	Arson	45	4395
Romania	2002-2005	Negligence	82	204
Russian Federation	1994-2000	Negligence	74	26 977
Slovakia	2002-2006	Negligence	90	466
Sweden	2001-2005	Negligence	46	6075
Switzerland	2002-2008	Negligence	52	70
Ukraine	1994-2001	Negligence	99	4411
UK	1994-2001	ND	ND	347

* Number recorded only in the State Forests

Table 4: Main cause of forest fires, its percentage and mean number of fires/year for each country of Southern Europe.

Country	Period	Main cause	%	Fires/year
Albania	1994-2001	Negligence	62	395
Bosnia	1994-1995	Negligence	74	136
Croatia	2002-2006	Unknown	51	265
Cyprus	2000-2005	Negligence	66	269
France*	2002-2008	Negligence	36	2138
FYROM	1994-2000	Unknown	77	94
Greece	2002-2008	Unknown	80	1461
Israel	1987-2002	Negligence	43	930
Italy	1997-2002	Arson	60	464
Portugal	2000-2005	Negligence	37	28 482
Serbia & Montenegro	1999-2001	Unknown	47	258
Slovenia	2002-2008	Negligence	45	104
Spain	2000-2005	Arson	57	21 516
Turkey	2002-2006	Negligence	41	1833

* Data recorded only in the Prométhée Database

Figure 4 shows that in Northern Europe, there is a strong variation of the fire frequency for each cause between the different countries. Some countries have not a deep knowledge of their fire causes and show a high proportion of fires due to unknown causes (Norway, Luxembourg, Hungary, and Bulgaria). Some countries classify all their fires within the same cause (negligence/accident) such as Armenia, Moldova or Ukraine, or at least, a great part of their fires (Belarus, Ireland, Latvia, Lithuania, Russian federation or Slovakia). Montainous countries present the highest level of natural fires (Austria and Switzerland). At last, some countries have a high level of arson (Netherlands, Poland) compared to the general trend.

The same observation can be made for the Southern Europe (Fig. 5). FYROM, Croatia and Greece have a high proportion of fires due to unknown causes; for some of them (Greece for instance), the main part of these fires would be due to arson. Albania, Cyprus and Bosnia have a lot of fires recorded as unintentional fires. The highest proportions of fires due to arson are found in Italy, Portugal and Spain compared to the other countries. Sometimes, this can result from differences in the classification of the types of causes depending on the country. The proportion of fires due to lightning is generally weak in Southern Europe, the highest occurring in Greece, Slovenia and Turkey.

The comparison of Northern Europe and Southern Europe (Fig. 6) shows that the frequencies of fires due to negligence/accident are on average higher in Northern Europe than in Southern Europe. The reverse trend is observed with fires due to arson and to unknown causes. Fires due to natural causes are not very frequent in Northern Europe as in Southern Europe.

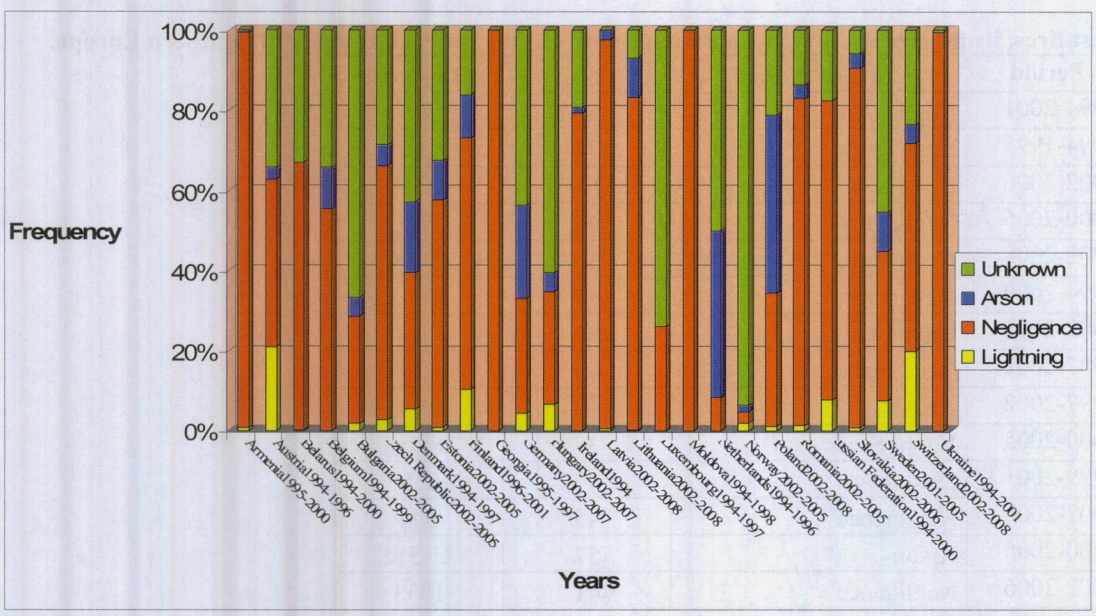


Figure 4: Distribution of fire frequency by causes in Northern European countries *(Sources: Timber Bulletin, Forest fires in Europe, national and regional databases).*

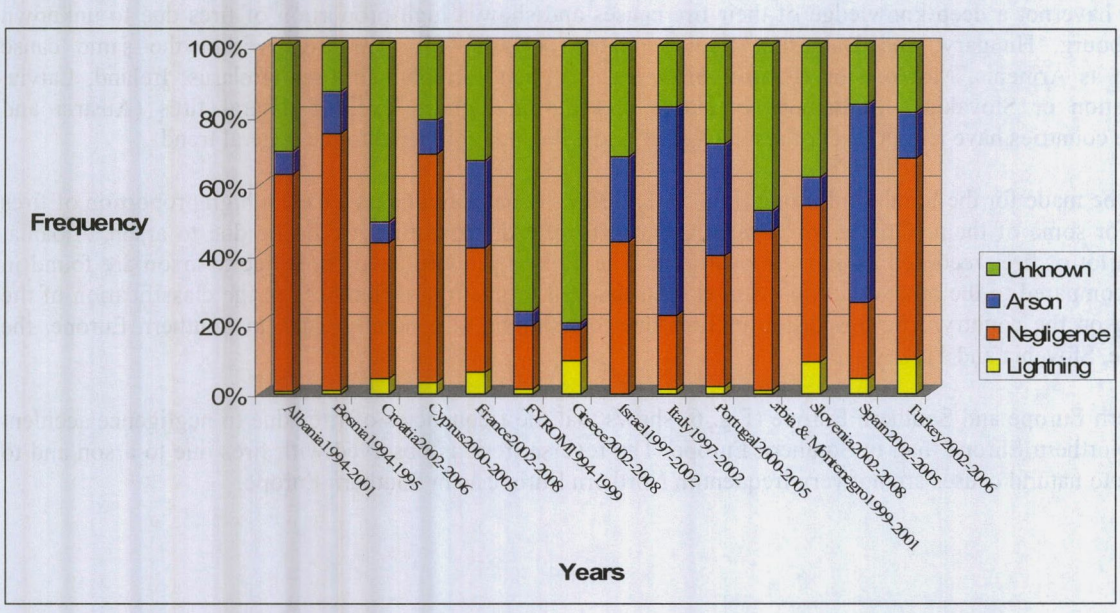


Figure 5: Distribution of fire frequency by causes in Southern European countries *(Sources: Timber Bulletin, Forest fires in Europe, national and regional databases).*

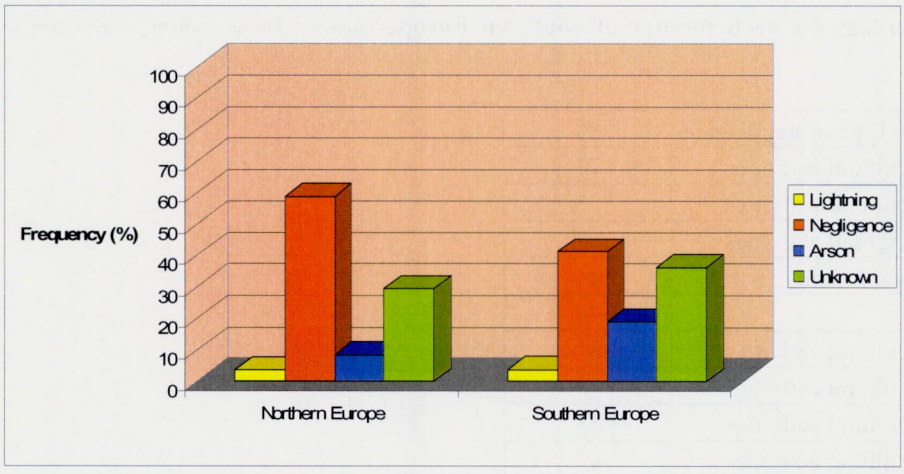


Figure 6: Comparison of fire frequency by causes in Northern Europe and Southern Europe.

Tables 5 and 6 present, for each country of Northern and Southern Europe, the main type of cause due to negligence (based on the classification given in the UNECE Timber Bulletin) and its mean percentage calculated on the period the most recent with stable data.

Table 5: Main type of negligence, its percentage for each country of Northern Europe *(Sources: Timber Bulletin, Forest fires in Europe, national and regional databases).*

Country	Period	Main type of negligence	%
Armenia	1995-2000	General Public	87
Belarus	1994-1997	General Public	86
Belgium	1997-2001	Forest activities	43
Bulgaria	1998-2000	Agricultural activities	90
Czech Republic	1994-2000	General Public	65
Denmark	1994-2001	General Public	54
Estonia	2002-2005	General Public	82
Georgia	1995-1997	General Public	80
Germany	2002-2007	General Public	53
Ireland	1994	General Public	87
Latvia	2002-2008	General Public	83
Lithuania	2002-2008	General Public	74
Moldova	1994-1998	General Public	67
Netherlands	1994-1996	General Public	100
Poland	2002-2008	General Public	74
Romania	1994-2000	Agricultural activities	63
Russian Federation	1995-2000	General Public	87
Slovakia	2002-2005	General Public	61
Sweden	1994-1997	Other	60
Switzerland	2002-2008	General Public	57
Ukraine	1994-2001	General Public	96

Table 6: Main type of negligence, its percentage for each country of Southern Europe *(Sources: Timber Bulletin, Forest fires in Europe, national and regional databases).*

Country	Period	Main type of negligence	%
Bosnia	1994-1998	Agricultural activities	71
Croatia	2002-2006	Agricultural activities	55
Cyprus	2000-2008	Agricultural activities	37
France**	2002-2008	General Public	46
FYROM	1994-2000	Other	48
Greece	1994-1996	Agricultural activities	37
Israel	1994-1996	Agricultural activities	30
Italy	1998-2002	Agricultural activities	55
Portugal	2004-2005	Agricultural activities	47
Serbia & Montenegro	1999-2001	Other	73
Slovenia	2002-2008	Communication	50
Spain	2002-2005	Agricultural activities	36
Turkey	1994-2001	Other	86

The analysis of the types of causes due to negligence/accident shows the following trends:

- In Northern Europe (Fig. 7), fires due to people visiting the forest (general public) such as recreational activities were most frequent and in some countries, it was recorded as the unique or the main fire cause (Latvia, Netherlands, Russian federation, Slovakia, Ukraine). Some countries had a high frequency of fires due to agricultural activities (Bulgaria, Romania) or to Forest activities (Belgium). Fires due to other types of negligence/accident (such as military activities) were frequent in Sweden or Czech Republic during the given periods.

- In Southern Europe (Fig. 8), fires due to "other causes" were frequent especially in Serbia-Montenegro, FYROM and Turkey. Fires due to agricultural activities were also frequent in this part of Europe, especially in Bosnia, Italia and Croatia. The proportion of fires due to logging and forest operations was highest in Greece and fires due to general public were most frequent in Cyprus and Israel. For Italy, the classes "Agricultural activities" and "Forest activities" were given merged.

The comparison between Northern Europe and Southern Europe (Fig. 9) shows that the fires due to general public were, by far, most frequent in Northern Europe. Fires due to Forest activities were as less frequent in Northern Europe than in Southern Europe. The others types were more frequent in Southern Europe, especially "Agricultural activities" and "other".

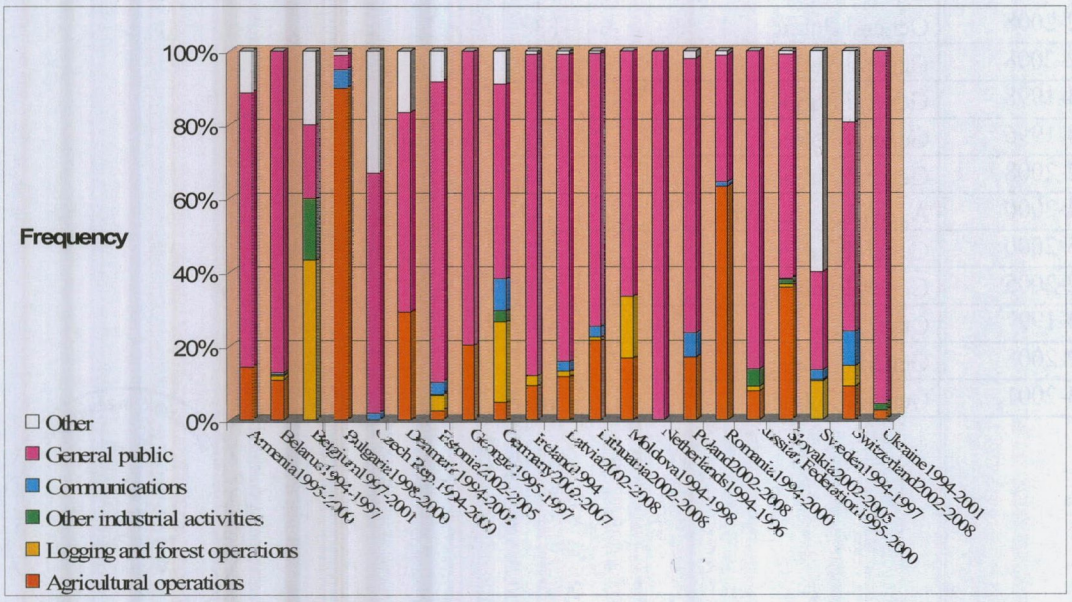


Figure 7: Break-down of causes due to negligence in Northern European countries *(Sources: Timber Bulletin, national and regional databases).*

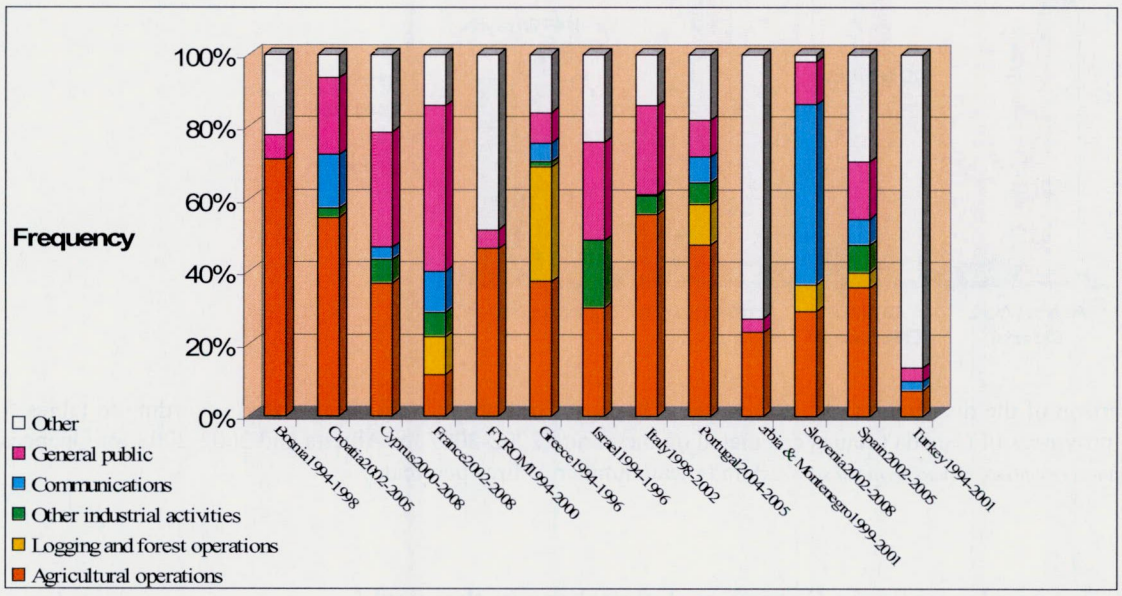


Figure 8: Break-down of causes due to negligence in Southern European countries *(Sources: Timber Bulletin and national and regional databases).*

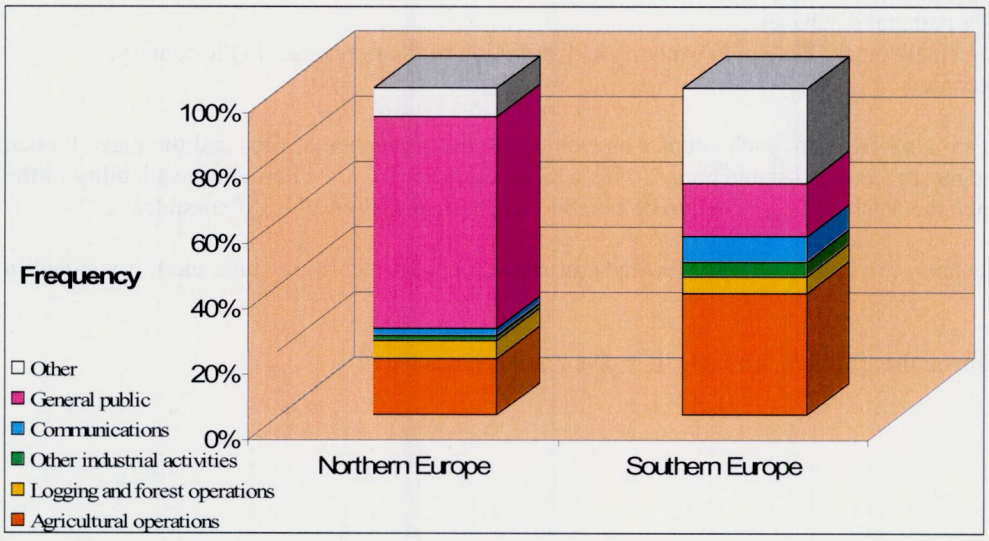


Figure 9: Comparison of fire frequency by causes due to negligence/accident in Northern Europe and Southern Europe.

The comparison of the fire frequency by causes between Europe (South and North) and Canada (East and West) shows that the proportion of fires due to lightning was by far higher in Canada, especially in the Western Province of Alberta, than in Europe (Fig. 10). Negligence/Accident was the main cause of fires regardless of the continent but arson was less frequent in Canada than in Europe. Generally, the fire causes were well known in Canada (less than 5% of unknown causes in Alberta, 0% in Quebec) compared to the situation in Europe, especially in the South (36% of unknown causes on average).

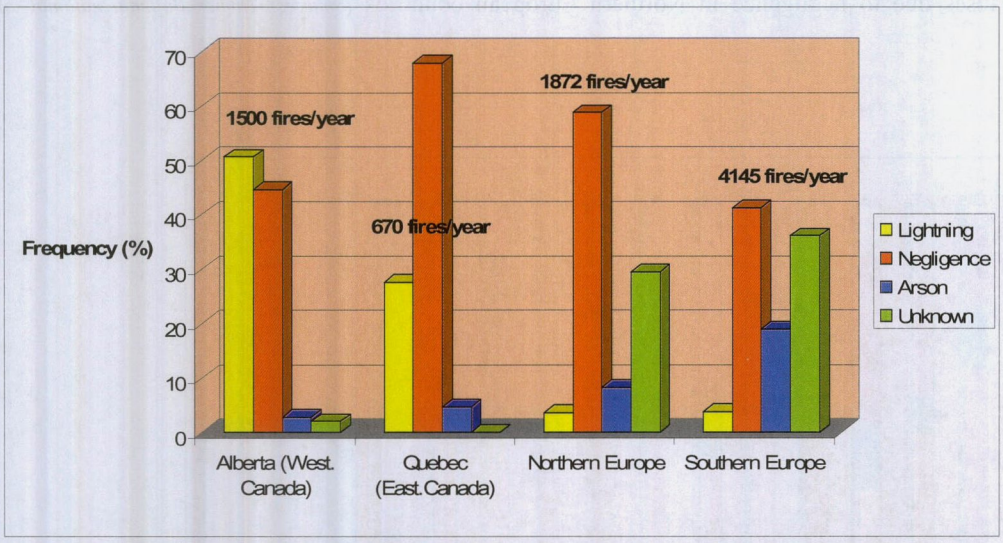


Figure 10: Comparison of the distribution of fire frequency by causes in Europe (values calculated according to tables 5 and 6) and in two provinces of Canada (values calculated on the period 2002-2007 for Alberta and 2002-2008 for Quebec, *Source: Ministry of natural resources, Canadian forest services*) and mean number of fires per year.

3.2. Synthesis for each country in Europe and elsewhere in the world

Countries are classified according to three groups: (i) EU member states (and new candidates), (ii) other European countries and (iii) countries elsewhere in the world.
For each country, different kinds of information are given in the synthesis:

- the source of data on forest fire causes (what institution collects data),
- the type of database (regional or national database),
- the socio-economic or environmental context that could explain the distribution of the fire causes in the country,
- the different types of causes recorded.

The most recent fire statistics are also given for each country as well as the mean number of fires and the mean burned area per year, calculated on the most recent and stable period. This period can differ from the period of availability of the database and the period on which the database is assumed to be reliable (database quality) is given if possible.

When the data collected in a country are not usual (very few data available, unusual record of cause, etc.), it is noted in the specificity of the country.

When more detailed information on fire causes is available, it is given in the appendix.

Database Availability	Database Quality	AUSTRIA	Mean nb of fires/year (1994 - 1996)	Mean burned area/year (1994 - 1996)	AT
1994 - 1996			66	39 ha	

Source of data

In Austria, all the data on wildland and forest fires are recorded by the fire brigades. The summary of the data will be collected by the federal country fire service associations that give the database to the Austrian federal fire brigade association.

Type of database

Non available

Type of fire recorded

Due to the high number of fire-fighters and to the short distance to cover, most fires are smaller than 100m². In the database, agricultural and forest fires are differentiated and only the number of fires is taken into account.

Socio-economic or environmental context

Non available

Causes recorded

The fire causes are not especially investigated but they seem to be the same than in other countries: Burned woods by the farmers, agricultural machinery, railway and other vehicles; there is not a lot of arson according to the fire brigades. Because of this, very few data are available on fire causes and their statistics, especially for the last decade.

Statistics on fire causes

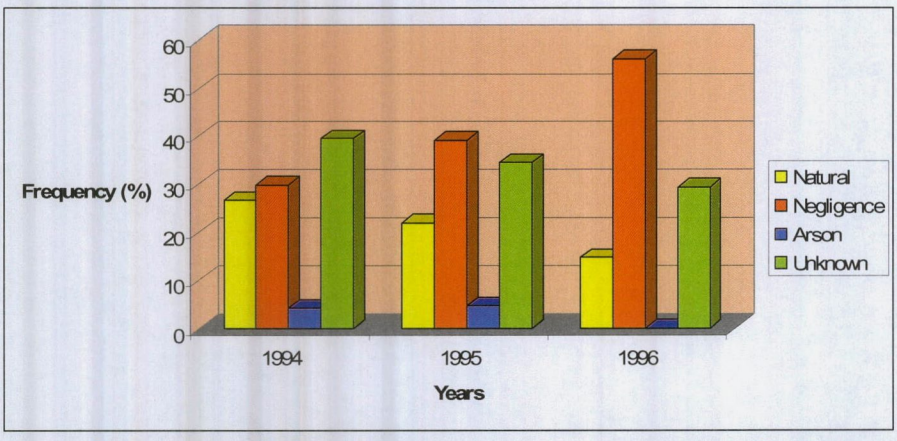


Figure 11: Distribution of the fire frequency by causes in Austria in 1994, 1995 and 1996 *(Source: Timber Bulletin).*

From 1994 to 1996, the proportion of fires due to negligence increased greatly. Proportion of fires due to natural causes, quite high in 1994 (more than 20% of the fires) decreased over this period (Fig. 11). In 1989, it was reported that on a total number of 88 fires affecting an area of 52.3 ha of forest land, 50 % of all fires nationwide were caused by negligence, and the State of Vorarlberg showed a relatively high proportion of lightning fires attributing to 10 % of fire causes all over the country. Between 1980 and 1996, an important part of the wildfires were caused by lightning, especially at high elevations (27% in 1994).

Causes	Mean %1994-1996	Main types of cause
Lightning	21%	
Negligence	**42%**	No data
Arson	3%	
Unknown	34%	

Specificity of the country: In Austria, the only data available concern statistics from 1994, 1995 to 1996 (UNECE Timber bulletin).

Database Availability	Database Quality	**BELGIUM**	Mean nb of fires/year (1994-1996)	Mean burned area/year (1994-1996)	BE
1994 – 2001			**41**	**235 ha**	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

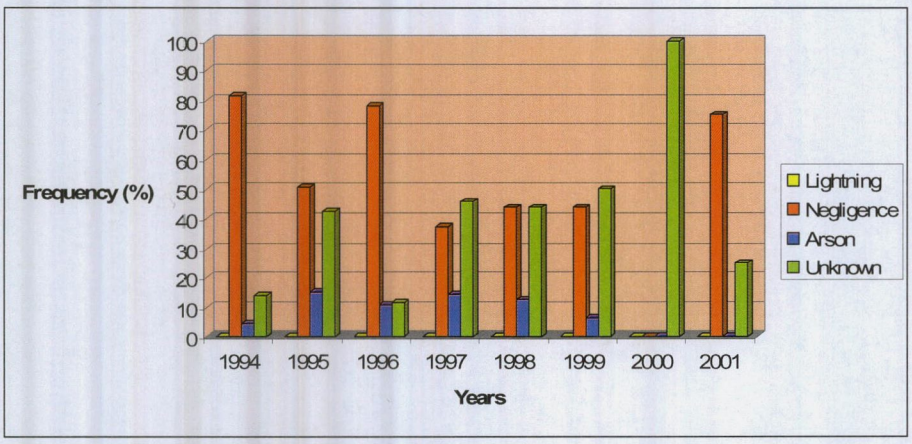


Figure 12: Distribution of the fire frequency by causes in Belgium from 1994 to 2001 *(Source: Timber Bulletin)*.

Proportion of fires due to negligence and unknown causes were the highest from 1994 to 2001. Fires due to arson (10% of the fires till 1999) have not been recorded anymore since 2000. Natural fires were not recorded in Belgium (Fig. 12). Negligence was mainly due to Forest activities in 1998 and to general public and industrial activities in 2001 (UNECE Timber Bulletin).

Causes	Mean %1994-2001	Main types of cause
Lightning	0%	
Negligence	**51%**	Forest activities, industrial activities
Arson	8%	
Unknown	41%	

Specificity of the country: In Belgium, the only data available concern statistics from 1994 to 2001 (UNECE Timber bulletin).

Database Availability	Database Quality	BULGARIA	Mean nb of fires/year (2003-2007)	Mean burned area/year (2003-2007)	BG
1994 - 2008	1999 - 2008		572	10826 ha	

Source of data

In Bulgaria, the institution that records and gathers data on forest fires is the State Forestry Agency (SFA). All the information is collected electronically from the State Forestry's in one SFA server and information can be extracted from the database at local, regional or national level.

Type of database

Non available.

Type of fire recorded

The minimal fire area to be recorded is 0.1 ha. SFA has obligation to record all the fires occurring in forest (State Forestry Agency).

Socio-economic or environmental context

In the past, forest fires had never been a serious problem in Bulgaria thanks to the natural and climatic conditions in the country. They became a problem and a threat during the last decade mainly due to the global climate warming, the social and economic changes in the country during the process of transition towards market economy and the change in the organization of the activities in the forestry sector.

Causes recorded

Agricultural burning was classified as a fire cause as well as negligence, arson, natural and unknown. For the analysis, negligence and agricultural burning have been merged in the same category.

Statistics on fire causes

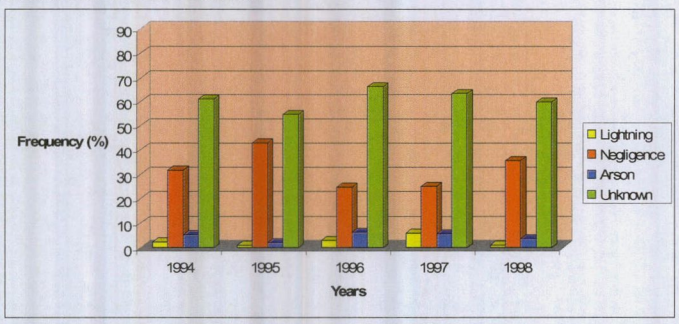


Figure 13: Distribution of the fire frequency by causes in Bulgaria from 1994 to 1998 *(Source: Timber Bulletin).*

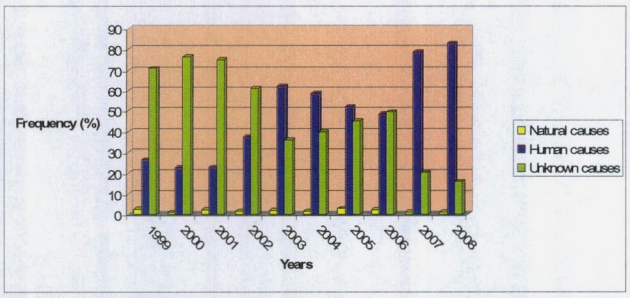


Figure 14: Distribution of the fire frequency by causes in Bulgaria from 1994 to 2008. Human causes are not detailed *(Sources: Fire report, State Forestry Agency, V. konstantinov).*

At first, detailed statistics were given from 1994 to 1998 (Fig. 13). The unknown cause was most important (>50% and up to 65%) but negligence increased in 1998 in contrast of arson and natural causes (Fig. 13). After 1998, negligence and arson were not detailed anymore and merged in a single category "Human causes". During the period 1994-2008, the proportion of fires due to unknown causes has strongly decreased, especially since 2002 (after a slight increase above 70% between 1999 and 2001) in contrast of the proportion of fires due to human causes. Since 2007, human causes are the most important (>70%). The proportion of fires due to natural causes remained low over the period (Fig. 14). In 2008, the break-down of fire causes was available. The main human cause was by far general negligence and uncontrolled fires that were ignited for field clearing (80%). Only 3% of the fires were due to arson and 16% remained unknown.

Causes	Mean % 1994-1998	Main types of cause	Causes	% in 2008
Lightning	2%		Lightning	1%
Negligence	27%	Agricultural activities	Negligence	**80%**
Arson	5%		Arson	3%
Unknown	**66%**		Unknown	16%

Database Availability	Database Quality	CROATIA	Mean nb of fires/year (2002-2006)	Mean burned area/year (2002-2006)	HR
1994 – 2006			4281	40 296 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Only the fires larger than 500ha, occurring in forests, shrublands and pasture lands are recorded, underestimating the total number of wildfires in Croatia.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

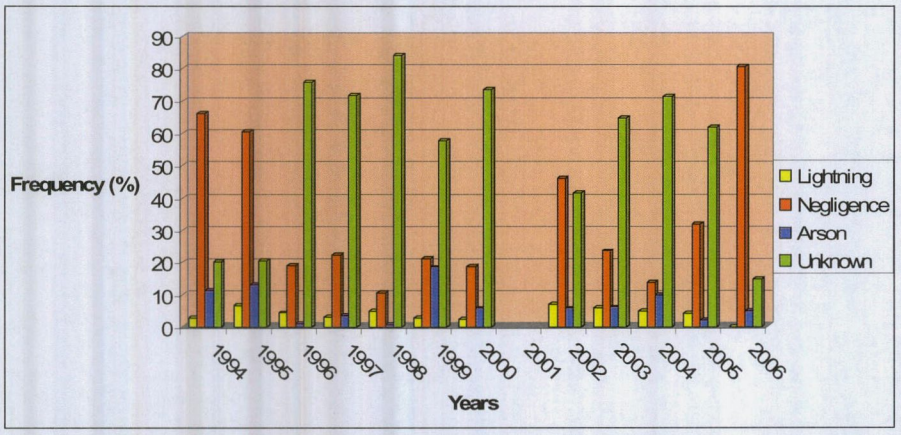


Figure 15: Distribution of the fire frequency by causes in Croatia from 1994 to 2006 *(Sources: Forest Fires in Europe, Timber Bulletin. From 2002 to 2005, data have been prepared for the UNECE bulletin and computed by JRC using the EFFIS fire database).*

The distribution of fire frequency by causes was available from 1994 to 2006 (except 2001). From 1994 to 2000, the proportion of fires due to negligence decreased strongly (from 65% to 10%) in contrast of the proportion of fires due to unknown causes (up to 83%). In 2006, the trend was reversed (80% due to negligence, 10% due to unknown causes). Natural fires were not recorded in 2006 and fire due to arson, after a rise in 1999, became less frequent (Fig. 15).

Causes	Mean % 2002-2006	Main types of cause
Lightning	4%	
Negligence	39%	Agricultural activities
Arson	6%	
Unknown	**51%**	

Specificity of the country: New candidate.

For more information, see Appendix.

Database Availability	Database Quality	CYPRUS	Mean nb of fires/year (2000-2008)	Mean burned area/year (2000-2008)	CY
1980 - 2008	2000-2008		80	445 ha	

Source of data

The institutions in Cyprus that gather and record data on forest fires are the Department of Forests and the Fire Service. The contact point for EU is the Department of Forests in which the central database for the forest fires is based. The Department of Forests by law is responsible for the state forests and a radius of 1 km around. All the fire statistics in these areas are recorded (for the EU database, pure agricultural fires are excluded). The Fire service, responsible for the fires, sends the data to the Department of Forests (Central Database). After evaluation by the Department of Forests, it is sent to EFFIS (source department of forest). Fires in occupied areas are not included in the statistics.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

The main fire causes are: agricultural activities such as the burning of stubble and grasses, hunting, recreation activities, military exercises, and burning of rubbish. The biggest percentage of forest fires in Cyprus is of human origin and is mainly a result of negligence and lack of attention despite the fact that in some cases, it is a result of arson.

Statistics on fire causes

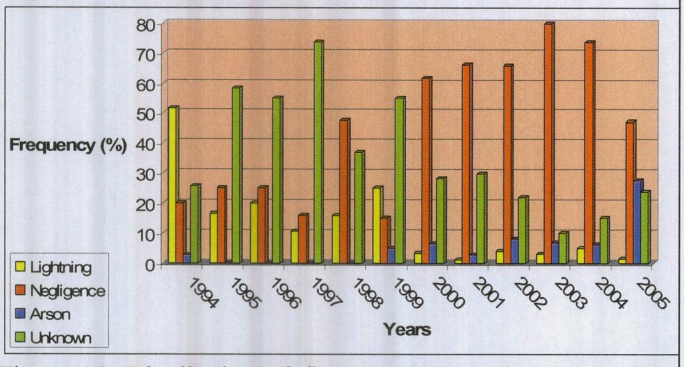


Figure 16: Distribution of fire causes according to the fire frequency in Cyprus from 1994 to 2005 *(Sources: Forest Fires in Europe, Timber Bulletin. From 2002 to 2005, data have been prepared for the UNECE bulletin and computed by JRC using the EFFIS fire database).*

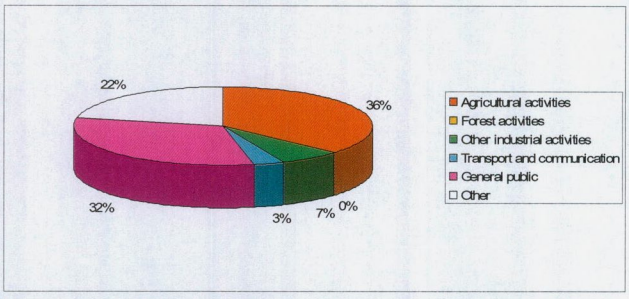


Figure 17: Break-down of the fire causes due to negligence and accident in Cyprus the periods 2000-2008 *(Sources: Ministry of Agriculture, department of forest, C. Papageorgiou)*

Figure 16 presents the fire statistics of the period 1994-2005. It shows that after 1997, the proportion of fire due to negligence increased strongly up to 80% in contrast of the proportion of fires due to unknown causes. Negligence was mainly due to agricultural activities, general public and other types of causes (Fig. 17). Since 1999, the proportion of fires due to arson also increased slightly (up to 25% in 2005). Fires due to natural causes were frequent (>10%) between 1994 and 1999 (Fig. 16).

Causes	Mean % in 2000-2005	Main types of cause
Lightning	3%	
Negligence	**66%**	Agricultural activities
Arson	10%	
Unknown	21%	

For more information, see Appendix.

Database Availability	Database Quality	CZECH REPUBLIC	Mean nb of fires/year (2002-2005)	Mean burned area/year (2002-2005)
1994 – 2005			963	494 ha

CZ

Europe EU

Europe out of EU

Out of Europe

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

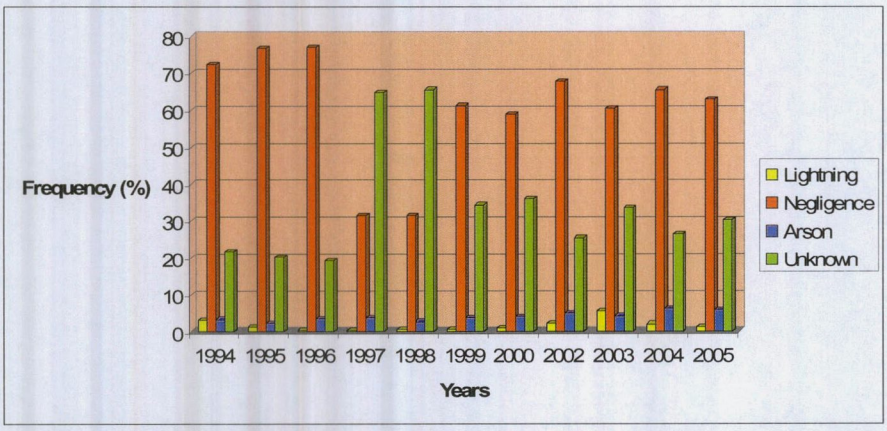


Figure 18: Distribution of the fire frequency by causes in Czech Republic from 1994 to 2005 No data available for 2001
(Sources: Forest Fires in Europe, Timber Bulletin. From 2002 to 2005, data have been prepared for the UNECE bulletin and computed by JRC using the EFFIS fire database).

Figure 18 shows that in 1997 and 1998 there was an increase in the proportion of fires due to unknown causes in contrast of the proportion of fires due to negligence. During the rest of the period, negligence was the main cause of fires, mainly due to recreational activities (general public) and other types of negligence (UNECE Timber Bulletin). Natural and intentional fires were not frequent (<5%).

Causes	Mean % 2002-2005	Main types of cause
Lightning	3%	
Negligence	**64%**	General public
Arson	5%	
Unknown	29%	

Specificity of the country: The only data available for Czech Republic are the fire statistics from 1994 to 2005 (UNECE Timber bulletin).

Database Availability	Database Quality	DENMARK	Mean nb of fires/year (1994-1997)	Mean burned area/year (1994-1997)	DK
1994 - 1997			8	18 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

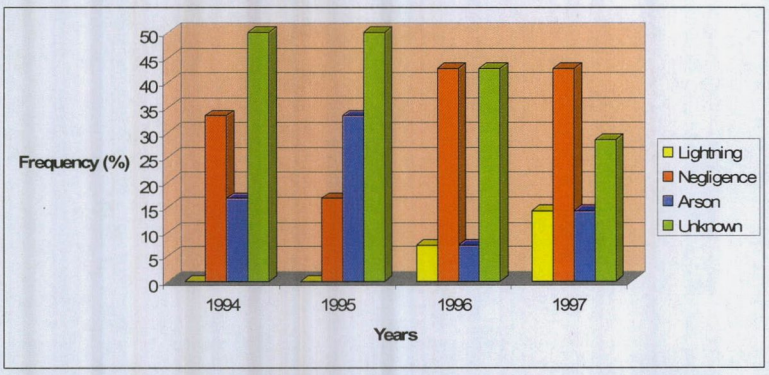


Figure 19: Distribution of the fire frequency by causes in Denmark from 1994 to 1997 *(Source: Timber Bulletin).*

Between 1994 and 1997, the proportion of fires due to unknown causes decreased (fewer than 30%) whereas the proportion of fires due to negligence increased (over 40%). More than 30% of the fires were due to arson in 1995, the other years; it was less than 15%. Since 1996, the proportion of fires due to natural causes has increased up to 14% (Fig. 19).

Causes	Mean % 1994-1997	Main types of cause
Lightning	5%	
Negligence	34%	General public
Arson	18%	
Unknown	**43%**	

Specificity of the country: The only data available for Denmark are the fire statistics from 1994 to 1997 (UNECE Timber Bulletin).

Database Availability	Database Quality	ESTONIA	Mean nb of fires/year (2002-2005)	Mean burned area/year (2002-2005)	EE
1994 - 2005			65	689 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Fire occurrence depends on climate variability and human activity. Most forest fires take place in forests situated near urban areas, predominantly near Tallinn and Kohtla-Järve. The majority of human-made forest fires are caused by negligent smokers and people making campfires, most of them beginning at the roadside.

Causes recorded

Non available.

Statistics on fire causes

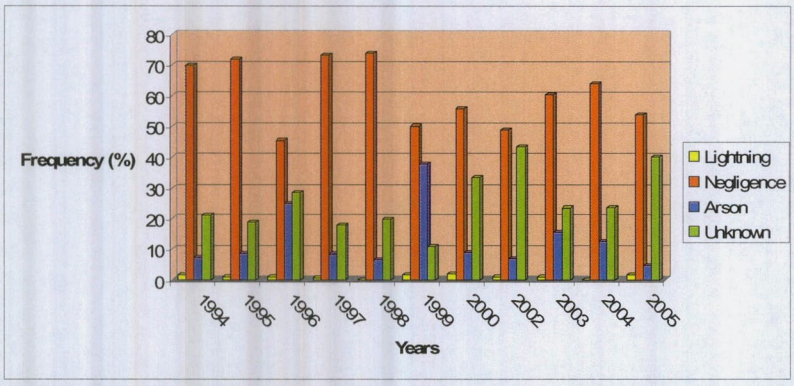


Figure 20: Distribution of fire frequency by causes in Estonia from 1994 to 2005. No data available in 2001. *(Sources: Timber Bulletin, Forest Fires in Europe. From 2002 to 2005, data have been prepared for the UNECE bulletin and computed by JRC using the EFFIS fire database).*

Figure 20 shows that negligence was the main cause of fire over the period 1994-2005 sometimes up to 70% and more (1995, 1997, 1998), mainly due to general public (UNECE Timber bulletin). The proportion of fires due to arson increased strongly in 1996 (25%) and 1999 (>35%). Fires due to natural causes were rare.

Causes	Mean % 2002-2005	Main types of cause
Lightning	1%	
Negligence	**57%**	General public
Arson	10%	
Unknown	33%	

For more information, see Appendix.

Database Availability	Database Quality	FINLAND	Mean nb of fires/year (1996-2001)	Mean burned area/year (1996-2001)	FI
1996 – 2001	1996 – 2001		1093	459 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

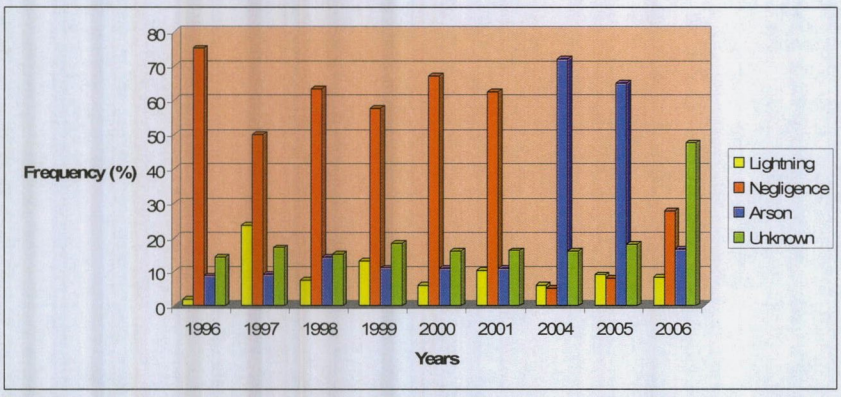


Figure 21: Distribution of the fire frequency by causes in Finland from 1996 to 2006. No data available for the period 2002-2003 (*Sources: Ministry of Interior, N. Alpo, Forest fires in Europe. From 2004 to 2005, data have been prepared for the UNECE bulletin and computed by JRC using the EFFIS fire database*).

Between 1996 and 2001, negligence was the main cause of fire above 50% except in 1997 when a rise in the fire frequency due to natural cause occurred (>20%). General public was the main type of negligence (UNECE Timber bulletin). Fires due to arson and to unknown causes represented less than 20% of the fires during this period but the proportion of intended fires became the highest in 2004 and 2005 in contrast of the proportion of causes due to negligence. There was a drop in the knowledge of causes in 2006 (more than 40% of unknown causes) (Fig.21).

Causes	Mean %1996-2001	Main types of cause
Lightning	10%	
Negligence	**63%**	General public
Arson	11%	
Unknown	16%	

Specificity of the country: Currently, no data available after 2001.

Database Availability	Database Quality	FRANCE	Mean nb of fires/year (2006-2008)	Mean burned area/year (2006-2008)	FR
1983 – 2008 (Prométhée DB)	**1997 – 2008** (Prométhée DB)		**3595** (whole country)	**7491 ha** (whole country)	

Europe EU

Europe out of EU

Out of Europe

Source of data

In France, data on forest fire causes are collected either by the fire brigades, the forest managers or the gendarmes. Then, data are gathered in a database at regional scale and at national scale.

Type of database

There are two regional databases on forest fire causes in France: one for the southeastern France (concerning the 15 départements of southeastern France) created in 1973 (Prométhée database) and one for the southwestern France (Region Aquitaine) created in 2006. Both are included in a national database where are also recorded data on fires occurring in the rest of the country. This national database has a new support and a new protocol of filling since 2006. The classification of fire causes is more detailed in the Prométhée database than in the other databases and the number of fires recorded in the southeastern France is highest.

Type of fire recorded

All the forest and natural space fires are recorded in the databases, regardless of their area, except the agricultural and suburban fires that are recorded in other databases.

Socio-economic or environmental context

Non available.

Causes recorded

In the Prométhée database: After 1997, the fire causes were recorded with 4 levels of knowledge: (i) sure, (ii) likely, (iii) supposed and (iv) unknown, then 6 groups of causes were identified: (i) unknown, (ii) natural, (iii) diverse accidents, (iv) diverse intentional (arson), (v) diverse professional works and (vi) diverse individual works. To be coherent with the European classification, the groups (iii), (v) and (vi) were merged in a unique group "Negligence/Accident" for the statistics on fire causes.

Statistics on fire causes

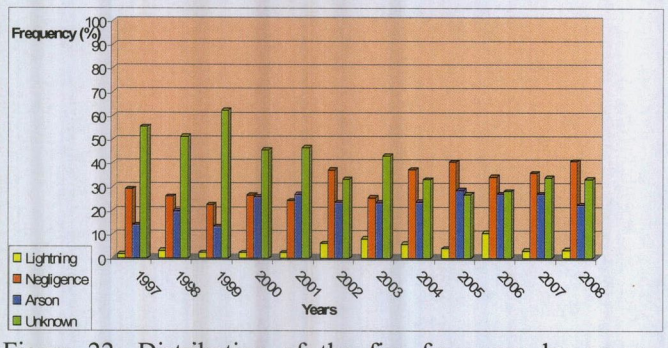


Figure 22: Distribution of the fire frequency by causes in southeastern France from 1997 to 2008 (*Source: Prométhée*).

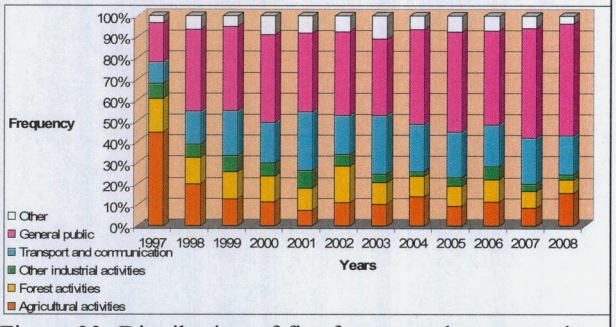


Figure 23: Distribution of fire frequency by causes due to negligence in southeastern France from 1997 to 2008 (*Source: Prométhée*).

The frequency of fires due to unknown causes has decreased since 2000 (mostly >50% before 2000, around 30% in 2008) in contrast of the frequency of fires due to negligence/accident (less than 30% before 2002, up to 40%). The proportion of fires due to arson increased slightly in 2000, exceeding 20%, and seemed constant since then. The frequency of fires due to natural causes remained low over the period except some years (12% in 2006) (Fig. 22). Since 1998, the main cause of negligent fires has been the general public with individual works, surpassing the agricultural activities. The frequency of fire due to forest activities also decreased over this period (Fig. 23).

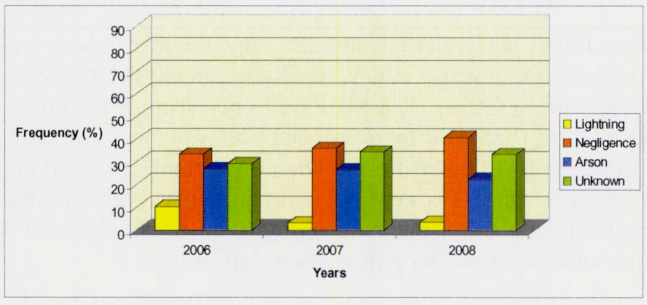


Figure 24: Distribution of the fire frequency by causes in southeastern France from 2006 to 2008 (*Source: Prométhée*).

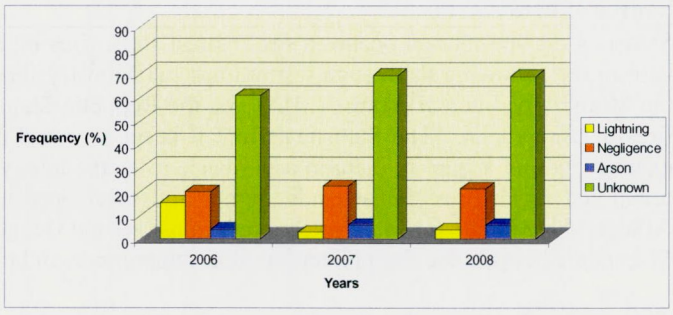
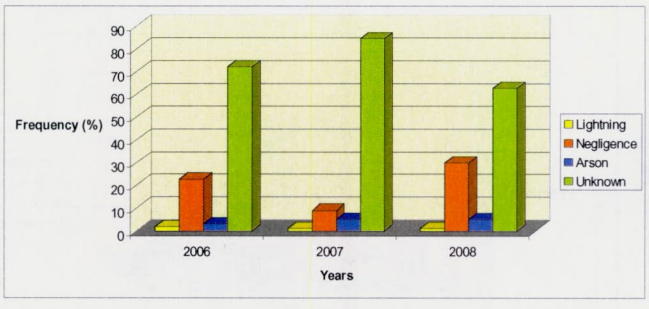


Figure 25: Distribution of the fire frequency by causes in southwestern France from 2006 to 2008 (*Source: PPFCI Aquitaine*).

Causes	Mean %2006-2008	Main types of cause
Lightning	6%	
Negligence	**37%**	General public
Arson	25%	
Unknown	32%	

Causes	Mean %2006-2008	Main types of cause
Lightning	7%	
Negligence	21%	General public
Arson	5%	
Unknown	**66%**	



Causes	Mean %2006-2008	Main types of cause
Lightning	2%	
Negligence	21%	General public
Arson	5%	
Unknown	**73%**	

Figure 26: Distribution of the fire frequency by causes in the rest of France from 2006 to 2008 (*Source: BDIFF France*).

Figures 24 to 26 present the comparison of the fire frequency by causes of the two regional databases and of the rest of the country, between 2006 and 2008. The total number of fires recorded during this period in southeastern France was equal to 5901, it was equal to 4408 in southwestern France and only to 462 in the rest of France. The proportion of fires due to unknown causes was lowest in the southeastern region (around 30%) and it was of the same range than the proportions of fires due to negligence and arson during the period (Fig. 24). For the two other regions, the proportion of fires due to negligence was higher than the proportions of fires due to arson and to lightning but the knowledge of causes was poor.

Specificity of the country: High geographical variation of the fire causes frequency. Database of the southeastern France (Prométhée) is more complete and reliable than the others, especially after 1997.

For more information, see Appendix.

Database Availability	Database Quality	FYROM Former Yougoslavian Republic of Macedonia	Mean nb of fires/year (1994-2000)	Mean burned area/year (1994-2000)
1994 – 2000 2002			94	4272 ha

MK

Europe EU

Europe out of EU

Out of Europe

Source of data

Statistics on fire data on occurred fires (forest fires, fires on agricultural lands, dumps and other uncultivated lands) are kept in the following three state institutions: the Ministry for Agriculture, Forestry and Water Management (MAFWM), the Ministry of Internal Affairs (MIA) and the Republic Statistical Bureau (RSB). The MAFWM only keeps a record of fires on forest lands. The Statistical Bureau keeps a record on all fires, but only for parameters relevant for their use, quantifying and acquiring them in accordance to methodology fit solely for statistical uses. The most complete record on urban and forest fires (forest lands, dumps and other open urban/rural spaces) is kept only in the Ministry of Internal Affairs – Directorate for Fire Protection, Explosions and Dangerous Materials. It is the main authority for fire protection in Macedonia because the fire pre-suppression, suppression and liquidation are under its principal responsibility.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

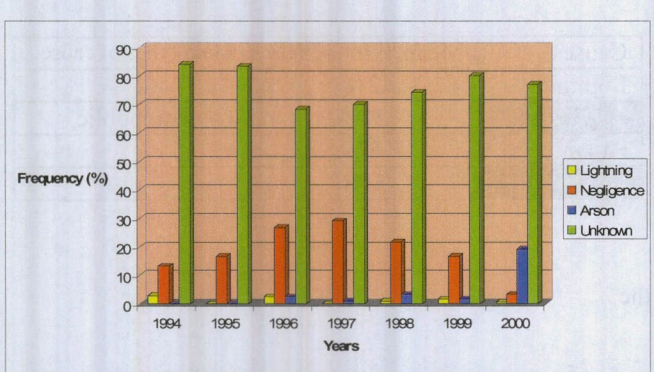


Figure 27: Distribution of the fire frequency by causes in FYROM from 1994 to 2000 *(Source: Timber Bulletin).*

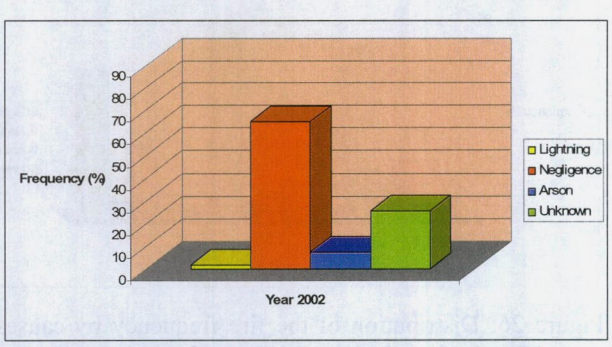


Figure 28: Distribution of fire frequency by causes due to negligence in FYROM in 2002 *(Source: IFFN).*

Between 1994 and 2000, the proportion of fires due to unknown causes was the highest (>65%). After a rise in 1996, the proportion of fires due to negligence, mainly due to agricultural activities and military exercises (UNECE Timber Bulletin), decreased. In 2000, the number of fires due to arson increased greatly from less than 5% up to 20% (Fig. 27). In 2002, compared to the previous period (from 1994 to 2000), negligence was the main cause of fires (65%) decreasing the proportion of fires due to unknown causes to 25% (Fig. 28). Arson represented 7.5% of the fires.

Causes	Mean %1994-2000	Main types of cause
Lightning	1%	
Negligence	18%	Agricultural activities and military exercises (Other)
Arson	4%	
Unknown	**77%**	

Specificity of the country: No data available in 2001 and after 2002.

Database Availability	Database Quality	GERMANY	Mean nb of fires/year (2002-2007)	Mean burned area/year (2002-2007)	DE
1977 - 2007	1992 - 2007		978	459 ha	

Source of data

In Germany, data on forest fires are gathered by the Federal Agency for Agriculture and Food. The fire statistics of the former German Democratic Republic were first included in 1991.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

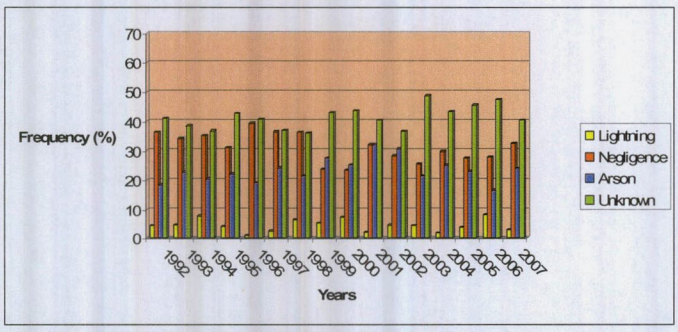


Figure 29: Figure 78: Distribution of the fire frequency by causes in Germany from 1992 to 2007 (*Sources: Timber Bulletin, Forest Fires in Europe, Federal Agency for Agriculture and Food).*

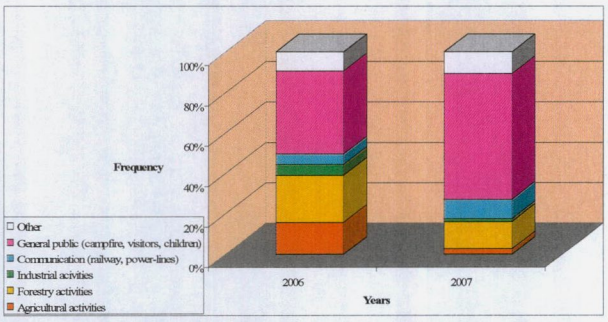


Figure 30: Break-down of the fire causes due to negligence in Germany in 2006 and 2007 (*Source: Federal Agency for Agriculture and Food*).

Figure 29 shows that during the period 1992-2007, fires due to arson were quite frequent (>20%). Between 2002 and 2005, their proportion was almost the same than the proportion of fires due to negligence that has decreased since 1998. The fires due to unknown causes were the most frequent (around 40%) especially since 1998. Natural causes were not frequent (<10%). The main type of negligence was due to people in forest (general public) as shown in figure 30.

Causes	Mean %2002-2007	Main types of cause
Lightning	4%	
Negligence	29%	General public
Arson	23%	
Unknown	**44%**	

Specificity of the country: Before 1992, the fire statistics were recorded only in West Germany, after that, they concern the whole country. Both periods cannot be compared.

For more information, see Appendix.

Database Availability	Database Quality	GREECE	Mean nb of fires/year (2002-2008)	Mean burned area/year (2002-2008)	GR
1994 - 2008	2002 - 2008		1461	241 702 ha	

Source of data

In Greece, the Forest Services are in charge to record the data on forest fires.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

The number of people leaving the cities in the summer, seeking cooler places along the coastline and in the mountain villages for their vacation, has gradually increased, increasing the probability of accidental fires. The same is true for tourists who visit Greece every summer at the peak of the fire season. Before 1990, most of the large fires were identified as arsons (in Greece, only 5% of the total number of fires are responsible for the 70% of the total burned area). Since Greece lacks nationwide land ownership and utilization maps, many of the burned forest lands are subsequently misappropriated and occupied by the arsonists and converted into agricultural or grazing land or used for housing construction development. It is characteristic that most cases of arson occur in coastal forests at areas of high population density, increased land value, and touristically popular during the summer. Revenge, political unrest, and pasture improvement are also causes of arson in Greece. Farmers are also involved in the forest burning. There is a substantial fragmentation of forest and agricultural land which alternate in the Greek landscape. Thus, fires started in cultivated fields easily spread to nearby forests. Moreover, in Greece, grazing of sheep and goats, traditional in the country, has become one of the main causes of wildfires. Indeed, shepherds react to overgrazed lands by burning to stimulate new growth of shrubs and grasses.

Causes recorded

The nine groups of fire causes are recorded in Greece: Arson, negligence, lightning, military, engines, explosives, short-circuits, hunting and unknown.

Statistics on fire causes

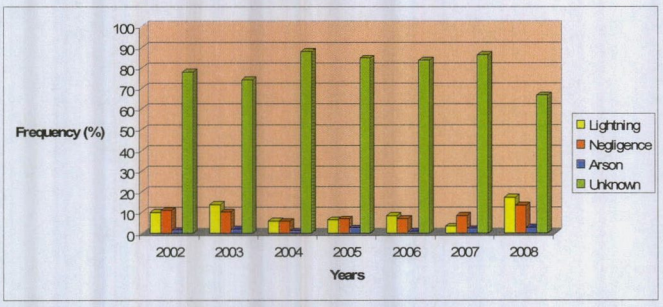


Figure 31: Distribution of the fire frequency by causes in Greece from 2002 to 2008 *(Source: T. Pallas, Ministry of rural development and food).*

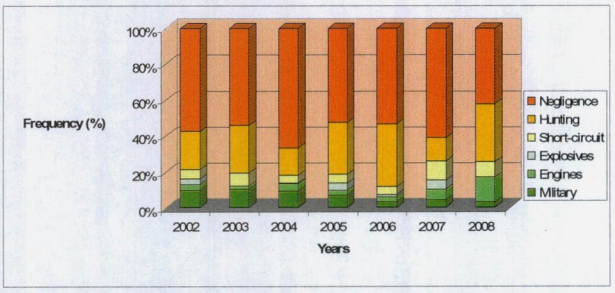


Figure 32: Distribution of fire frequency by causes due to negligence in Greece from 2002 to 2008 *(Source: T. Pallas, Ministry of rural development and food).*

Figure 31 shows the dominance of the fires with unknown cause in Greece between 2002 and 2008, only few fires had a known cause (less than 20%). In this case, lightning and negligence were the main causes. Hunting was the most frequent accidental cause (Fig. 32). Compared to the previous period, the frequency of fires due to negligence decreased during this period 2002-2008 whereas the frequency of fires due to lightning increased (>10% some years).

Causes	Mean %2002-2008	Main types of cause
Lightning	9%	
Negligence	9%	Agricultural and forest activities
Arson	2%	
Unknown	**80%**	

Specificity of the country: Most fires due to unknown causes are supposed to be intentionally ignited. The lack of investigation is the main cause of this lack of knowledge.

For more information, see Appendix.

Database Availability	Database Quality	HUNGARY	Mean nb of fires/year (2002-2007)	Mean burned area/year (2002-2007)	HU
2002 - 2007			285	1852 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

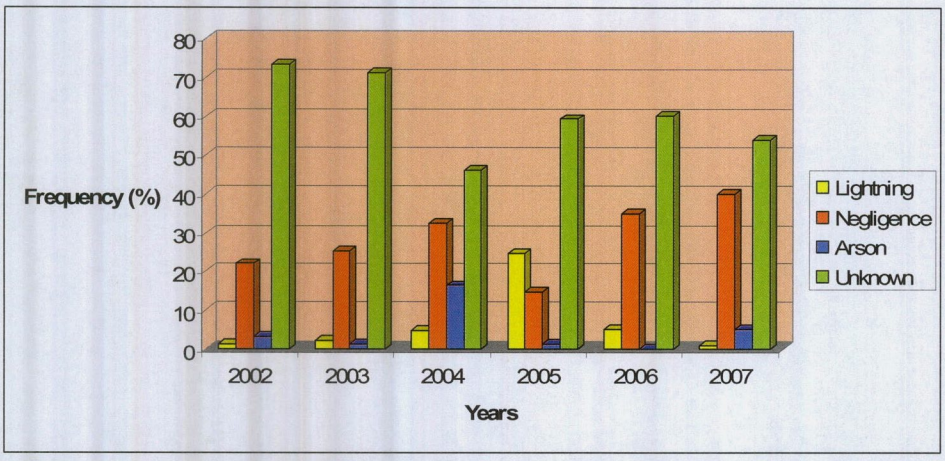


Figure 33: Distribution of the fire frequency by causes in Hungary from 2002 to 2007 *(Sources: Forest Fires in Europe. From 2002 to 2005, data have been prepared for the UNECE bulletin and computed by JRC using the EFFIS fire database).*

Figure 33 shows that during the period 2002-2007, the proportion of fire due to negligence increased (from 20 to 40%). The proportion of fires due to natural causes increased over 20% in 2005 but was generally under 5% the rest of the period. Unknown causes were the most frequent (>50%) and intentional causes the less frequent, except an increase up to 15% in 2004. Typical unintentional fires were incompletely extinguished fires of hikers and the illicit agricultural fires.

Causes	Mean %2002-2007	Main types of cause
Lightning	7%	
Negligence	28%	General public
Arson	5%	
Unknown	**61%**	

Specificity of the country: No data available for Hungary before 2002.

Database Availability	Database Quality	IRELAND	Mean nb of fires/year (1994)	Mean burned area/year (1994)	IE
1994			149	275 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

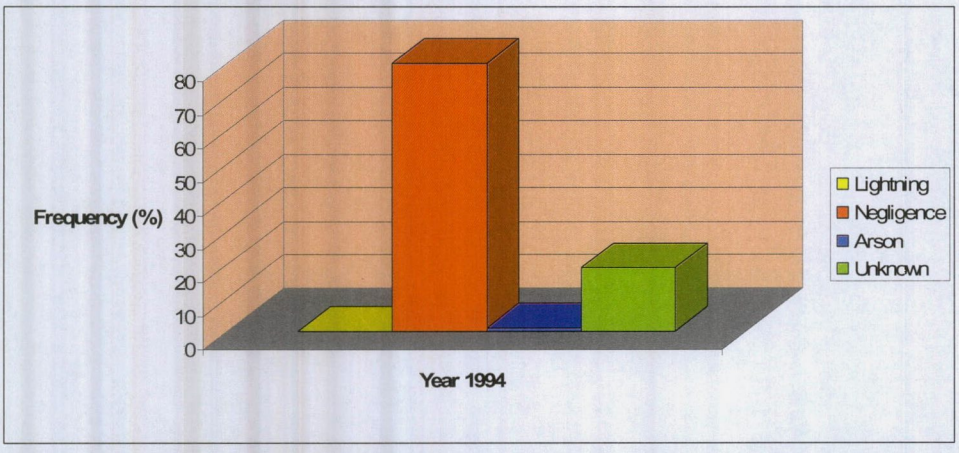


Figure 34: Distribution of the fire frequency by causes in Ireland in 1994 *(Source: Timber Bulletin)*.

In 1994, negligence was recorded to be the main cause of forest fire in Ireland (80%), mainly due to recreational activities (General public, UNECE Timber Bulletin). Only 1% of the fires were due to arson and no fires due to natural causes were recorded this year (Fig. 34).

Causes	Mean %1994	Main types of cause
Lightning	0%	
Negligence	**80%**	General public
Arson	1	
Unknown	19%	

Specificity of the country: The only data available for Ireland are the fire statistics in 1994 (UNECE Timber bulletin).

Database Availability	Database Quality	ITALY	Mean nb of fires/year (2000-2007)	Mean burned area/year (2000-2007)	IT
1984 – 2007	1984 – 2007		7585	87 387 ha	

Europe EU | Europe out of EU | Out of Europe

Source of data

In Italy the information concerning the fire ignition causes are collected from 1984 by the National Forestry Service (CFS). Modalities and standardization to collect and record fire causes have anyway changed during this time interval; in fact a national uniform procedure to define forest fire causes was established starting from 2000, with different date of acknowledgement by different Institution involved in the forest fires database redaction (Mountain Communities, Municipalities, Regions).
At present, the first step of data collection is carried out by the Regional Fire Fighting Office (AIB), responsible apart from anything else, of coordination in operational phases. Periodically the Regional AIB inserts all the different data concerning each fire event in a national database of CFS, based on data collected by the standard model AIB/FNi.

Type of database

Some Region have a "local" database, defined by each regional AIB structures, where the recorded information are validated (geographical coordinate, date, ISTAT references etc.) and successively jointed to the national CFS database.

Type of fire recorded

The minimum area needed to record the fire is usually equal to 0.1 ha. There is no limitation on the type of vegetation.

Socio-economic or environmental context

Non available.

Causes recorded

In Italy, the list of the causes of forest fire includes a range of motivations that are dependant on economic, social and behavioural profiles. This is continuously updated. Five categories of causes were taken into consideration: **natural** fires, **accidental** fires, fires due to **negligence**, fires due to **arson**, and fires of **dubious or unknown** cause. These causes have been detailed into a range of motives relating to the social, economic, and productive profiles of the various territorial realities.
The efficiency to collect and record mentioned information is very different region by region, in some case coordinates, surfaces and frequently causes are missing; this is true in particular for the first data recorded (1984 – 2000). Moreover the analysis of fires causes, collected by the CFS using the AIB/FNi, does not include detailed investigations concerning real causes, motivations and Information on the socio-economic or environmental context of single fire event.

Statistics on fire causes

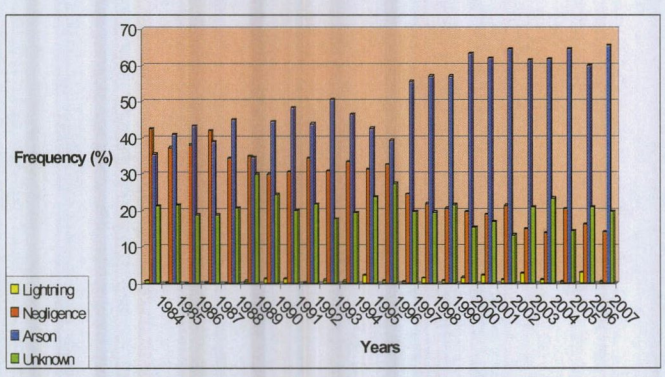


Figure 35: Distribution of the fire frequency by causes in Italy from 1984 to 2007 (*Source: National Forest Services, Corpo Forestale dello Stato*).

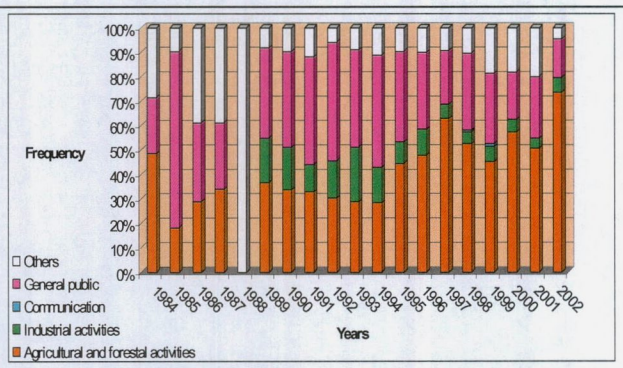


Figure 36: Distribution of forest fire by causes due to negligence or accident in Italy from 1984 to 2002. No data available between 2002 and 2007 (*Source: National Forest Services, Corpo Forestale della Stato*).

Figure 35 shows that, between the periods 1984-1996 and 1997-2007, there was a strong increase in the percentage of fires due to arson (around 40% during the first period and around 60% in the second) linked to a decrease especially in the percentage of fires due to negligence. The knowledge of fire causes was quite good on the whole period (around 20% of unknown causes) and the frequency of natural fires was very low (<5%). The type of negligence was mainly the general public (recreational activities and especially smoking since 1989 according to the database of CFS) before 1995 and mainly agricultural and forest activities between 1996 and 2002 (Fig. 36).

Causes	Mean % 2002-2007	Main types of cause
Lightning	2%	
Negligence	17%	Agricultural and forest activities (in 2002)
Arson	**62%**	
Unknown	19%	

Specificity of the country: Accident and negligence have been merged in the same group "Negligence". Agricultural and forest activities are merged in the same type of negligence in the Italian classification.

For more information, see Appendix.

Database Availability	Database Quality	LATVIA	Mean nb of fires/year (2002-2007)	Mean burned area/year (2002-2007)
1995 - 2008	1995 - 2008		861	1174 ha

LV

Europe EU

Europe out of EU

Out of Europe

Source of data

According to the legislative acts, the State Forest Service (on behalf the Ministry of Agriculture) is responsible for gathering data of forest fires.

Type of database

There is a unique national database, based on intranet network. State Forest Service central administration and Forest Fire Control Unit provide supervision and coordination to gather information. Any forestry can add necessary data of forest fires which had occurred in this area.

Type of fire recorded

As average fire size in Latvia is small enough, all forest fires are accountered from 0.001ha. According to the national legislation, the State Fire and Rescue Service (on behalf the Ministry of Interior) is responsible for structural firefighting and firefighting in agricultural (grass fires) areas. Sometimes there are some interferences in the data gathering when in spring, fires extend to the forest from agricultural areas due to the grass burning. Generally, State Forest Service is responsible for all forest fire data collection.

Socio-economic or environmental context

Non available.

Causes recorded

The forest fire causes recorded are the following: (i) Arson, (ii).Negligence and accident: 1. Old grass, straw burning, 2. Forest logging residues burning, 3. Railway influence, 4. Motorized vehicles influence, 5. Short circuit of electrical power lines, 6. Negligence of forest visitors (e.g. smokers, bonfires etc.), 7. Other causes (e.g. army shooting training, structural fire, etc.) and (iii) Natural cause (Lightning).

Statistics on fire causes

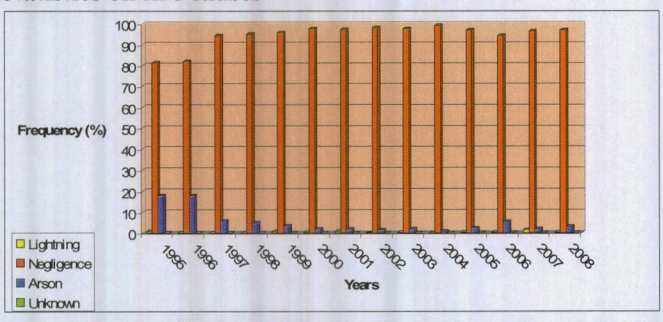


Figure 37: Distribution of fire frequency by causes in Latvia from 1995 to 2008 *(Source: State Forest Service, A. Sumanis).*

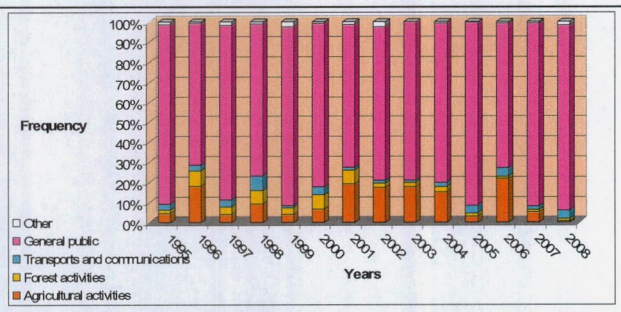


Figure 38: Distribution of forest fire by causes due to negligence in Latvia from 1995 to 2008 *(Source: State Forest Service, A. Sumanis).*

Figure 37 shows that negligence was still the main cause of fire till 2008 and it has been over 90% since 1997. The proportion of fires due to arson decreased fewer than 10% after 1996. Fires due to natural causes were insignificant. Figure 38 shows that the general public (especially recreational activities) was by far the main cause of fires due to negligence over the period (>50% and up to 90%). Agricultural activities could cause up to 20% of the fires during this period. It seemed to decrease in 2007.

Causes	Mean %2002-2007	Main types of cause
Lightning	1%	
Negligence	**97%**	General public
Arson	2%	
Unknown	0%	

For more information, see Appendix.

Database Availability	Database Quality	LITHUANIA	Mean nb of fires/year (2002-2008)	Mean burned area/year (2002-2008)	LT
1994 - 2008	1994 - 2008		736	389 ha	

Source of data

The Directorate General of State Forests depending on the Ministry of Environment is responsible for the recording and gathering of data on forest fires in Lithuania.

Type of database

There is only one national forest fires database.

Type of fire recorded

The minimal fire area is 0.1 ha and only fires occurring on forest land are recorded.

Socio-economic or environmental context

Non available.

Causes recorded

The fire causes recorded in Lithuania are the natural causes (lightning), the causes due to negligence, the causes due to arson, the unknown causes and the other causes.

Statistics on fire causes

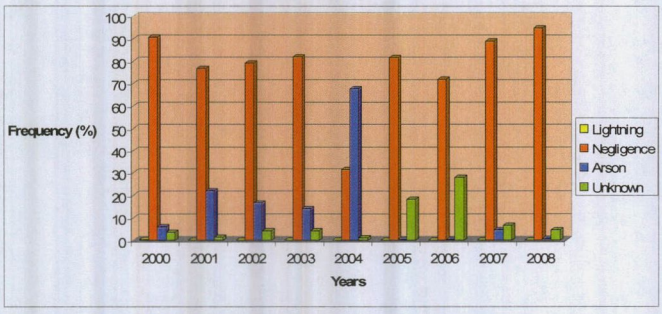


Figure 39: Distribution of the fire frequency by causes in Lithuania from 2000 to 2008 *(Source: Ministry of Environment, Forest Department, Z. Glazko)*.

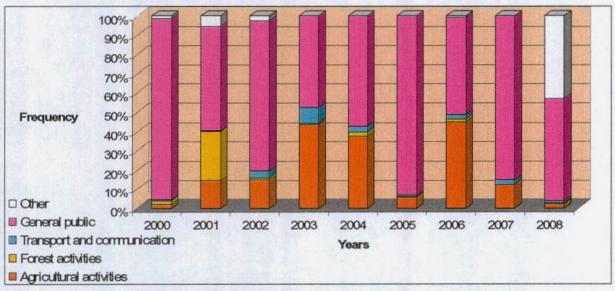


Figure 40: Distribution of the fire frequency due to negligence in Lithuania from 2000 to 2008 *(Source: Ministry of Environment, Forest Department, Z. Glazko)*.

Figure 39 shows that the main cause of forest fires in Lithuania was negligence (more than 70% except in 2004 when it dropped to 30%). During this period, these fires were mainly due to the general public (especially to campfires) and to agricultural activities (especially grass burnings), even if the frequency of the latter was not constant during this period (Fig. 40). Between 2000 and 2004, arson was the second cause of fire (between 10 and 32%) then it dropped under 5% of the fires in 2008. Fires due to natural causes were not significant in Lithuania (Fig. 39).

Causes	Mean %2002-2008	Main types of cause
Lightning	0%	
Negligence	**76%**	General public
Arson	15%	
Unknown	9%	

Specificity of the country: The Lithuanian fire causes classification has a group of causes called "other". It has been merged with the group "negligence" for the fire statistics.

For more information, see Appendix.

Database Availability	Database Quality	LUXEMBOURG	Mean nb of fires/year (1994-1997)	Mean burned area/year (1994-1996)	LU
1994 - 1997			4	2 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

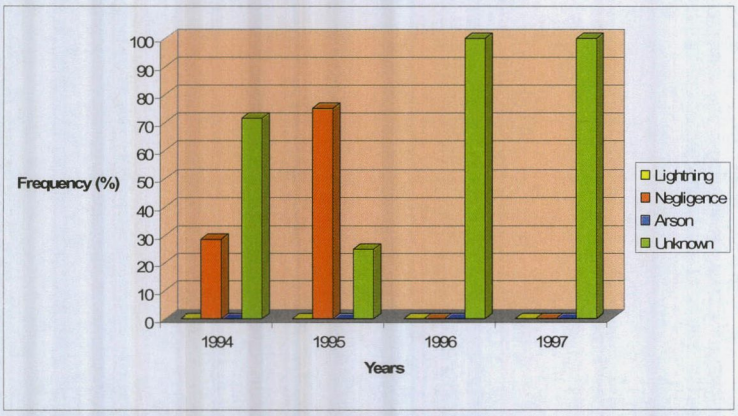


Figure 41: Distribution of the fire frequency by causes in Luxembourg from 1994 to 1997 *(Source: Timber Bulletin)*.

Only fires due to negligence and to unknown causes were recorded in Luxembourg between 1994 and 1997. Figure 41 shows that negligence was the main cause of fire in 1995 in Luxembourg. Its proportion has increased since 1994 while the proportion of fires due to unknown causes has decreased, but in 1996 and 1997, only fires due to unknown causes were recorded. The types of negligence were not available in the UNECE Timber Bulletin.

Causes	Mean %1994-1997	Main types of cause
Lightning	0%	
Negligence	26%	
Arson	0%	
Unknown	**74%**	

Specificity of the country: The only data available for Luxembourg are the fire statistics between 1994 and 1997 (UNECE Timber bulletin).

Database Availability	Database Quality	MONTENEGRO	Mean nb of fires/year	Mean burned area/year	ME
No data	**No data**		**No data**	**No data**	

Source of data

The institution in charge of forest management in Montenegro is the Forestry Directorate, a public institution subordinated to the Ministry of Forestry, Agriculture and Water Management, sector of Forestry.

Type of database

Non available.

Type of fire recorded

No spatial data are collected on forest fires, and the only data reported in hectares are coming from the Local Forestry Directorates. In the scope of the reform of forestry sector, the Ministry intends to include after fire data collection an improved methodology for Forest Management Planing. Currently UNDP (through Environmental GIS for Montenegro project) and LuxDevelopment (FODEMO II project) are involved in this process.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes
Non available.

Specificity of the country: New candidate. No fire statistics available yet.

Europe EU

Europe out of EU

Out of Europe

Database Availability	Database Quality	NETHERLANDS	Mean nb of fires/year (1994-1996)	Mean burned area/year (1994-1996)	NL
1994 - 1996			68	222 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

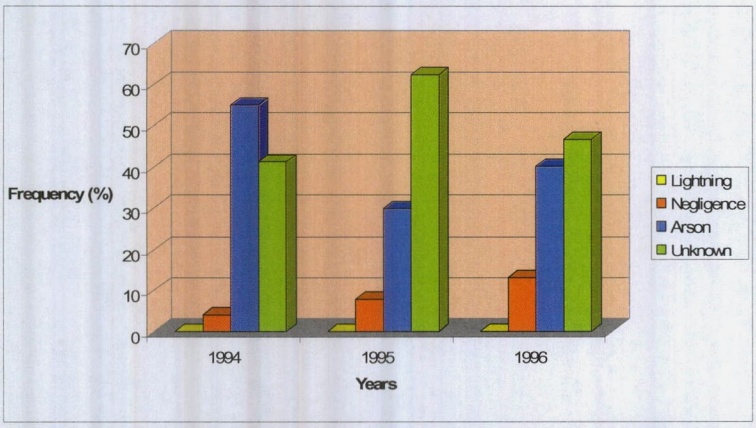


Figure 42: Distribution of the fire frequency by causes in Netherlands from 1994 to 1996 *(Source: Timber Bulletin).*

Figure 42 shows that arson was the main known cause in 1994 but the proportion of intentional fires decreased in 1995 and 1996 but was still high (25-38%). The proportion of fires due to unknown causes was highest since 1995 and the proportion of fires due to negligence, mainly due to the general public, especially the recreational activities (UNECE Timber Bulletin), increased from 1994 (5%) to 1996 (10%) (Fig. 42).

Causes	Mean %	Main types of cause
Lightning	0%	
Negligence	8%	General public
Arson	42%	
Unknown	**50%**	

Specificity of the country: The only data available for Netherlands are the fire statistics between 1994 and 1996 (UNECE Timber bulletin).

Database Availability	Database Quality		POLAND	Mean nb of fires/year (2002-2008)	Mean burned area/year (2002-2008)
1989 – 2008	**1989 – 2008**	SFNFH		**4393**	**1430 ha**
1993 - 2008	**1993 - 2008**	NHSFS		**9951**	**6328 ha**

PL

Europe EU

Europe out of EU

Out of Europe

Source of data

The State Fire Service (National Headquarters of the State Fire Service, NHSFS) is responsible for recording all the fires that occur in Poland, regardless of ownership type, whereas forest divisions and national parks management are responsible for recording fires that occur in the State Forests and in national parks (State Forest National Forest Holding, SFNFH).

Type of database

The State Fire Service records and analyses information using computer program EWID-99 (Minister of Interior and Administration Decree of December 29, 1999, §8.1. concerning detailed guidelines for national firefighting and rescue system structure, Journal of Laws No. 111, Item 1311). Issues of recording fires in the State Forests and in national parks are regulated by *Directions for fire prevention on forest territories* of 1996. Until 1995 there was a different cause classification that applied to the State Forests. There are two databases on forest fires, one from NHSFS, and the other from SFNFH.

Type of fire recorded

Non available.

Socio-economic or environmental context

An increase of fires spreading from non-forest grounds has frequently been observed, the main causes being burning of stubble, meadows, near-road ditches or fallow grounds. The tradition to burn meadows, despite the legal restrictions that are in place since many years, continues to be a serious problem every spring. Arson continues to be an important cause of forest fires. The share of purposely set fires has been growing regardless of forest ownership. In the period of transformation arson may have been result of the difficult economic situation of people. Earlier in most cases the cases of intentional fire setting were connected with some mental disorders of the perpetrator. It happens that the perspective of getting even temporary job at the burnt area is the only possible opportunity to get a job. This is especially the case of the regions with high structural unemployment.

Causes recorded

The causes recorded in the SFNFH are (i) Carelessness of adults, (ii) Carelessness of minors, (iii) Machines and equipment (Failure of power lines, road transport, rail transport), (iv) Atmospheric discharges (Lightning), (v) Breakovers from non-forest land, (vi) Arson, (vii) Other and unidentified causes.

Statistics on fire causes

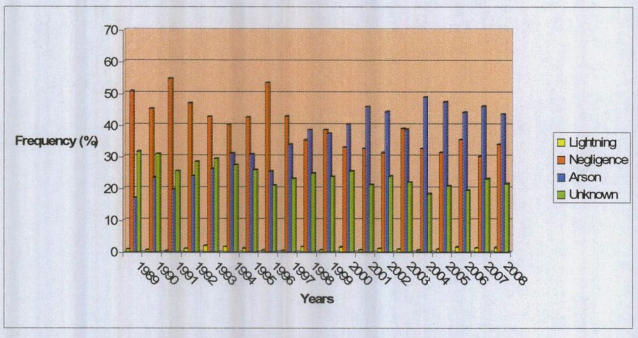


Figure 43: Distribution of the frequency of fires by causes in the 'State Forests' of Poland from 1989 to 2008 *(Source: National Forest Holding).*

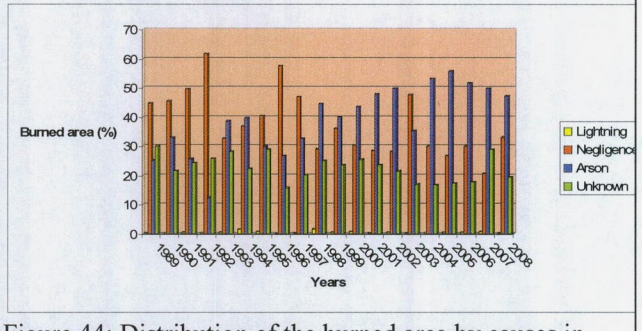


Figure 44: Distribution of the burned area by causes in the 'State Forests' of Poland from 1989 to 2008 *(Source: National Forest Holding).*

Figure 43 shows that, between the periods 1989-1997 and 1998-2008, there was a strong increase in the percentage of fires due to arson in Poland (around 25% during the first period and around 40% during the second) linked to a decrease in the percentage of fires due to negligence. There was also a slight decrease in the percentage of fires due to unknown causes over the whole period. The frequency of fires due to natural causes was unsignificant. The variation of the percentage of burned area according to the fire causes over the period 1989-2008 followed the same trend that the fire frequency (Fig. 44). Concerning the types of negligence causing the forest fires, the general public (especially the carelessness of adults) was the main cause over the whole period, sometimes with the agricultural activities (1996, 1997, 2003) (Fig. 45).

Causes	Mean %2002-2008	Main types of cause
Lightning	0%	
Negligence	31%	General public
Arson	**49%**	
Unknown	20%	

(Source: National Forest Holding)

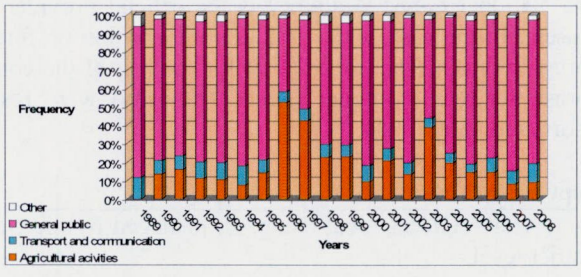


Figure 45: Distribution of the fire frequency due to negligence in the 'State Forests' of Poland from 1989 to 2008 *(Source: National Forest Holding).*

Specificity of the country: For the fire statistics, carelessness of adults, carelessness of minors, machines and equipment and breakovers from non-forest land were merged in a single group of causes: Negligence.

For more information, see Appendix.

Database Availability	Database Quality	PORTUGAL	Mean nb of fires/year (2000-2005)	Mean burned area/year (2000-2005)	PT
2000 - 2008	2000 - 2005		28 482	214 899 ha	

Source of data

The National Forest Authority is the official provider of data and statistics on forest fires (number, area, species and causes). In the past, until 1977, the information on forest fires was made only in the forest areas managed by the State Forest Services. The information for the rest of the country was made by estimation, with all the associated errors. The Forest Services (National Forest Authority) were responsible for the forest fires cause investigation and statistical information until 2006.

Type of database

There is a single national database, managed by the National Forest Authority and loaded by the National Guard at the district level.

Type of fire recorded

The minimum fire area recorded is 0.0001 ha. The type of land use - forest stand, shrub land, agriculture, urban/industry –, where the fire started, is also recorded in the database.

Socio-economic or environmental context

Non available.

Causes recorded

To better uniform the work made by the forest fires causes investigators in the field, during the 90 and later in 2000, the Forest Services made a codification of the forest fires causes in categories and the definition of each cause. The classification of the forest fires causes is made under a three level structure, which lead to three digit code of each fire ignition cause:

- higher level (first digit) – group the causes classification in six main categories: (i) Negligent usage of fire; (ii) Accidents; (iii) Structural causes; (iv) Arson/deliberate; (v) Natural; (vi) Unknown
- The second level (second digit) disaggregates the high categories in smaller groups of causes, identifying common behaviours/activities.
- The third level (third digit) corresponds to each cause of forest fire ignition.

Statistics on fire causes

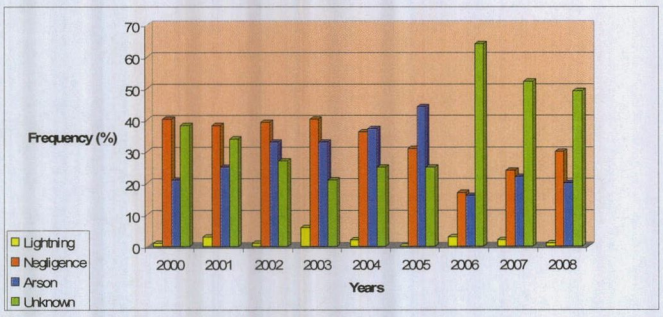


Figure 46: Distribution of fire frequency by causes in Portugal from 2000 to 2008 *(Source: AFN)*.

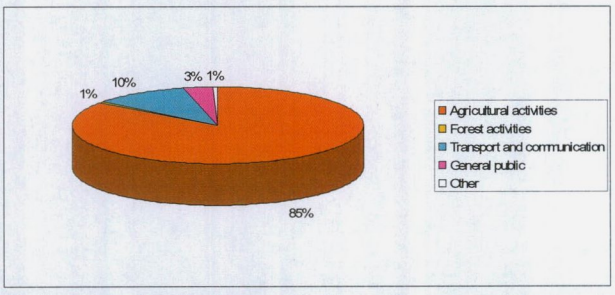


Figure 47: Break-down of fires due to.negligence in Portugal in 2008 *(Source: AFN)*.

In 2006, there was the extinction of the national corps of the forest guards on the Forest Services, with its integration in the National Guard. Derived to this institutional change, there was an increase in the number of fires with unknown causes (Fig. 46).

- From 2000 to 2005, there was an increase related to arson fires, which seems to be directly related with a reduction of the unknown causes;
- Natural causes had an overall small impact (1-2%). The exception registered in 2003 fire season (8%), in result of a severe dry storm, is a concern for the future.
- Negligent usage of fire with a higher impact comparing to arson/deliberate fires.

In 2008 the National Guard proceeded with the criminal investigation of 6 781 forest fires (49.4% of the total of forest fires registered in 2008). The most probable cause of the fire was determined in 54% of the investigations. Intentional fires corresponded to 42% of the determined causes and Accidents or negligence was present in the ignition of 58.6% of the human-caused fires (Fig. 47). Pasture renewal and agricultural burnings represented 78.8% of the unintentional fires.

Causes	Mean %2000-2005	Main types of cause
Lightning	3%	
Negligence	**37%**	Agricultural activities
Arson	32%	
Unknown	28%	

Specificity of the country: One of the problems related to the forest fires causes investigation derives from the lack of representation of the investigated fires to the total amount of forest fires. In fact, due to the fire investigation activity being performed by trained forest rangers, there is a significant difference among the higher number of investigations in the most forested areas comparing to the other areas, specially the urban and peri-urban municipalities. Also, in a regional (district) analysis, there are significant differences among regions. Some have plenty of forest fires investigations with their cause identified, while other regions have only few useful results. This situation compromises the results of the cause analysis in some districts.

For more information, see Appendix.

Database Availability	Database Quality	ROMANIA	Mean nb of fires/year (2002-2005)	Mean burned area/year (2002-2005)	RO
1994 - 2005	2002 - 2005		204	1147 ha	

Source of data

The National Forests Administration (ROMSILVA) is in charge of the measures for prevention, and extinguishing the forest fires, including the activity of guarding the forestry domain under his administration. Also with the cooperation of the territorial environmental agencies, it assures the protection and the limitation of other anthropical activities with adverse impact.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

The followed fire causes are recorded in Romania: (i) the unknbown causes and (ii) the known causes. The latter is composed of the natural causes (lightning) and of the human causes that are divided into criminal causes (arson) and causes due to negligence (Agricultural practices, pathways and public).

Statistics on fire causes

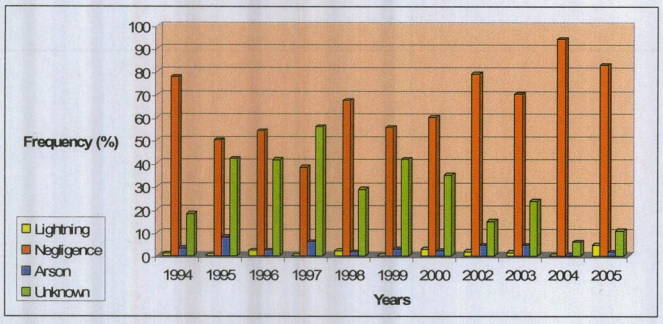


Figure 48: Distribution of the fire frequency by causes in Romania from 1994 to 2005. No data available in 2001 *(Sources: Timber Bulletin, Forest Fires in Europe. From 2002 to 2005, data have been prepared for the UNECE bulletin and computed by JRC using the EFFIS fire database).*

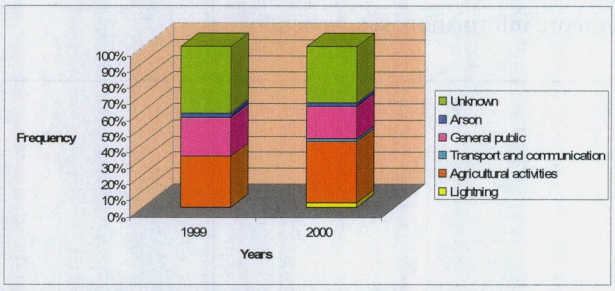


Figure 49: Break-down of the fire frequency by causes in Romania in 1999 and 2000 with detailed unintentional causes *(Source: Regional Environmental Protection Agency of Cluj-Napoca, M. Proorocu).*

Figure 48 shows that over the period, the proportions of fire due to negligence, mainly due to agricultural activities and general public (Fig. 49) was the highest (except in 1997 when the proportion of unknown causes exceeded 50%). Arson and lightning were not significant causes in Romania over this period (<10%). During 2000, the major causes of forest fires were the agricultural activities such as the cleaning of the fields by uncontrolled ignition of the dried plant wastes. (NEDIES project).

Causes	Mean %2002-2005	Main types of cause
Lightning	2%	
Negligence	**82%**	Agricultural activities
Arson	3%	
Unknown	14%	

Database Availability	Database Quality	SLOVAKIA	Mean nb of fires/year (2002-2006)	Mean burned area/year (2002-2006)	SK
1994 - 2006	1994 - 2006		424	625 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

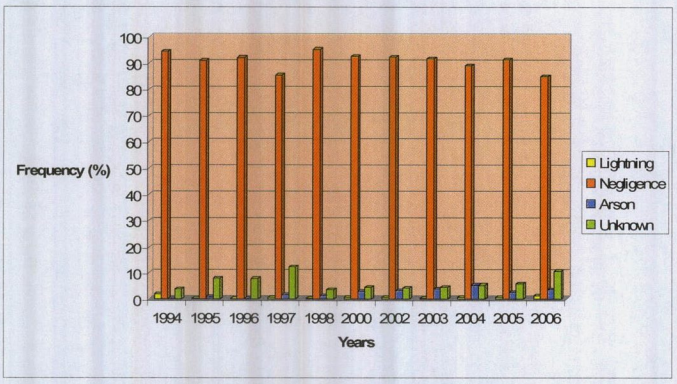


Figure 50: Distribution of the fire frequency by causes in Slovakia from 1994 to 2006. No data available in 2001 *(Sources: Timber Bulletin, Forest Fires in Europe. From 2002 to 2005, data have been prepared for the UNECE bulletin and computed by JRC using the EFFIS fire database).*

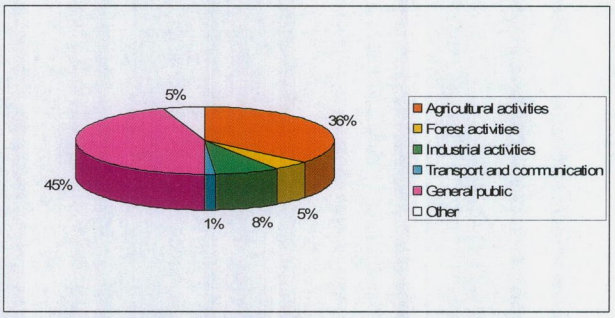


Figure 51: Break-down of fire causes due to negligence in Slovakia in 2003 *(Source: Forest Fires in Europe).*

Figure 50 shows that negligence was by far the main cause of fire (>80%) over the period, the other causes were not significant (<10%). The unintentional fires were mainly due to general public (camp fire 35%) and agricultural activities (36%) in 2003 (Fig. 51).

Causes	Mean %2002-2006	Main types of cause
Lightning	1%	
Negligence	**90%**	General public
Arson	3%	
Unknown	6%	


BF Oddelek za gozdarstvo in obnovljive gozdne vire
GOZDARSKA
KNJIŽNICA
Večna pot 2
LJUBLJANA
Gozdarski inštitut Slovenije

Database Availability	Database Quality	SLOVENIA	Mean nb of fires/year (2002-2008)	Mean burned area/year (2002-2008)	SI
1997 - 2008	1997 - 2008		104	611 ha	

Source of data

The Slovenia Forest Service and the Administration of the Republic of Slovenia for Civil Protection and Disaster Relief are the main institutions gathering information on forest fires.

Type of database

In Slovenia, two classifications concerning the causes of forest fires are in force. The first was drafted within the framework of forestry profession and refers exclusively to forest fires. Grades of forest fire hazards, the factors that influence them, and causes of forest fires are defined by law.

The second classification of the causes of forest fire refers to natural and other disasters in Slovenia. It was developed by the Administration of the Republic of Slovenia for Civil Protection and Disaster Relief in cooperation with various organisations, in particular with the Slovenian Fire-fighting Association. This concerns the so-called ISRIA (Information System for Reporting Interventions and Accidents), programme for the collection of information on natural and other disasters, as well as interventions in terms of protection, rescue and relief. The system was introduced in 2005.

Type of fire recorded

The minimal area which is recorded in forest fire causes statistic is 0.01 ha.

Socio-economic or environmental context

Non available.

Causes recorded

The fire causes recorded by the forestry profession are the following: (i) the known causes composed of the human causes (arson and negligence) and the natural causes (lightning and self-igniton in timber yard) and (ii) the unknown causes.

Within Classification ISRIA - **I**nformation **S**ystem for **R**eporting **I**nterventions and **A**ccidents – forest fires are not specially classified, and neither are the causes of forest fires. In this classification, forest fires are placed among fires in the natural environment or in the open air (section: group of events) and among fires in tree and shrub areas (section: subgroup of events). But as fire can spread into forests from elsewhere, other categories in this subgroup should not be neglected either, i.e.: fires on cultivated grounds, grassland fires, fires on rubbish dumps and landfills, and other fires in nature (in the open air).

Statistics on fire causes

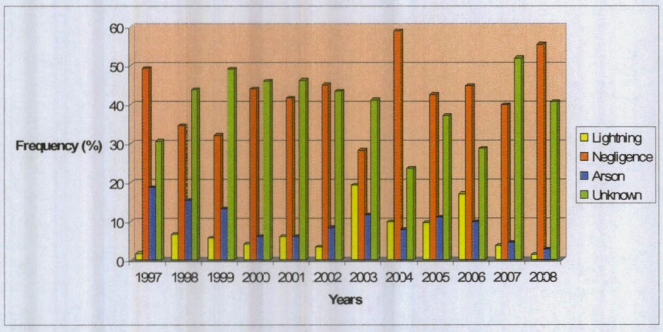


Figure 52: Distribution of the fire frequency by causes in Slovenia from 1997 to 2008 (*Source: Slovenia Forest Services*).

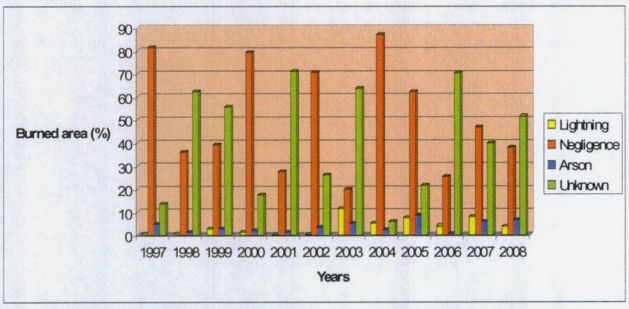


Figure 53: Distribution of the burned area by causes in Slovenia from 1997 to 2008 (*Source: Slovenia Forest Services*).

Figure 52 shows the detail of fire frequency by causes between 1997 and 2008. The proportions of fires due to negligence, mainly due to transport and communication (Fig. 54) and to unknown causes were the highest between 1997 and 2008. The proportion of fires due to arson and lightning could reach 18% some years. The fires the most wrenching in terms of burned area were also due to negligence or to unknown causes (Fig. 53). Generally, "transport and communication" was the main type of negligence that involved highest burned areas except some years (1998, 1999, 2000 and 2005) when it was "agricultural activities" or "other" (Fig. 55).

Causes	Mean %	Main types of cause
Lightning	9%	
Negligence	**45%**	Transport and communication
Arson	8%	
Unknown	38%	

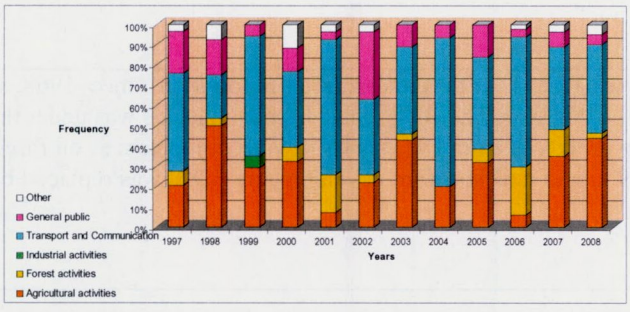


Figure 54: Distribution of the fire frequency due to negligence in Slovenia from 1997 to 2008 (*Source: Slovenia Forest Services*).

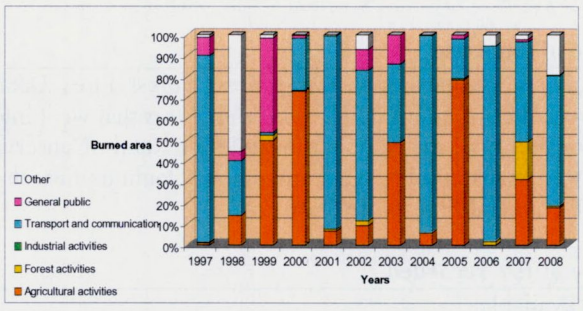


Figure 55: Distribution of the burned area due to negligence in Slovenia from 1997 to 2008 (*Source: Slovenia Forest Services*).

For more information, see Appendix.

Database Availability	Database Quality	SPAIN	Mean nb of fires/year (2000-2007)	Mean burned area/year (2000-2007)	ES
1986 - 2005	1998 - 2005		19 546	136 411 ha	

Source of data

The information provided in this section refers to the Forest Fires Statistics prepared by the General Secretariat for the Territory and Biodiversity, of the Ministry of the Environment and Rural and Marine Affairs.

The organization of the Spanish forest fire reporting system is conditioned by the distribution of competencies among the State Administration and the Autonomous Communities. In Spain, there is a single definition of forest fire, and there is an information transfer system that is accepted by all Public Administrations and that allows for each of them to work with the same figures existing in a National Statistics.

Type of database

Spain has a database of forest fires, Forest Fires Data Base (BDIF), with standardized information since 1968 as consequence of *Law 85/1968 on Forest Fires* that went into force this year. The BDIF database maintenance was under the responsibility of the National Institute for Nature Conservation (ICONA) from 1971 to 1984 when competences on forest fire were transferred to the Autonomous Communities. In 1989 due to new software developments BDIF was replaced by EGIF (General Forest Fire Statistics).

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Fire causes are being collected since the first stages of fire statistics. The first classification of causes was described as *Immediate Causes*, understanding them as the most probable fire ignition agents and actions. By means of this, around 40% of fires were being classified as Unknown, and around 30% as Intended, without distinguishing between fires due to criminal or careless causes. For this reason, and to improve the quality of the collected data, information on Fire Motivations was introduced in 1989. The different groups of causes recorded are: lightning, negligence and accidental causes, intended causes (arson), unknown and reproduction of a previous fire.

Statistics on fire causes

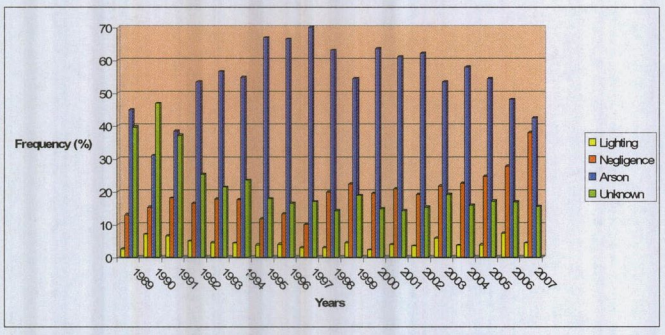


Figure 56: Distribution of the fire frequency by causes in Spain from 1989 to 2007 (*Source: Ministry of Environement, rural and marine Affairs*).

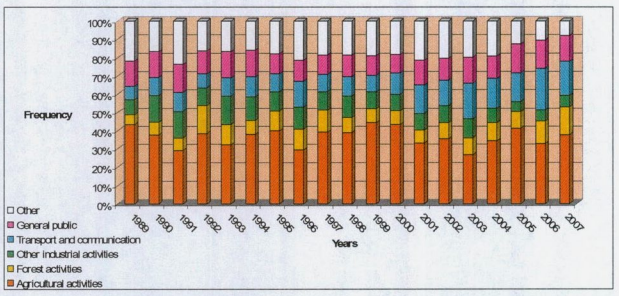


Figure 57: Distribution of the fire frequency due to negligence in Spain from 1989 to 2007 (*Source: Ministry of Environement, rural and marine Affairs*).

Since 1992, the fire frequency due to arson has increased (between 50 and 70%) in contrast of the frequency of fires due to unknown causes (Fig. 56). Since 1998, fires due to negligence, mainly due to agricultural activities (Fig. 57) are more and more frequent (38% in 2007). Natural fires due to lightning were not frequent (less than 10%) during this period. There was an increase in the frequency of the intended fires lighted by farmers and by arsonists (pyromania) since 1997 (Fig. 58). The main proportion of the intentional fires was due to diverse arson (>50%, especially in the case of no data recorded on the motivation).

Causes	Mean %2002-2007	Main types of cause
Lightning	6%	
Negligence	26%	Agricultural activities
Arson	**53%**	Diverse arson
Unknown	17%	

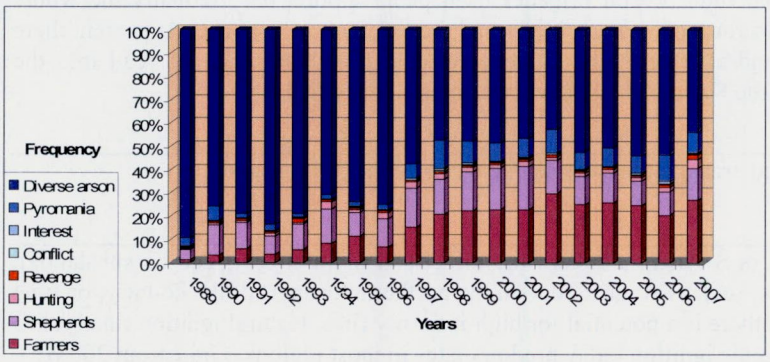


Figure 58: Distribution of the fire frequency due to intended causes in Spain from 1989 to 2007 (*Source: Ministry of Environement, rural and marine Affairs*).

Specificity of the country: The group of causes "reproduction of a previous fire" has been merged in the group of cause "Negligence" for the fire statistics. In the fire statistics, the group of causes called "arson" corresponds to the group "Intended" of the Spanish classification.

For more information, see Appendix.

Database Availability	Database Quality	SWEDEN	Mean nb of fires/year (2002-2005)	Mean burned area/year (2002-2005)	SE
1994 - 2005			6075	2519 ha	

Source of data

From 1988 to 1995 the Swedish Rescue Services Agency had to base its incident statistics on questionnaires sent out annually to the municipal fire brigades. The greatest problem for reliable statistics at that time was a lack of common reporting procedures and definitions of the terms involved. It was decided that the Swedish Association of Fire Officers, Swedish Association of Local Authorities and Swedish Rescue Services Agency should develop a national incident report with definitions of the terms used and education material for incident commanders.

Type of database

The national report was introduced in 1996. At that time several brigades used paper reports but gradually the whole country has gone over to use computer-based systems for recording incidents and the emergency response. At present there are three broadly similar systems on the market and all three systems generate data files which can be read into the national incident report database now maintained at the Swedish Civil Contingencies Agency (MSB).

Type of fire recorded

Fire statistics are recorded on forests (including felled areas), other wooded lands and non-wooded lands.

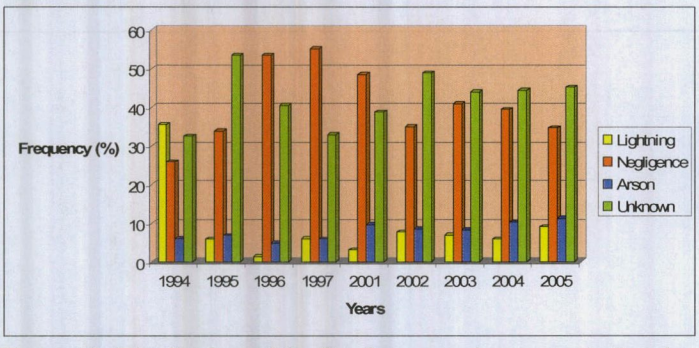
Socio-economic or environmental context

Today, forest fires cause relatively small problems in Sweden, although the direct and indirect costs can be substantial. However, events during climatically extreme periods, such as August 2006 in the northernmost part of the country, or June 2008 in the central part of the country, illustrate that there is a potential for high-intensity fires. Natural ignition finally, is a climate-controlled phenomenon, although anthropogenic ignition today predominates in most regions (Granström 2008).

Causes recorded

In Sweden, according to the Swedish Civil Contingencies Agency, the 20 direct fire causes are the following: Arson, Child playing with fire, Smoking, Fireworks, Hot work, Fire spread when burning grass, Fire spread when burning other things than grass, Camp fire/grill, Explosion, Technical fault, Heat transfer, Transport accident, Sparks from train brakes, Other sparks, Friction, Lightning, Spontaneous combustion, Re-ignition, Unknown, Other.

Statistics on fire causes



Causes	Mean % 2002-2005	Main type of cause
Lightning	7%	
Negligence	37%	General public
Arson	10%	
Unknown	**46%**	

Figure 59: Distribution of the fire frequency by causes in Sweden from 1994 to 2005. No data available for the period 1998-2000 *(Source: Timber Bulletin. From 2002 to 2005, data have been prepared for the UNECE bulletin and computed by JRC using the EFFIS fire database).*

Figure 59 shows that since 1994, the proportion of fire due to lightning has strongly decreased in contrast of the proportion of fires due to unknown causes and to negligence, mainly due to forest activities and to general public (UNECE).

Specificity of the country: Sweden still lack a thorough analysis of today forest fires in different parts of the country regarding causes, relation to season, position in the landscape and fire weather situation. The country is relatively variable in a fire perspective, with strong gradients in climate, population density etc, which makes regional differences in ignition causes, fire behaviour and suppression efforts likely. Such analyses require a better input of fire statistics. For Sweden these statistics are unreliable since more than 30% of all fires are put in the category "unknown causes" (Annual reports from MSB), but if it is assumed that most of these are anthropogenic, the proportion of lightning-ignited fires are below 10%. Engström (2000) showed (for a minor part of the country) that e.g. the area estimates in reports from the fire brigades were flawed (on average a 2 times exaggeration for burned area). There is also a need to link each reported fire to the current fire weather, and to reduce the large proportion of all fires that are today listed under "unknown causes" (Granström 2008).

Database Availability	Database Quality	TURKEY	Mean nb of fires/year (2002-2006)	Mean burned area/year (2002-2006)	TR
1990 - 2006	1997 - 2006		1833	6123 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

In the past, there was a large proportion of fires due to arson in Turkey, nowadays it is lesser. Arson fires are set for several reasons. Socio-economic life standards of most people are well below the national average. People with low income and low life standards see the forests as an earning ground for their sustenance. So, people set fire in the forest to create jobs that will earn them some provision or manipulate vegetation to improve and produce useful plants for their animals to graze. Personal conflicts between people and forestry officials or between shepherds or different villagers have also been reported to have been a cause for fires. Borders separating public and private lands are not completely drawn in Turkey. Only in 30% of the country total area are the ownership boundaries delineated. So, there are always ownership disputes and conflicts in and around forests and protected areas. People take advantage of this situation to increase their properties to the disadvantage of public forests. Forests have also received their share of terrorism. A number of fires have been reported to have been set by terrorist groups or individuals. A majority of fires, however, are often caused by people through sheer inadvertence or accident. These types of fires usually occur in and around recreation areas and camp sites or along major highways.

Causes recorded

Non available.

Statistics on fire causes

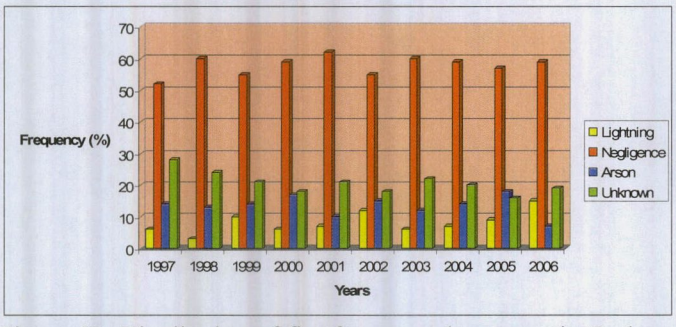


Figure 60: Distribution of fire frequency by causes in Turkey from 1997 to 2006 *(Source: Ministry of Environment and forest). (http://www.ogm.gov.tr/koruma/istatistik/cikis97_06.htm).*

Causes	Mean %2002-2006	Main types of cause
Lightning	10%	
Negligence	**58%**	Other
Arson	13%	
Unknown	19%	

Figure 60 shows statistics on fire causes between 1997 and 2006 in Turkey according to the Ministry of Environment and forests. During this period, the proportion of fires due to human causes remained higher than 60% still increasing since the period 1990-1997 in contrast of the proportion of fires due to unknown causes (around 20%). More than half of human-induced fires were due to negligence. Arson could be quite frequent (between 10 and 20%) and fires due to lightning represented up to 15% of the fires in 2006.

Specificity of the country: New candidate.

For more information, see Appendix.

Database Availability	Database Quality	UNITED KINGDOM	Mean nb of fires/year (1994-2001)	Mean burned area/year (1994-2001)	GB
No data			**348**	**402 ha**	

Source of data

The information on wildfires is poor gathered by fire brigade attendance at fires. Statistics published by the Home Office Statistical Bulletin (ODPM 2005) include intentional straw and shubble burning as well as wildland fires but only fires attended by the Fire and Rescue services and do not include management fires or wildfires that were dealt with solely by land managers. Recently, United Kingdom Vegetation Fire Standard (UKVFS) project is a multigovernment agency and organisation approach aiming at (i) delivering vegetation fire (Outdoor fires) reporting, (ii) developping data fields that provides correspondence between Incident and (iii) providing a framework for the reporting of Vegetation Fire (Wildfires and Prescribed Fires) incidents and operations in the United Kingdom. Presently the United Kingdom has limited evidence on the impacts of, and use of, vegetation fire. Many vegetation fires are poorly, if at all, reported and the true impact of these incidents and operations is not fully understood. This has resulted in United Kingdom not being on an equal footing with European and international colleagues in assessing and reporting the scale of wildfire as a policy area. At a national level the systems are limited and uncoordinated (Gazzard, 2009).

Type of database

Non available.

Type of fire recorded

A reportable fire is an event of uncontrolled burning involving flames, heat or smoke attended by a UK fire brigade. Reportable fires are classified for data collection purposes by the Department of Communities and Local Government and by fire brigades into two main categories, the more serious primary fires for which data are collected about fires individually and secondary fires for which aggregate data are collected. Limited information about chimney fires is also collected.

Socio-economic or environmental context

Non available.

Causes recorded

Taken from IRS (2008), UKVFS uses three categories of fire causes; deliberate, accidental and unknown as shown in UKVFS Data Field 42. Fire Cause is defined by motive category (deliberate, accidental and not known) and subdefined by cause type. All reported deliberate fires in UKVFS are assumed to be on the owner property. All cause types are relevant to wildfire incidents, but only deliberate fires are relevant to 'prescribed burning operations'. Where a prescribed burning or suppression fire goes 'out of control' a deliberate, accidental or unknown category can be recorded. This classification is not in use yet.

Statistics on fire causes

No temporal series of fire frequency by fire causes are available in the UKVFS yet. The only information was found in the IFFN reports and in the Fire Statistics UK. No statistics are available on the area of land consumed neither by wildfires nor on the number of fires put out solely by private or state forest (Forestry Commission) staff. No statistics are available specifically on forest fires and especially on forest fire causes as the statistics are mainly carried out on dwelling fires and road vehicles fires (Fire statistics UK 2006). However, the statistics show that 2003 was a particularly bad year for the wildland fires with 152700° fires. The vast majority of fires are human caused but there are historical records of lightning started fires of small and landscape scale. A very high proportion of wildland fires in UK are anthropogenic in origin though lightning fires do occur in rare occasion (Bruce 2000).

Specificity of the country: Currently, no fire statistics are available. Data on the mean number of fires and the mean burned area from 1994 to 2001 were recorded by UNECE (Timber bulletin).

For more information, see Appendix.

Database Availability	Database Quality	ALBANIA	Mean nb of fires/year (1994-2001)	Mean burned area/year (1994-2001)
1996 - 2004			395	423 ha

AL

Europe EU

Europe out of EU

Out of Europe

Source of data

Forest Fires Statistics are collected by the Forest districts and evaluated by the General Forest Directorate.

Type of database

Non available.

Type of fire recorded

Forest services collect data only on forest and pasture fires occurrence.

Socio-economic or environmental context

In Albania, people are a main factor causing forest fires. Among the forest fires caused by negligence and carelessness, the most important ones are the fires arisen from cropland burning and clearing fields for agricultural purpose, smoking, picnic fire, other fires set by shepherds and hunters. Among the fires occurring accidentally, the fires arisen from breaking off the electricity line are also important. Clear cutting for agricultural purposes and covering the tracks of criminal are intentional fires started by people. Climate conditions and the ongoing of specific meteorological elements, which facilitate the starting process and consequently also an easy distribution of fires in other spaces, are also of primary importance.

Causes recorded

Non available.

Statistics on fire causes

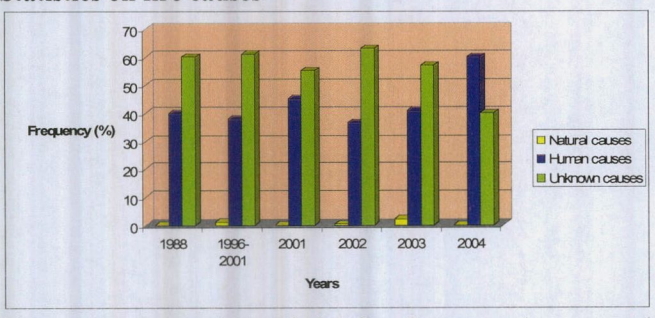


Figure 61: Comparison of the fire frequency by causes in Albania in 1988, 1996-2001 and from 2001 to 2004 *(Sources: Timber Bulletin, IFFN)*.

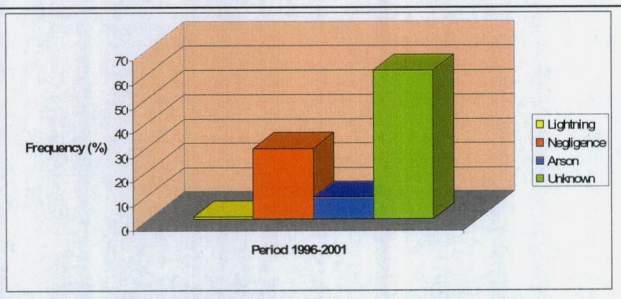


Figure 62: Distribution of the fire frequency by causes due to negligence in Albania during the period 1996-2001 (*Source: IFFN*).

Figure 61 shows that the proportion of fires did not vary a lot between 1988 and the period 1996-2001, regardless of the cause but there was an increase in the proportion of fires due to human causes in 2004 in contrast of the proportion of fires due to natural and unknown causes. Figure 62 gives the details on fire causes for the period 1996-2001. The main causes of fires were unknown. However, it should be understood that even forest fires marked as "unknown" were considered as started by people. In this case, it can be concluded that people caused a great portion of the forest fires occurred in Albania. These values did not differ so much from the other data of Mediterranean countries.

Causes	Mean %1996-2001	Main types of cause
Lightning	1%	
Negligence	29%	
Arson	9%	
Unknown	**61%**	

Specificity of the country: No temporal series are available after 2004. Human causes are not detailed between 2002 and 2004.

Database Availability	Database Quality	ARMENIA	Mean nb of fires/year (1995-2000)	Mean burned area/year (1995-2000)	AM
1995 - 2000			11	115 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

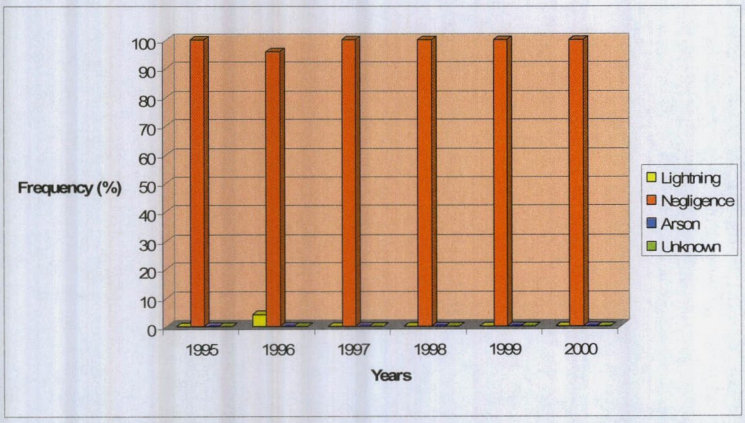


Figure 63: Distribution of fire frequency by causes in Armenia from 1995 to 2000 *(Source: Timber Bulletin)*.

Figure 63 shows that negligence was reported to be by far the main cause of fire in Armenia between 1995 and 2000, mostly due to agricultural activities and general public (UNECE Timber bulletin).

Causes	Mean %1995-2000	Main types of cause
Lightning	0.5%	
Negligence	**99%**	General public
Arson	0.5%	
Unknown	0%	

Specificity of the country: The only data available for Armenia are the fire statistics between 1995 and 2000 (UNECE Timber bulletin).

Database Availability	Database Quality	BELARUS	Mean nb of fires/year (1994-2000)	Mean burned area/year (1994-2000)	BY
1994 - 2000			2757	3506 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

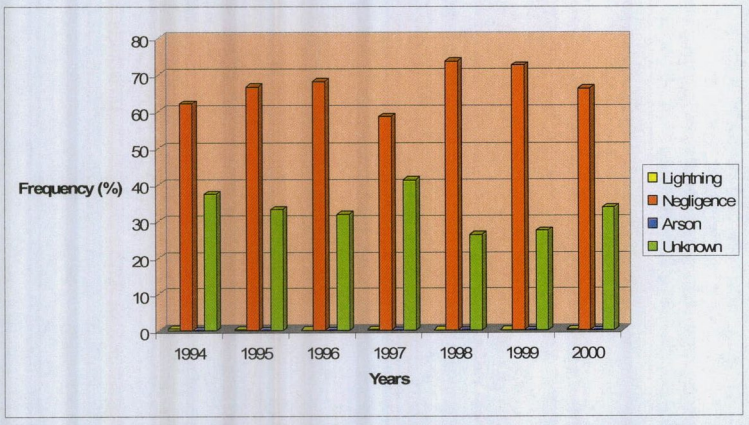


Figure 64: Distribution of fire frequency by causes in Belarus from 1994 to 2000 *(Source: Timber Bulletin)*.

Negligence was the main cause of fire (>55%) over the period 1994-2000, mainly due to general public (UNECE Timber bulletin). The proportion of fires due to unknown causes ranged between 25 and 40%. No intentional fires and no natural fires were recorded during this period (Fig. 64).

Causes	Mean 1994-2000%	Main types of cause
Lightning	0%	
Negligence	**67%**	General public
Arson	0%	
Unknown	33%	

Specificity of the country: The only data available for Belarus are the fire statistics between 1994 and 2000 (UNECE Timber bulletin).

Europe EU

Europe out of EU

Out of Europe

Database Availability	Database Quality	BOSNIA	Mean nb of fires/year (1994-1995)	Mean burned area/year (1994-1995)	BA
1994 - 1995			139	529 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

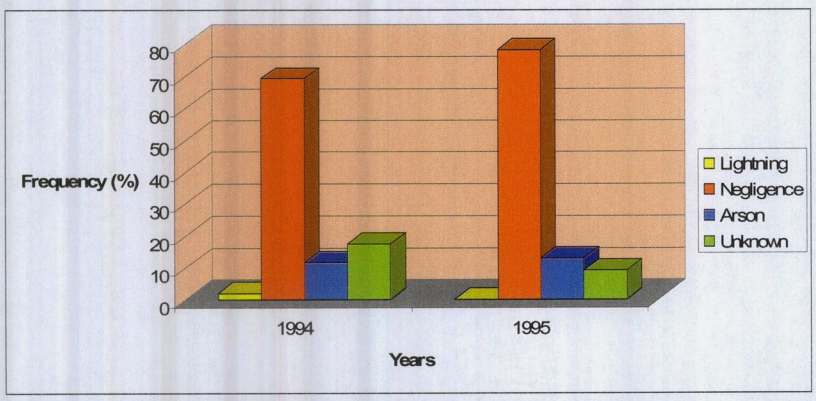


Figure 65: Comparison of the fire frequency by causes in 1994 and 1995 in Bosnia *(Source: Timber Bulletin)*.

Negligence was the main cause of fires in 1994 and 1995 (>60%), mainly due to agricultural activities (UNECE Timber bulletin). The proportion of fire due to arson reached 10% in 1995. Proportion of fires due to unknown causes and natural causes decreased from 1994 to 1995 (Fig. 65).

Causes	Mean %1994-1995	Main types of cause
Lightning	1%	
Negligence	**74%**	Agricultural activities
Arson	12%	
Unknown	13%	

Specificity of the country: In Bosnia, the only data available concern fire statistics in 1994 and 1995 (UNECE Timber bulletin).

Database Availability	Database Quality	GEORGIA	Mean nb of fires/year (1995-1997)	Mean burned area/year (1995-1997)	GE
1995 - 1997			6	134 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

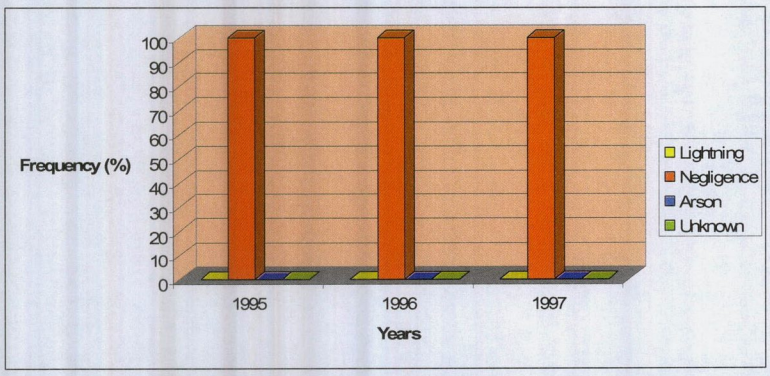


Figure 66: Distribution of the fire frequency by causes in Georgia from 1995 to 1997 (*Source: Timber bulletin*).

From 1995 to 1997, the only fire cause recorded in the UNECE's database was negligence (100%), mainly due to general public and agricultural activities (Fig. 66).

Causes	Mean %	Main types of cause
Lightning	0%	
Negligence	**100%**	General public
Arson	0%	
Unknown	0%	

Specificity of the country: In Georgia, the only data available concern fire statistics from 1995 to 1997 (UNECE Timber bulletin).

Database Availability	Database Quality	MOLDOVA	Mean nb of fires/year (1994-1998)	Mean burned area/year (1994-1998)	MD
1994 –1995 1998			13	82 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

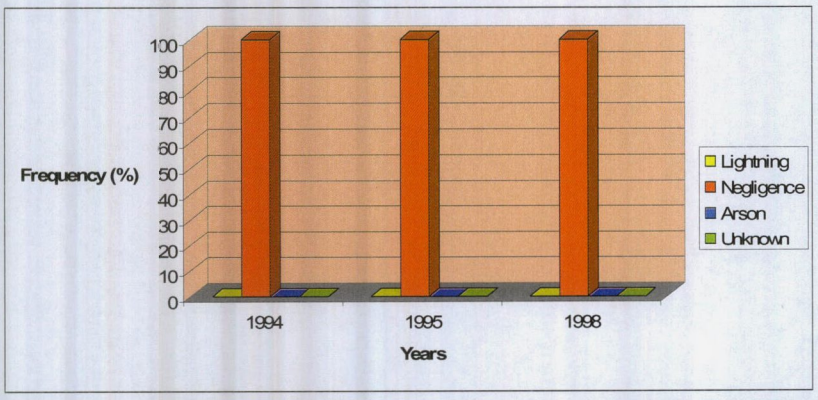


Figure 67: Distribution of the fire frequency by causes in Moldova in 1994, 1995 and 1998 (*Source: Timber bulletin*).

In 1994, 1995 and 1998, the only fire cause recorded in the UNECE's database was negligence (100%), mainly due to agricultural activities and forest activities in 1998, to the general public the other years (Fig. 67).

Causes	Mean %1994-1998	Main types of cause
Lightning	0%	
Negligence	**100%**	Agricultural activities, general public
Arson	0%	
Unknown	0%	

Specificity of the country: The only data available for Moldova are the fire statistics in 1994, 1995 and 1998 (UNECE Timber bulletin).

Database Availability	Database Quality	NORWAY	Mean nb of fires/year (2002-2005)	Mean burned area/year (2002-2005)	NO
1994 - 2005			163	406 ha	

Source of data

Directorate for Civil Protection and Emergency Planning is responsible for the fire statistics. Local fire brigades shall report all fires, of any size, to the Directorate for Civil Protection and Emergency Planning. This is done electronically or by ordinary mail.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Even if the natural fire regime has been of a cool and moderate type, this does not mean that forests in Norway have historically burned less than in more continental areas. A survey of available sources indicates that anthropogenic ignition, i.e. culturally induced fires, has influenced the development of vegetation and the landscape to a much greater extent than is generally realised.

Causes recorded

Non available.

Statistics on fire causes

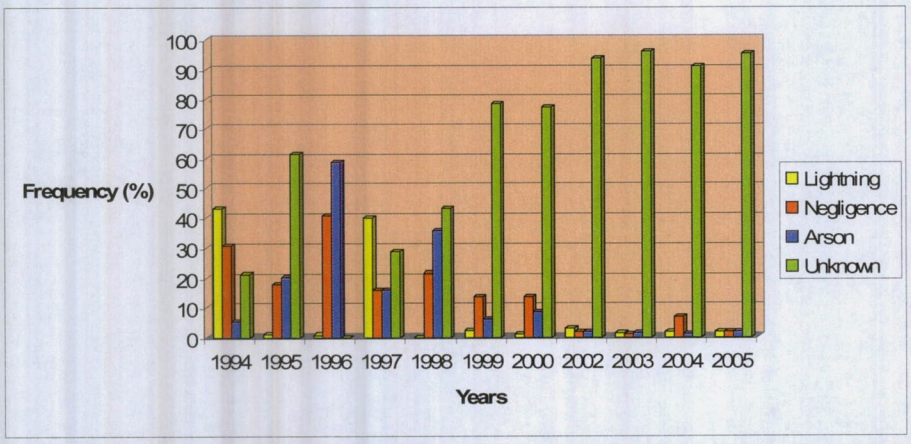


Figure 68: Distribution of the fire frequency by causes in Norway from 1994 to 2005. No data available in 2001
(Source: Timber Bulletin. From 2002 to 2005, data have been prepared for the UNECE bulletin and computed by JRC using the EFFIS fire database).

The distribution of the fire frequency between 1994 and 2005 (Fig. 68) shows that in 1994 and 1997, the proportion of fires due to natural causes (lightning) was high (up to 40%). In 1996, the main cause of fire was arson (57%). Since 1999, the proportion of fires due to unknown causes has increased greatly becoming the highest in contrast of fires due to negligence that decreased a lot between 1996 and 2005 (from 40% to less than 10%).

Causes	Mean %2002-2005	Main types of cause
Lightning	2%	
Negligence	3%	
Arson	1%	
Unknown	**94%**	

Specificity of the country: Since 2002, the knowledge of fire cause has dropped greatly. Data on the mean number of fires and mean burned area and fire statistics between 2002 and 2005 were prepared for the UNECE Timber bulletin (thus the fire causes classification follows the UNECE scheme) and have been computed by JRC using the EFFIS fire database.

Database Availability	Database Quality	RUSSIAN FEDERATION	Mean nb of fires/year (1994-2000)	Mean burned area/year (1994-2000)
1988 - 2000	1994 - 2000		26 977	181 2316 ha

RU

Europe EU

Europe out of EU

Out of Europe

Source of data

The Forest Service of the Russian Federation gathers the information on forest fires.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

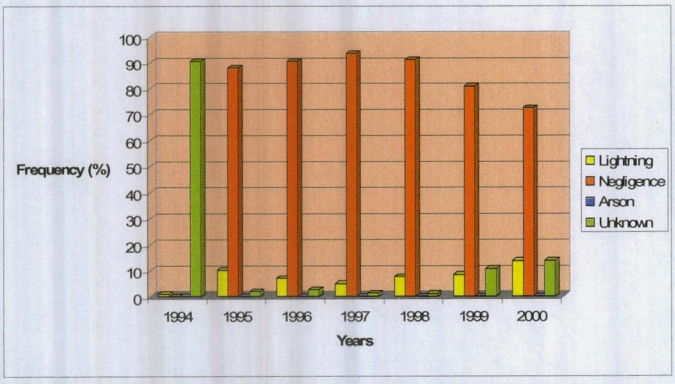


Figure 69: Distribution of the fire frequency by causes in the Russian Federation from 1994 to 2000 *(Source: Timber Bulletin).*

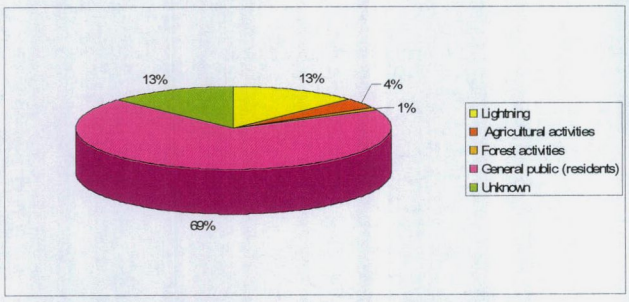


Figure 70: Break-down of fire causes in Russia in 1999 *(Source: IFFN).*

Figure 69 shows that, from 1995 to 2000, in Russia, negligence was the main cause of fires in spite of the cessation of the traditional burning practices. This negligence was mainly due to general public (residents) (Fig. 70). The proportion of fires due to lightning was rarely over 10% (Fig 69).

Causes	Mean %1994-2000	Main types of cause
Lightning	8%	
Negligence	**74%**	General public
Arson	0%	
Unknown	17%	

Specificity of the country: There is a high geographical variation of the fire causes frequency in Russia. No data available after 2000.

For more information, see Appendix.

Database Availability	Database Quality	SERBIA-MONTENEGRO	Mean nb of fires/year (1999-2001)	Mean burned area/year (1999-2001)	RS
1999 - 2001			258	4409 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

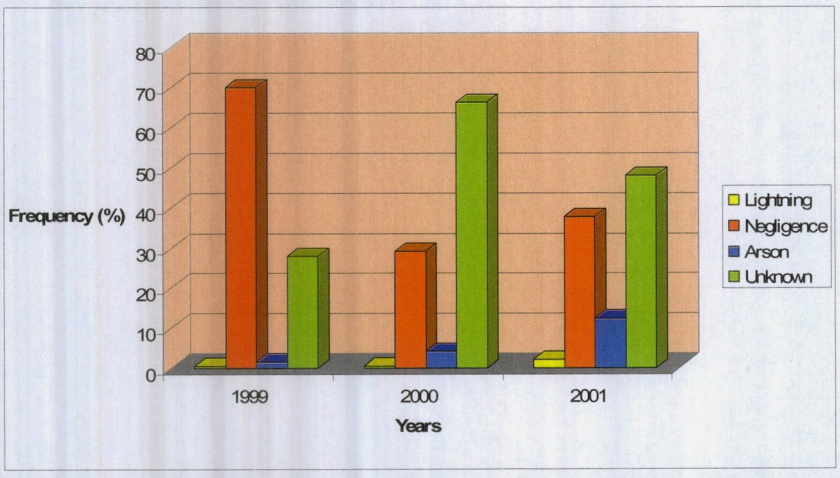


Figure 71: Distribution of the fire frequency by causes in Serbia-Montenegro in 1999, 2000 and 2001 *(Source: Timber Bulletin)*.

Negligence was the main cause of fire in 1999, mainly due to agricultural activities and military exercises (UNECE Timber bulletin) but in 2000 and 2001, the proportion of fires due to unknown causes was the highest. The proportions of fires due to arson and lightning also increased during this period (Fig. 71).

Causes	Mean %1999-2001	Main types of cause
Lightning	1%	
Negligence	46%	Agricultural activities
Arson	6%	
Unknown	**47%**	

Specificity of the country: No data are available in Serbia-Montenegro except the fire statistics of 1999, 2000 and 2001 (UNECE Timber bulletin).

Database Availability	Database Quality	SWITZERLAND	Mean nb of fires/year (2002-2008)	Mean burned area/year (2002-2008)	CH
1980 - 2008	1980 - 2008		70	270 ha	

Source of data

Each canton has its own database, and data are recorded by the forest service or natural danger services. At a national level, the Federal Office of Environment (OFEV) gathers all the regional data in the database.

Type of database

Until 2007, there were regional databases only for the four cantons the most concerned by forest fires (Tessin, Valais, Grisons and Uri). Since 2008, a national database has been created.

Type of fire recorded

All the forest fires are recorded and the minimum area recorded is 0.01 ha, even if the burned area is smaller. The database gathers forest fires and pasture fires reaching the forest.

Socio-economic or environmental context

Non available.

Causes recorded

Besides fires due to lightning, to arson and to unknown causes, the types of negligence recorded in Switzerland are: not extinguished camping fires, private (tourists, hickers, smoking, other), children, forestry, agriculture, army, rail, electric line, other technical systems, cross-border, fire restarting and other known causes.

Statistics on fire causes

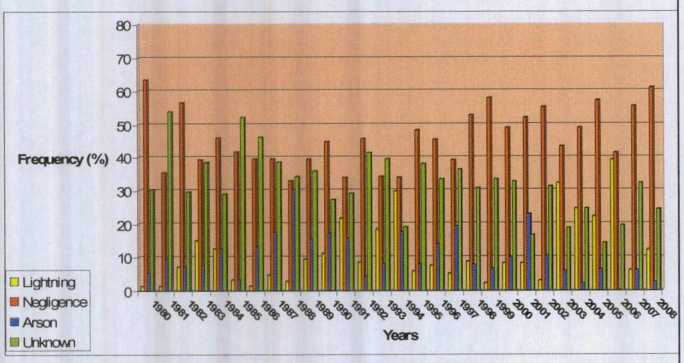


Figure 72: Distribution of the fire frequency by causes in Switzerland from 1980 to 2008 *(Source: OFEV, B. Pezzatti).*

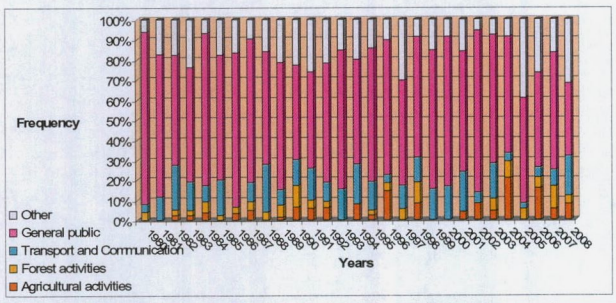


Figure 73: Distribution of the fire frequency due to negligence in Switzerland from 1980 to 2008 *(Source: OFEV, B. Pezzatti).*

Figure 72 shows that, since 2000, the proportions of fires due to unknown causes and to arson have decreased in contrast of the proportion of fires due to negligence (around 50%). Fires due to lightning were frequent (up to 30%) depending on the years (1994, 2003 and 2006). Negligence by general public (private and not extinghished camp fire) was by far the main cause of fire during the period 1980-2008 (Fig. 73).

Causes	Mean % 2002-2008	Main types of cause
Lightning	20%	
Negligence	**52%**	General public
Arson	5%	
Unknown	24%	

Database Availability	Database Quality	UKRAINE	Mean nb of fires/year (1994-2001)	Mean burned area/year (1994-2001)	UA
1994 - 2001			4411	19 987 ha	

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

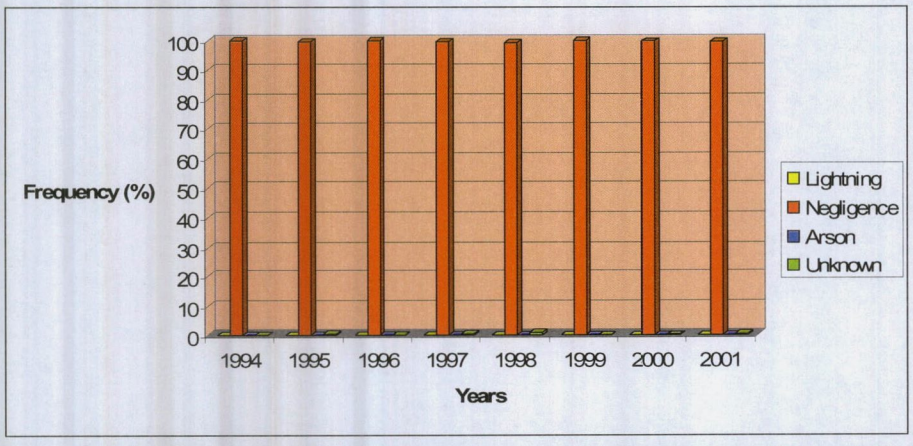


Figure 74: Distribution of the fire frequency by causes in Ukraine from 1994 to 2001 (*Source: Timber bulletin*).

From 1994 to 2001, the only fire cause recorded in the UNECE's database was negligence (100%), mainly due to general public (Fig. 74).

Causes	Mean %1994-2001	Main types of cause
Lightning	0%	
Negligence	**100%**	General public
Arson	0%	
Unknown	0%	

Specificity of the country: The only data available for Ukraine are the fire statistics between 1994 and 2001 (UNECE).

Europe EU

Europe out of EU

Out of Europe

Database Availability	Database Quality	ALGERIA	Mean nb of fires/year	Mean burned area/year	DZ
1907 – 1957 1977 - 1991					

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

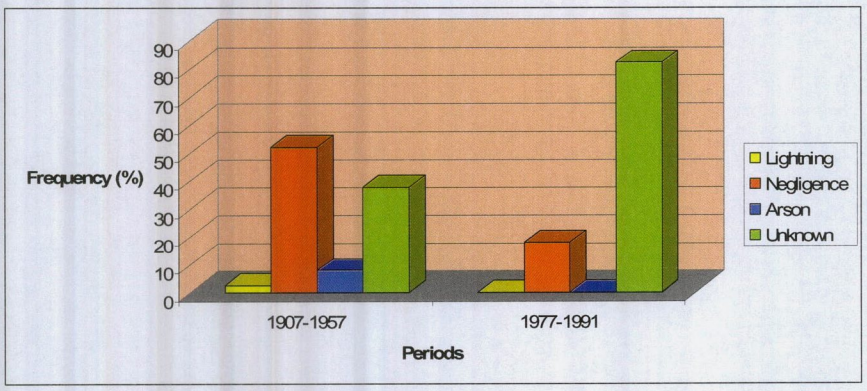


Figure 75: Comparison of the frequency of fire by cause from the periods 1907-1957 to 1977-1991 *(Source: IFFN).*

The comparison of data recorded between 1977 and 1991 to those recorded before the independence (1907-1957) allowed the reconstruction of the long-term evolution of fire causes (Fig. 75) and showed that the proportion of fires due to unknown causes increased strongly (up to 80%) after the Independence in contrast of the proportions of fires due to other causes.

Causes	Mean %1977-1991	Main types of cause
Lightning	0%	
Negligence	18%	General public
Arson	0%	
Unknown	**82%**	

Specificity of the country: The only data available for Algeria are the fire statistics recorded before the Independence and from 1977 to 1991 (IFFN).

For more information, see Appendix.

Europe EU

Europe out of EU

Out of Europe

Database Availability	Database Quality	ARGENTINA	Mean nb of fires/year	Mean burned area/year	AR
1992 - 1999					

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

In Argentina, the region the most concerned by wildfires is the Southern territories of Patagonia. Most data on wildfires are recorded in this region. Some of the forest and grazing land fires in Argentina are started by natural causes but this accounts for less than 1% of all fire starts. Lightning storms are rare. The main origin of forest fires remains human. The most important source of forest fires, however, is related to the pastoral land use. Like in many places in the world the introduction of animal husbandry in forested lands leads to an increase of the wildfire risk.

Causes recorded

Non available.

Statistics on fire causes

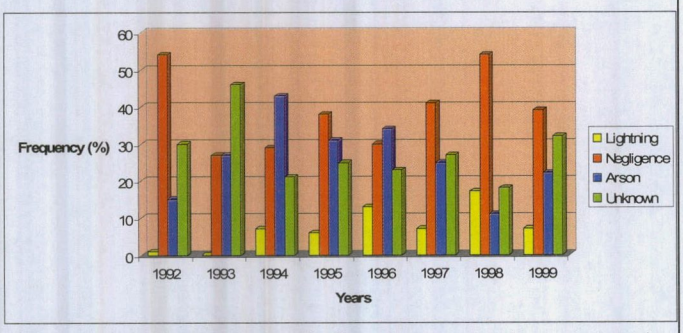


Figure 76: Distribution of fire frequency by causes in Argentina from 1992 to 1999 *(Source: IFFN)*.

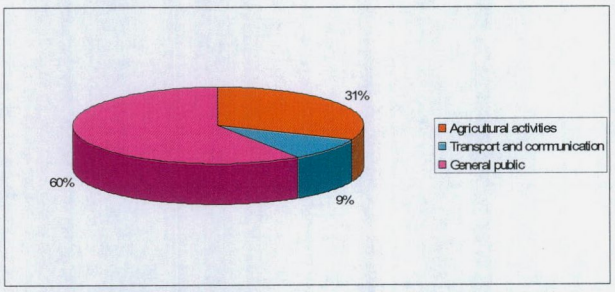


Figure 77: Break-down of fire causes due to negligence in Patagonia (Argentina) in 1992 *(Source: IFFN)*.

Figure 76 shows the distribution of fire frequency by causes from 1992 to 1999. Fires due to negligence were the most frequent over this period (up to 54%), mainly due to general public (Recreational activities) (Fig. 77). From 1994 to 1996, the frequency of fire due to arson increased over 30%. 20 to 30% of the fires were due to unknown causes (up to 46% in 1993) and less than 10% (up o 46% in 1993) were due to natural causes (except 13% in 1996 and 17% in 1998).

Causes	Mean %1992-1999	Main types of cause
Lightning	7%	
Negligence	**39%**	General public
Arson	26%	
Unknown	28%	

However, the origins of the fires varied strongly within the Patagonia. While almost all fires in the Río Negro area in the south were caused by men, climatic reasons (lightning) accounted for 46% of the fires in Neuquén province. The largest wildfires happened in mountain native forests in remote areas with difficult access, but the most dangerous fires happened in the area of S.C. Bariloche (Rio Negro) due to arson. In central and southern Patagonia natural phenomena accounted for very few fires, since lighting storms were limited almost exclusively to northern regions. Here, as in many other parts of the world, man caused most fires. Andean Patagonian region statistics showed 7% of natural causes and 93% of human causes (including the unknown causes).

Specificity of the country: The only information available in Argentina concerns the Patagonia region between 1992 and 1999 (IFFN).

Database Availability	Database Quality	AUSTRALIA	Mean nb of fires/year (1976-1996)	Mean burned area/year (1976-1996)	AU
1976 - 1996			719	115 518 ha	

Source of data

Data on forest fire causes in Australia are gathered by the States, but for most of them, there is no information available. In the state of Victoria, the database on wildfires is held by the Department of Natural Resources and Environment's FIRES (Fire Information Resources and Equipment System).

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

From 1976 to 1996, the 25 fire causes responsible for the greatest number of fires and total burned area were identified and recorded on FIRES (Davis 1997).

Statistics on fire causes

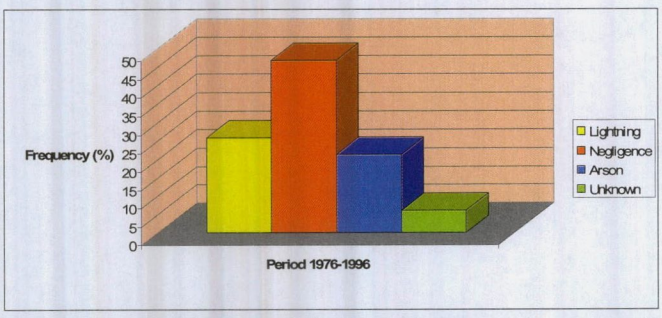


Figure 78: Distribution of the fire frequency by causes in Victoria State (Australia) during the period 1976-1996 *(Source: Davis, 1997)*.

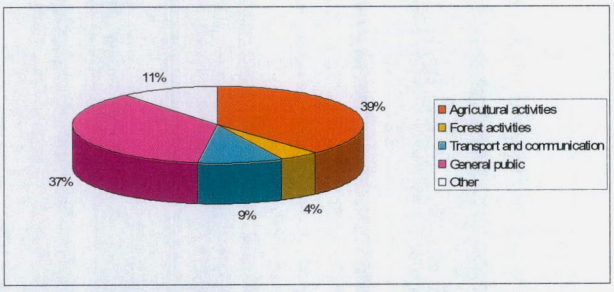


Figure 79: Break-down of fire causes due to negligence in Victoria State (Australia) during the period 1976-1996 *(Source: Davis, 1997)*.

In overall, most of the fires were started by people accidentally or intentionally, although lightning was an important cause of wildfire especially in remote regions. Figure 78 shows that, during the period 1976-1996, lightning and arson were among the main causes of forest fires. (26% and 21%). The proportion of fires due to unknown causes is low (6%).but the major cause was negligence, mainly due to agricultural activities and general public (Fig. 79).

Causes	Mean %1976-1996	Main types of cause
Lightning	26%	
Negligence	**47%**	Agricultural activities
Arson	21%	
Unknown	6%	

Specificity of the country: The only information available for Australia concerns only the state of Victoria between 1976 and 1996 (IFFN).

For more information, see Appendix.

Database Availability	Database Quality	CANADA	Mean nb of fires/year (1999-2008)	Mean burned area/year (1999-2008)
1994 - 2008	1994 - 2008		3629	873 020 ha

CA

Source of data

Forest fire protection is the responsibility of the Provinces (or Territories), although there is also a national coordination of resources through CIFFC (Canadian Interagency Forest Fire Centre). The Ministry of natural Resources (Canadian Forest Services) gathers data on forest fires for each Provinces and Territories of Canada.

Type of database

Each Provinces and Territories of Canada have their own forest fires database. Besides, there is also a database where only the forest fires larger than 500 ha are recorded (Large Fire DataBase).

Type of fire recorded

Non available.

Socio-economic or environmental context

Regional-scale lightning fire occurrence varies significantly across Canada, but on average lightning accounts for 35 % of fires nationally. However, it accounted for ~85 % of the total burned area, largely due to the fact that lightning fires occur randomly and often in large numbers, presenting access problems not normally associated with human-caused fires. The result is that lightning fires generally grow larger, as detection and subsequent initial attack is often delayed.

Causes recorded

The causes generally recorded are the following: Recreation, resident, forest industry, oil&gas industry, power line industry, other industry, railroad being the types of causes due to negligence/accident, but also lightning, incendiary (arson), miscellaneous known and unknown.

Statistics on fire causes

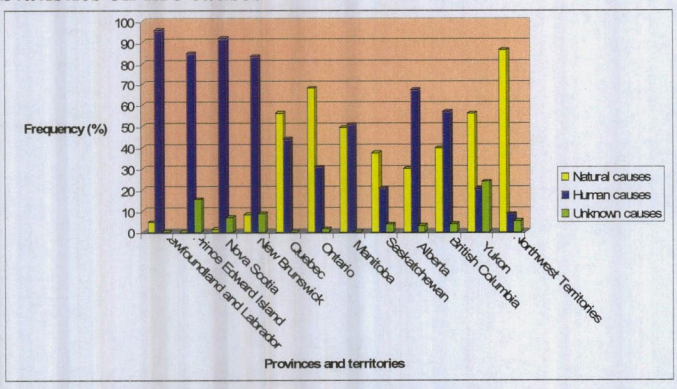


Figure 80: Distribution of the fire frequency by causes in the different Provinces and Territories of Canada in 2005. Human causes are not deatiled *(Source: Natural Forestry database program 2007, www.nrcan-mcan.gc.ca).*

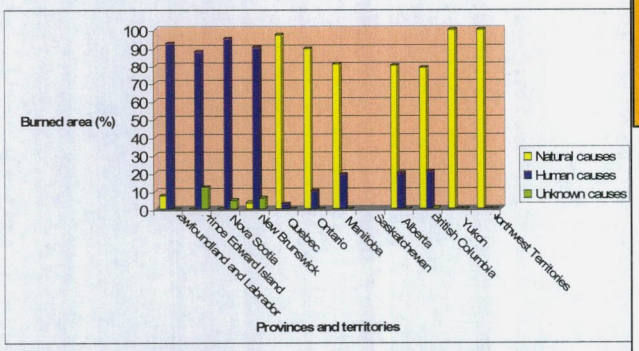


Figure 81: Distribution of the percentage of burned area by causes in the different Provinces and Territories of Canada in 2005. Human causes are not deatiled *(Source: Natural Forestry database program 2007, www.nrcan-mcan.gc.ca).*

Data on fire statistics in the different Canadian Provinces and Territories are available in the following website: www.nrcan-mcan.gc.ca. Figure 80 presents the variability of the fire frequency between the different Provinces and Territories of Canada in 2005. In the Eastern Provinces, human causes were the main cause of fires (up to 95% in Newfoundland and Labrador) as well as in Alberta and British Columbia in the West of the country. According to the temporal series in each Province or Territory, it seems that 2005 was a special year with more man-induced fires than usually (See Appendix). In the others Provinces or Territories, lightning was the main cause of fires, especially in Yukon and Northern Territories (>80%). Except in the Eastern Maritime Provinces, the percentage of burned area was the highest when the cause of fire was natural (Fig. 81).

Causes Alberta	Mean %1996-2007	Main types of cause
Lightning	**51%**	
Negligence	45%	General public
Arson	3%	
Unknown	2%	

Causes Quebec	Mean %1999-2008	Main types of cause
Lightning	27%	
Negligence	**68%**	General public
Arson	5%	
Unknown	0%	

Specificity of the country: There is a high geographical variation of the fire causes frequency in Canada according to the Province or Territory.

For more information, see Appendix.

Database Availability	Database Quality	CHILE	Mean nb of fires/year (1995-2004)	Mean burned area/year (1995-2004)
1990 - 1999			6050	51 042 ha

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Lightning storms or other natural agents (e.g. volcanic activities) as wildfire causes are insignificant or not presen in Chile. Most fires are caused by human activities: fires escaping from controlled burning in forests and in the agricultural sector and children playing with matches are the most important causes. Arson can be frequent in Chile.

Causes recorded

Non available.

Statistics on fire causes

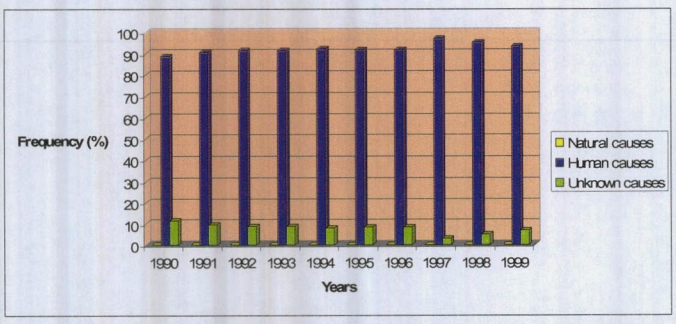


Figure 82: Distribution of fire frequency by causes (human causes not detailed) in Chile from 1990 to 1999 (natural fires were not recorded and only 9.1% of the fire causes are investigated) *(Source: IFFN)*.

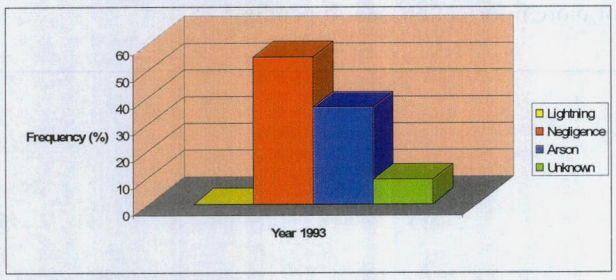


Figure 83: Distribution of fire frequency by causes in Chile in 1993 *(Source: IFFN)*.

Figure 82 shows that there was no variation in the fire frequency due to human causes between 1990 and 1999 in Chile and the frequency of fires due to unknown causes remained always less than 10%. The detail of the fire frequency in 1993 (Fig. 83) shows that negligence, mainly due to general public (Fig. 84) and arson were the main causes of fire (>40%).

Causes	Mean %1990-1999	Main types of cause
Lightning	0%	
Negligence	**58%**	General public
Arson	29%	
Unknown	13%	

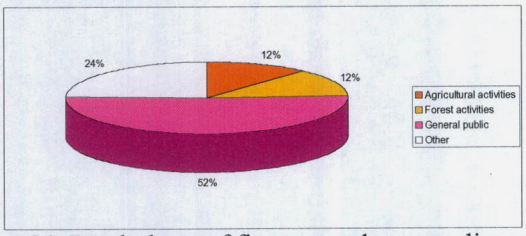


Figure 84: Break-down of fire causes due to negligence in Chile during the period 1990-1999 *(Source: IFFN)*.

Specificity of the country: There are no statistics available on fire causes in Chile after 1999. Data on the mean number of fires and mean burned area between 1995 and 2004 were found on the following website: www.fire.uni-freiburg.de/inventory/stat/ch/ch_statistic_1964-2004.html. The source of data on fire statistics is IFFN.

Database Availability	Database Quality	ISRAEL	Mean nb of fires/year (1997-2001)	Mean burned area/year (1997-2001)
1987 - 2002			942	6189 ha

IL

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Forest fires have always been frequent in Israel. In the past (1950s, 1960s), agricultural burning was one of the main causes of fires; negligence mainly due to smokers was a secondary cause. An important category was, then, and still is, "unknown causes". It is most likely that many of them were actually human-caused fires, but in most of the cases, the fire investigators were unable to establish a clear link between human factors and the fire. Other factors found responsible for fires in the late 1950s and early 1960s were: military training, agricultural waste burning, hikers, campers and smokers. The first and most important cause of forest fires in Israel was arson during a long time. In the 1980s and early 1990s, arson comprised about one-third of all forest fires in Israel, often with the purpose of collecting insurance money. *Intifada*-induced arson gradually faded out as the uprising started to die out in the early 1990s.

Causes recorded

There are currently three groups of fire causes in Israel: 1) *Arson*: all fires proven or suspected to be intentionally lit; 2) *Negligence*: unintentional fires caused by campers, hikers, military training and garbage dumps; 3) *Unknown*: cause undetermined or unreported. No fires are due to natural causes. There are four major incendiary causes for forest fires in Israel. First is the military: Army units who train with live ammunition in fire ranges near wildlands and burning waste in army camps cause, on the average, 5-6% of the fires. This type of fire prevails in northern Israel and the Golan Heights where many of the training areas (and forests) are located. A second category of accidental forest fires are the fires started by hikers and people who visit the forests for recreational purposes. A third category of fires is that of agricultural fires, namely fires which were accidentally started by farmers who burn agricultural waste, such as dry wood and vegetation. Finally, the number of fires caused by arson, namely fires set with the sole intention of destruction, is on the rise.

Statistics on fire causes

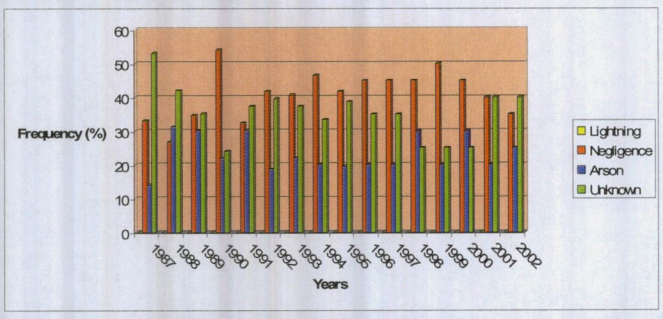


Figure 85: Distribution of fire frequency by causes in Israel from 1987 to 2002 *(Source: IFFN)*.

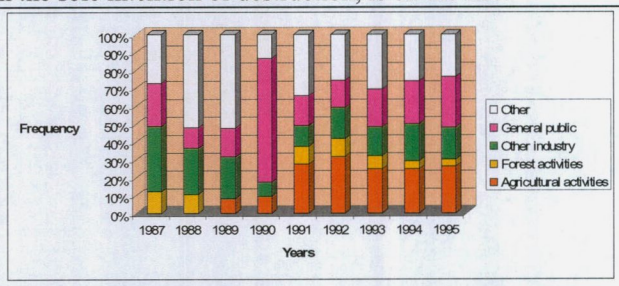


Figure 86: Distribution of fire frequency by causes due to negligence in Israel from 1987 to 1995 *(Source: IFFN)*.

During the period 1987 to 2002, the origin of fires in Israel revealed an important human element, through both negligence, but also by arson still frequent (20% and over) (Fig. 85). The proportion of fires due to unknown causes was also important. Negligence was mainly due to agricultural works, industrial activities, recreational activities and other such as military activities (Fig. 86).

Causes	Mean %1997-2002	Main types of cause
Lightning	0%	
Negligence	**43%**	General public
Arson	24%	
Unknown	32%	

Specificity of the country: No data available after 2002. Data on the mean number of fires and mean burned area between 1997 and 2001 were found in UNECE Timber bulletin. The source of data on fire statistics is IFFN.

Database Availability	Database Quality	LEBANON	Mean nb of fires/year	Mean burned area/year	LB

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

In Lebanon the term forest fire indicates all fires occurring in forests, wildlands, pasture land, and even in agricultural land. Most fire-prone forests are stands of *Pinus pinea, Pinus brutia* and *Quercus* spp. Wildfires occur both on private and government property.

Socio-economic or environmental context

Non available.

Causes recorded

It is often difficult to determine the causes of fires. It is known, however, that in addition to the traditional and well known causes (shepherds, hunters, owners living close to forest belonging to the government), the war in Lebanon and all military actions (explosives, power lines cutting by missiles, etc) sometimes cause forest fires.

Statistics on fire causes

Non available.

Specificity of the country: The only data available in Lebanon are undetailed information of IFFN. No data on fire statistics are available for Lebanon.

Europe EU

Europe out of EU

Out of Europe

Database Availability	Database Quality	MOROCCO	Mean nb of fires/year	Mean burned area/year
1998				

Source of data

Data are gathered in each regional Directorates.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

The forest land is an open space where access (except rare exceptions) is free. The population, especially those living at the forest edge, lives from subsistence economy (using forests for construction wood and firewood needs, the gathering of various non-timber forests products, and pasture). Consequently, forests are under a very strong human pressure and are overexploited. This human pressure increases the fire risk, since Moroccan forests, as all Mediterranean forests, are extremely flammable, particularly during the summer season when the fuel moisture content of plants is very low. It is often very difficult to determine the fire cause for instance because of the multitude of stakeholders in forest areas: commercial loggers, logging sites, shepherds, farmers, bee-keepers, distillers of aromatic essences, illicit charcoal production, and hikers.

Causes recorded

Non available.

Statistics on fire causes

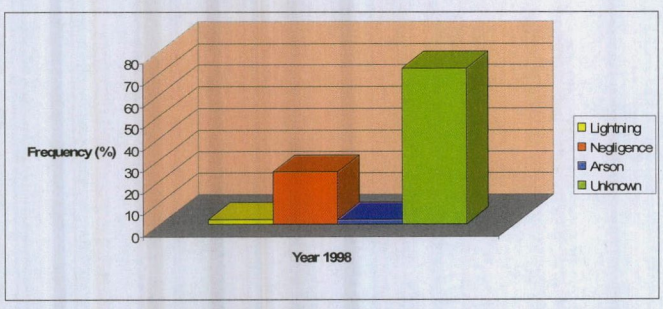


Figure 87: Distribution of the fire frequency by causes in Morocco in 1998 *(Source: IFFN).*

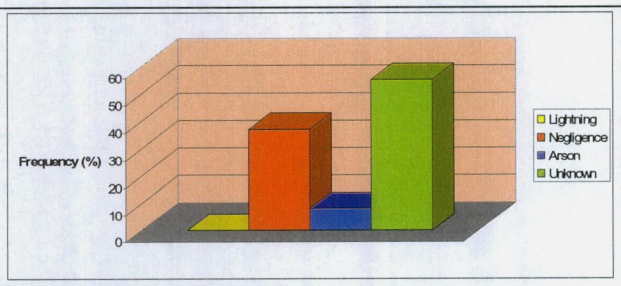


Figure 88: Distribution of the fire frequency by causes in Morocco *(source: Colin et al., 2001).*

The analysis of forest fire causes in 1998 shows a large dominance of the unknown causes (72%). The fires due to negligence/accident were also important (24%), generally due to the carelessness of smokers or people in the forest. The natural causes were rare (2%) occurring in the Atlas region. Fires due to land clearing, forest exploitation are considered in Morocco as intentional and represented 2% of the total number of fires (Fig. 87). Colin *et al.* (2001) reported a decrease in the proportion of the fires due to unknown causes and an increase in the proportions of fires due to negligence and arson compared to the previous results (Fig. 88). Figure 89 shows that, for each regional Directorate, forest fires of unknown causes were dominant (>60%). In the Rif region, they were up to 90%. Regions where the negligence was the higher were Haut-Atlas (26%) and North-East (20%).

Causes	Mean %	Main types of cause
Lightning	2%	
Negligence	24%	General public
Arson	2%	
Unknown	**72%**	

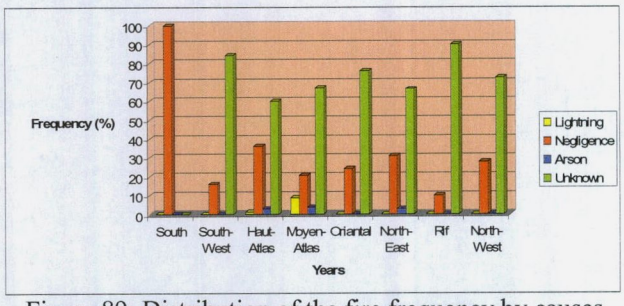


Figure 89: Distribution of the fire frequency by causes according to the regions in Morocco *(Source: IFFN).*

Specificity of the country: The only fire statistics available for Morocco were recorded in 1998 (IFFN).

Database Availability	Database Quality	SOUTH AFRICA	Mean nb of fires/year (1994-1996)	Mean burned area/year (1994-1996)	ZA
1994 - 1996			66	39 ha	

Source of data

The forest fires databases kept by the government until 1994 do not exist anymore and no statistics are being kept anymore in South Africa and it is quite difficult to gather information. Moreover, South-Africa is divided into regions differing in climate, vegetation and Information on the socio-economic or environmental context and not all the regions have data available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

According to FAO (2001), local people are the main cause of wildfires in Africa, but a few reliable data are available. These data come from the protected areas where local people cannot access to and where the prescribed burning is carried out. In 1998, the eastern Free State region - a mixture of nature reserves and agricultural land – suffered an unusual amount of fires due to arson. In the Tsitsikamma region, the extremely dry conditions and absence of rainfall during the period preceeding the wildfires contributed significantly to the fires, which were mainly caused by human beings, by allowing prescribed burns to become uncontrolled, and through arson. However, sometimes, dry thunderstorms caused most of the fires in the mountains.

Causes recorded

Non available.

Statistics on fire causes

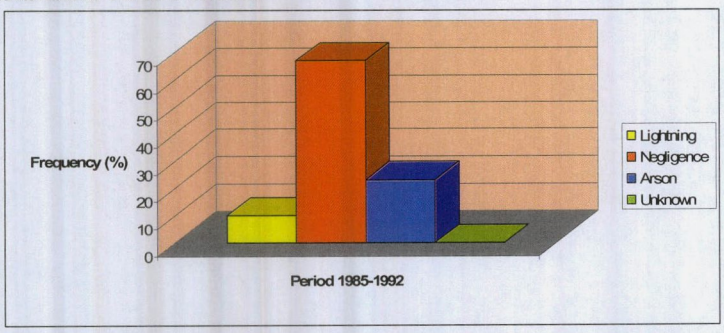


Figure 90: Distribution of the fire frequency by causes in the Kruger National Park (South Africa) during the period 1985-1992 *(Source: IFFN).*

A paper by van Wilgen *et al.* (2000) analysed the fire history of the Kruger National Park (1.9 million ha) for different periods in the park's history, where fire protection was followed by prescribed burning and then a "natural" (lightning) fire policy. Fires covering 16.79 million ha occurred between 1941 and 1996 (16% of the area burning each year on average). Between 1957 and 1991, 2213 prescribed burns covering 5.1 million ha (46.3% of the 10.98 million ha burned during that period) were carried out. Lightning fires burned 2.5 million ha between 1957 and 1996, or 21.6 % of the area. Fires occurred in all months, but 59% of all fires took place from September to November. Prescribed burns were concentrated late in the dry season (September to November). Lightning fires were later, with 84.7% of the area burning between September and January (van Wilgen *et al.* 1998, Brocket *et al.* 2000). Prescribed burning maked up 47% of the burned area in the Kruger National Park (KNP) in South Africa, between 1985 and 1992. Arson fires were set by the refugees from Mozambic (23%) and wildfires caused by other means (20%), lightnings caused 10% of the wildfires (Fig. 90).

Causes KNP	Mean %1985-1992	Main types of cause
Lightning	10%	
Negligence	**67%**	Forest activities
Arson	23%	
Unknown	0%	

Specificity of the country: No recent fire statistics are available for South Africa.

Database Availability	Database Quality	SYRIA	Mean nb of fires/year	Mean burned area/year
1987 - 1998				

Source of data

Databases are provided by the regional forestry departments.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

In Syria, the fire causes are directly related to human nature and to natural conditions. It is nevertheless possible to identify the categories of people who cause fires: Neighbouring farmers, resident people, shepherds, woodcutters, hunters, hikers, campers, traders in timber and forest by-products.

Causes recorded

Fires started by people generally are due to negligence and lack of knowledge of fire. Fires seem to be caused for direct personal material gain (improved grazing land, control of wildlife, hunting, exploitation of timber) or for indirect personal material gain (control and appropriation of forest land, new jobs in the forests, brush clearance, the timber trade). Some fires may be started by "natural" causes such as lightning, fragments of glass, high-voltage lines, car and trucks exhausts, trains, etc. In Syria, "Agriculture" is considered as a group of causes as well as "Negligence" or "Arson".

Statistics on fire causes

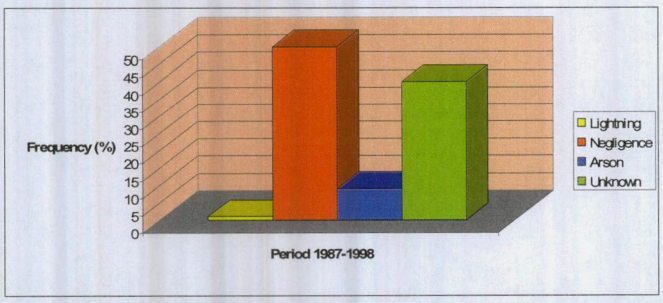


Figure 91: Distribution of the fire frequency by causes in the Latakia region (Syria) during the period 1987-1998 *(Source: COBASE report, 2006).*

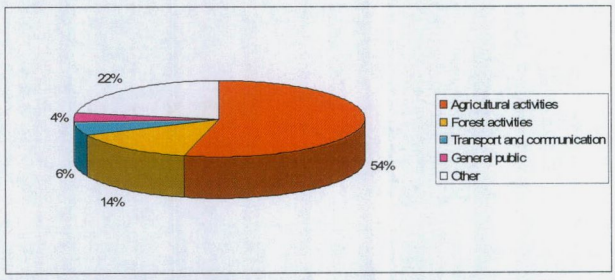


Figure 92: Break-down of fire causes due to negligence in the Latakia region (Syria) during the period 1987-1998 *(Source: COBASE report, 2006).*

Figure 91 shows that fires due to negligence/accident were the most frequent (50%) during the period 1987-1998 in the Latakia region of Syria but the proportion of fires due to unknown causes was also important (40%) but it seems that some fires classed in this last category or in negligence may be in fact intentional. Concerning the fires due to negligence or accident, figure 92 shows that agricultural burning was the main cause but as said above, a part of the fires due to this last cause and to forest employees could be classified in intentional fires (arson). Fires due to agricultural activities were merged in the group "Negligence".

Causes	Mean %1987-1998	Main types of cause
Lightning	1%	
Negligence	**50%**	Agricultural activities
Arson	9%	
Unknown	40%	

Specificity of the country: The only fire statistics available for Syria concern the period 1987-1998 in the Latakia region. The group of causes "Agriculture" has been merged with the group of causes "Negligence" for the fire statistics.

For more information, see Appendix.

Database Availability	Database Quality	TUNISIA	Mean nb of fires/year	Mean burned area/year
1985 - 1998				

Source of data

Non available.

Type of database

Non available.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

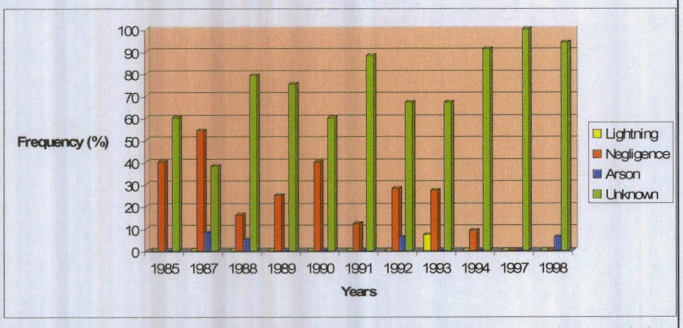


Figure 93: Distribution of fire frequency by causes in Tunisia from 1985 to 1998. No data available for 1986, 1995 and 1996 *(Source: IFFN)*.

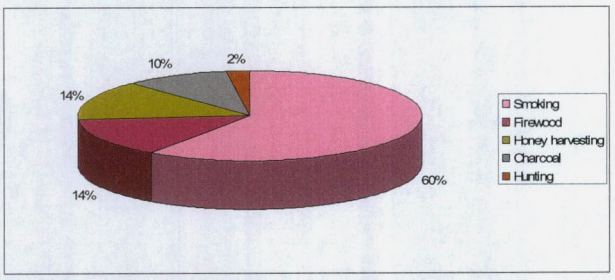


Figure 94: Break-down of accidental causes due to general public in Tunisia in 1997 *(Source: Mariel & Brochiero, 1998)*.

The analysis of the distribution of fire causes during the period from 1985 to 1998 shows that the natural causes were insignificant (7% only in 1993, 0% the other years). The proportion of fires due to unknown causes was the most important and increased after 1988 reaching 90% and over since 1994. Fires due to negligence were less frequent during this period. Arson was not a frequent cause and did not occur every year (Fig. 93). Figure 94 shows the break-down of accidental causes due to general public (Mariel and Brochiero, 1998). These types of fires were mainly due to smoking (60%). There is a geographical variation of the fire causes: negligence was the main cause in the Boukornine and Zoghouan regions, arson was the main cause in the Ghar Dimaou region because close to the Algerian border and lightning was the main cause in the Kef region (Mariel and Brochiero, 1998).

Causes	Mean %1985-1996	Main types of cause
Lightning	1%	
Negligence	23%	General public
Arson	2%	
Unknown	**72%**	

Specificity of the country: The only data available for Tunisia are the fire statistics between 1985 and 1998 (IFFN).

Database Availability	Database Quality	UNITED STATES OF AMERICA	Mean nb of fires/year (1991-1997)	Mean burned area/year (1991-1997)
1990 - 1997			110 335	146 7742 ha

US

Europe EU

Europe out of EU

Out of Europe

Source of data

Different institutions gather information on wildfire in USA and data are recorded on federal, state and private lands. The wildfire data are summarized from the computerized records maintained by the National Interagency Fire Center located in Boise, Idaho.

Type of database

Data are recorded in a state database and in a federal database.

Type of fire recorded

Non available.

Socio-economic or environmental context

Non available.

Causes recorded

Non available.

Statistics on fire causes

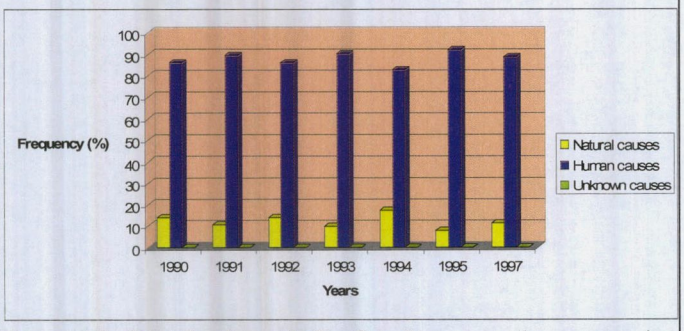


Figure 95: Distribution of the fire frequency by causes in USA from 1990 to 1997 *(Source: IFFN)*.

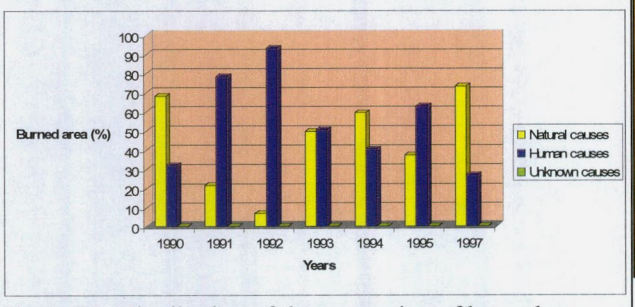


Figure 96: Distribution of the proportion of burned area by causes in USA from 1990 to 1997 *(Source: IFFN)*.

Figure 95 shows that fires due to human causes were the most frequent over the period 1990-1997 (≥90%). Concerning the burned area, the distribution of causes was different and depended on the year. In 1990, 1994 and 1997, the natural causes were responsible of the main part of the burned area in contrast of 1991, 1992 and 1996 (Fig. 96).

Causes State lands	Mean % 1995	Main types of cause
Lightning	3%	
Negligence	**71%**	Agricultural activities
Arson	26%	
Unknown	0%	

Causes Federal lands	Mean % 1995	Main types of cause
Lightning	34%	
Negligence	**56%**	Other
Arson	10%	
Unknown	0%	

Specificity of the country: No recent statistics on fire causes in USA are available. There is a variation of the fire cause frequency between the State lands and the Federal lands.

For more information, see Appendix.

4. Review on the main driving factors

Nowadays wildfires in Europe result mainly from the socio-economic development and the consequent change in life habits, linked to modern models of life, increased mobility, tourism and recreational activities which increase the number of visitors in the forest. But fire is also a traditional instrument for the management of Mediterranean ecosystems and the long established use of fire in agriculture, sylviculture and livestock breeding is well documented (Bonora *et al.*, 2002). The seriousness of the problem is that natural causes have been compounded by human action.
The main driving factors of ignitions have then been classified in 2 categories: (i) human factors, dominant in Europe, (ii) environmental factors mainly due to fuel, physiography and weather. The distribution of the fire occurrence varying in time and space, their spatial and temporal distributions were also reviewed. Despite its importance, the influence of human factors on the spatial and temporal patterns of wildfire occurrence is not well understood (Sturtevand and Cleland, 2007). In fact, while other variables associated to fire danger such as temperature or relative humidity are routinely generated, temporal and spatial data required to rate human risk simply do not exist or are rarely available (Martell *et al.*, 1987), i.e., there is a lack of accurate data on human activities within forested areas (Vega-Garcia *et al.*, 1995).
In the Eufirelab program, several factors impacting forest fires were identified (Lampin *et al.*, 2002):

- the demographic pressure factor depending mainly on the density of inhabitants and their proximity to the forest (economic characteristics, age, presence of tourists, communication infrastructures, etc, are taking into account);
- the forest probability factor 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 social tension factor indicating the degree of presence of opposing land use, illegal exploitation, wrongful fire use, and all types of conflicts that affect forest and its periphery;
- the forestry culture factor which is the symbolic system of collective representations concerning the forest and the derived products and services;
- the organisational logic factor which is considered through correct management and forest fire fighter organisation.

The knowledge of forest fire causes and the motivations of arsonists are necessary to inform, prevent and prosecute the people responsible for the fire. The analysis of the past fires allows the determining of the spatial and temporal characteristics of the fire risk in order to establish efficient plans of prevention and fire fighting. A good knowledge of the forest fire causes, related motivations and its spatial-temporal distribution is critical for the design of prevention policies adapted to the socio-economic, cultural and environmental circumstances of each region.

5.1 Human factors

Human agents are of great importance in fire risk assessment, especially in the Mediterranean countries where they are the main causes of forest fires either by accident/negligence or arson (Henderson *et al.* 2005).

In most countries, the specialized literature on human ignition factors is poor. Most commonly, when those factors were considered, the estimations were based on indirect assessments (proxy or surrogate variables) of human activity or in data on accessibility to forested areas. The first studies on human factors were based on indirect variables, obtained mainly from censuses and survey sources (Cunningham and Martell, 1976; Altobellis, 1983; Donoghue and Main, 1985) and were mostly non-spatial. Later on, the human factors were analyzed spatially. For instance, relations between fire occurrence and distance to roads, to settlements or to specific land uses have been documented in several studies (Chuvieco and Congalton, 1989; Vega-Garcia *et al.*, 1995; Vasconcelos *et al.*, 2001; Prestemon and Butry, 2005; Mollicone *et al.*, 2006; Maingi and Henry, 2007; Vasilakos *et al.*, 2007; Yang *et al.*, 2007). The human risk problem requires a comprehensive assessment within a spatial framework, which must include not only geographic or environmental variables (i.e. average distance to roads, to populated or recreational areas, length of wildland/urban interface) but also socio-economic factors (unemployment rates, rural population age, population density, etc.) that may cause high fire ignitions (Martinez et al 2009). Fire ignitions often occur closer to human activities, such as roads and populated places (Russell-Smith *et al.*, 1997; Cardille *et al.*, 2001; Pew and Larsen 2001). In the case of accidental fires, humans often inadvertently spread fire from their location (i.e. camp fire, cigarette thrown from car window, etc.), so one would expect these fires to occur near roads, towns, and campgrounds. In the case of intentional fires, arsonists

need access to wooded areas that provide an escape route. There are also certain regions, such as Galizia in NW Spain and neighbouring parts of Portugal, where arson is a major problem that has its roots in social conflicts; government plantations have been established on lands that were previously rangeland for the local community (Moreira *et al.* 2001, Tabara *et al.* 2003).

In Greece, applying stepwise and OLS methods on data covering the period 1978-1987, Lekakis (1995) concluded that political events and economic development leading to an increased demand for land along with some cultural and ecological phenomena were responsible for the destruction of the Greek forests. Regarding human presence and socio-economic impacts, the most important factors are the month of the year followed by proximities to urban areas, landfills and main roads; distance from recreational areas seems to have the smallest effect (Vasilakos et al 2008). A major factor is abandonment of countryside by rural populations that practised traditional professions in the forest (gum resin cultivation, pasturage, wood production etc), fact that involves enormous accumulation of natural fuel material. Other factors are negligence, existence of disposal area, combustion for renewal of pasture lands, arsons for economic motives and interests, not finalisation of Forest Cadastre and Cadastre, not syntax of forestal maps, lack of mapping of burned areas in annual base according to the Ministry of rural development and food.

In Spain, the direct or indirect influence of people is quite evident. The works of Badia-Perpinya and Pallares-Barbera (2006) and Romero-Calcerrada *et al.* (2008) showed that the high number of ignitions was a result of the high accessibility of the urban–forest interface areas, which led to a greater presence of people in woodlands. Proximity to urban areas and roads was found to be the most important causal factors. Romero-Calcerrada *et al.* (2008) suggested that these characteristics and recent socio-economic trends in Spain may be producing landscapes and wildfire ignition risk characteristics that were increasingly similar to Mediterranean regions with historically stronger economies, such as California, where the urban-wildland interface is large and recreation in forested areas is high. Badia-Perpinya and Pallares-Barbera (2006) also pointed out that the abandonment of traditional activities had transformed fertile soil into woodland areas, and changing uses of land and low breakage networks had favoured large forest continuity, making the territory more vulnerable to the spreading of forest fires. As high population density and easy accessibility has increased mobility within metropolitan area, their results showed that the dense use of the territory favouring ignitions in forest areas was explained by a clearly positive relationship between the high occurrence of fires and locations close to transport networks and urban areas. In their work, Martinez *et al.* (2009) found that human factors associated to high forest fire risk along 13 years of fire occurrence data were found to be linked to agricultural landscape fragmentation, agricultural abandonment and development processes. The variables used in their models were: (1) density of agricultural machinery, (2) density of agricultural plots, (3) persistence of livestock under traditional management, (4) unemployment rate, (5) rural population decrease between 1950 and 1991, (6) urban–forest interface density, density of roads (7) and railways (8), (9) urban population increase between 1950 and 1991, (10) density of the interface between risk infrastructures (waste dumps, mines, quarries, areas under construction, roads more than 100m wide) and forest areas, (11) percentage of municipal land in protected natural areas, (12) agricultural area which became forest land in 1970–1990, all increased the human risk of wildfire and (13) the increment in owners of agrarian holdings in 1989–1999.

In Portugal, in order to evaluate the distribution of wildfire ignitions, 127 492 fires detected in Portugal were analyzed during the period 2001-2005 in relation to variables such as population density, proximity to urban areas and road network, land cover types, altitude, causes and final burned area. Results showed that most part of fire ignitions were concentrated in the north and centre littoral areas, in the most populated municipalities, and were intentionally caused. Although municipalities with more than 100 persons per sqkm represents only 21% of the territory, they concentrated more than 70% of fire ignitions occurring in Portugal, but only about 14% of total burned area. 85% of fire ignitions occurred at less than 500m from urban areas and 98% were within a distance of 2km. Fire ignitions were also located very close to the main roads (70% at less than 500m, and 98% at less than 2km). Most ignitions were located in agricultural and social/urban areas (60% and 25%, respectively), and only 15% in forested or uncultivated areas (8.5% and 6.5%, respectively). About 80% of ignitions occurred at elevations below 500m, and 85% of fire ignitions originated a burned area lower than 1ha, and only 0.3% of them originated large wildfires with 500ha or more. These results emphasised the crucial role of human distribution and activity in the spatial distribution of wildfire ignitions, and could be very useful in fire risk management and in prevention strategies implementation (Catry *et al.*, 2007).

In France, Alexandrian and Gouiran (1990) found several tendancies concerning the temporal distribution of the fires according to their causes. A first tendancy opposed intentional fires lighted in summer, in the end of the afternoon or in the evening to fires due to agricultural or forest works lighted in autumn-winter during the day. The first ones are often lighted close to a road, around cities highly populated and where the forest area is small

because already burned several times whereas the second ones are rather lighted near an isolated dwelling in a large forest area. A second tendancy concerned the fires lighted by lightning, typical of the end of the summer; the ignition point being located within the forest, in remoted areas. A third tendancy opposed accidental fires, threatening a small area to intentional fires burning large areas.

In Switzerland, in general 70-75% of all fires are human caused and 25% are natural. Most human-caused fires have their outbreak near forest roads, hiking trails or settlements. Natural-caused fires show no such tendency (Langhart *et al.* 1998).

Even if in Russia statistics are unreliable, satellite-based analyses show that the density of ignitions decreases with the distance to roads, and a modelling of these data suggests that for all of Russia, 90% of ignitions are anthropogenic (Achard *et al.* 2008). With increasing exploitation of natural resources (timber, oil, gas, minerals), an increase in the number of fires is to be expected, both due to a high number of people *per se*, and to the expanded road network allowing access into remote areas.

In the boreal forest of Alberta (Canada) and in the mixed chaparral and conifer forest of Southern California, it has been found that the probability of human-caused wildfires occurrence decreased with increasing distance from different human infrastructures (Chou *et al.*, 1993; Vega Garcia *et al.*, 1993), and that in the boreal forest of Canada this probability increased with dryness (Martell *et al.*, 1987; Lawson *et al.*, 1993; Vega Garcia *et al.*, 1995). In the temperate rainforest of the Vancouver Island (Canada), the probability of burning was negatively correlated with distances to municipalities, campgrounds, dirt roads, railroads, and paved roads. Recreation and miscellaneous fires tended to be significantly smaller than logging fires and were most common in areas with highest probability of human-caused fires (Pew and Larsen, 2001). In the southern USA, wildfires in several forests occurred more frequently on public lands than on industrial and non-industrial private forests, and the probability of wildfires increased with proximity to urban areas (Zhai *et al.*, 2003). In Minnesota, Wisconsin and Michigan in the 1985–1995 period, another study found areas with higher population density, higher road density, and lower distance to non-forest were more likely to burn (Cardille *et al.*, 2001). Fire occurrence was also correlated with distance to roads (54% of the total variation in density of fires was explained by the distance to roads) and populated places (85% of the total variation observed in fire density was explained by the proximity of populated places) but no relationships between fire occurrence and county-level unemployment rates were found (Maingi and Henry, 2007).

In Argentina, in addition to the environmental factors, fire occurrence in the different regions is affected by such human factors as cultural practices, varying population density, tourism affluence and characteristics of fire suppression activities (IFFN).

In Australia, fire frequency was higher on pastoral lands and further away from roads (at distances of 5 to 25km from roads compared to distances within 5km of roads) (Vigilante *et al.*, 2004).

In Syria, among the socio-economic causes of wildfire, the large land abandonment of the rural areas in the hills and in the mountains should be underlined. Apparently, this social phenomenon has no relation with fire occurrence frequency. Indeed this rural abandonment implies a total lack of land management and a disappearance of human presence in the territory. As an example, the rural tradition terrace system for crops and orchards, built with dry masonry walls or vegetation contours, create a discontinuity in the landscape to the fire spread. The large accumulation of fuels often allows fires set for agricultural purposes to spread out of control. Furthermore, the scarcity of forest dwellers makes fire suppression more difficult. High population density makes the woodlands more prone to risk because of the incorrect human behaviour. Because a majority of the wildfires are ignited intentionally or unintentionally by humans, population density is included in the fire risk parameters. The distance to roads is also included to further capture the human/wildfire causal relationship. Travel corridors increase the probability of human presence which could in turn result in wildfire ignition. Hence, areas closer to roads attain a higher ignition probability (COBASE, 2006).

5.2 Environmental factors

Fewer fires occur in more remote areas. In terms of abiotic influences on fire, fire burns and spreads more easily in dry fuels (Pyne *et al.*, 1996). Topographic effects are more varied. Moisture differences and fuel loads are driven by topography, but these differences are more or less pronounced in different regions (i.e. steep or flat terrain, dry or moist climate).

Within parts of the boreal region there are still areas where a predominantly natural fire regime still reigns, and which is still largely beyond human control. In remote parts of Alaska, Canada and Siberia lightning ignitions supply most of the ignitions, particularly during episodes of severe drought (Granström, 2008). Weather conditions can be responsible of a great number of fires but above all, of large burned areas in some countries, mostly situated in Northern regions. Indeed, lightning-ignited fires contribute to 85% of the burned area and to 35% of the fires reported in Canada (Weber and Stocks, 1998). Lightning fires burn a disproportionate share of area because they are more likely to occur in remote areas, where they are harder to detect and to reach. This can lead to lightning-caused fires burning for longer periods of time before they are extinguished (Podur *et al.*, 2003). In Alberta (Canada), it takes, on average, over 1400 lightning strikes to start a fire, whereas in British Columbia (Canada) fewer than 50 strikes are required. In British Columbia, there was a high degree of spatial overlap of lightning fire occurrence patterns produced in the 1961–1994 fire seasons. Elevation, the distribution of lightning strikes, Severity Rating values (Van Wagner, 1987) and vegetation composition were identified as the primary agents controlling lightning fire occurrence (Wierzchowski *et al.*, 2002). In the temperate forests of Vancouver (Canada), the probability of burning was positively correlated with summer temperature and negatively correlated with precipitation (Pew and Larsen, 2001). In Ontario (Canada), a spatial statistical analysis of lightning-caused fires from 1976 to 1998 conducted with the spatial point pattern (SPP) method (Cressie, 1993), concluded that the principal determinants of the spatial clustering of lighting-caused fire occurrence were localized according to dry weather and lightning-storm occurrence (Podur *et al.*, 2003).

Extending from 22°S to 55°S, Argentina presents a great diversity of ecosystems associated with the different climates. Fire is present in the different vegetation associations, varying in frequency, intensity and time of the year in response to the different habitat types, frequency of lightning storms, strong dry winds and rainy seasons (IFFN).

In the Australian Capital Territory, no relationship between elevation, slope, aspect, or topography and lightning fires has been found (McRae, 1992). However, the highest fire frequencies were observed on basalt substrates, as edaphic factors drive vegetation patterns in the area (Vigilante *et al.*, 2004). In Kakadu National Park (Australia), relationships between precipitation patterns (dry *v.* wet season) and fire occurrence were also found (Russell-Smith *et al.*, 1997).

In Yosemite National Park (USA), altitude-dependence for lightning causes was founded (Van Wagtendonk, 1991) but not in Yellowstone Park where a dependence on fuel type and fuel moisture content was observed (Renkin and Despain, 1992). Although humans are responsible for the vast majority of fire ignitions in the eastern Kentucky (USA), weather conditions, topography, and other abiotic factors play a critical role in fire spread and behaviour (Pyne *et al.* 1996). There, human and abiotic factors influencing wildfire occurrence and distribution were studied from 1985 to 2002. The results showed that the total burned area was negatively associated with the 3-month mean Monthly Palmer Drought Severity Index (PDSI) from the National Climate Data Center of the US Department of Commerce for October-December. Higher elevations were associated with higher fire occurrence and significant differences were observed in median slope with steeper slope associated with a higher fire occurrence (Maingi and Henry, 2007).

The fire pattern in a region associated with natural ignition sources is traditionally referred to as a "natural fire regime". In Norway, this will mean fires ignited by lightning. Coniferous tree species and understorey vegetation, together with humus and litter on the forest floor, constitute the best fuel. Vegetation and organic soil conditions are therefore important in determining where the majority of natural fires can occur in Norway. The natural fire regime closely follows climate. Heavy precipitation is typical, and parts of Western Norway receive more than 4m. Thunder storms can periodically move in from the sea as part of large low pressure cells, and local thunder storms can also form above the landmass during summer. Lightning is frequent, but the high humidity creates much less optimal conditions for natural ignition as compared to more continental areas. The highest frequency of natural fires is expected in the boreal forests of the country's eastern lowlands, southwestward to the divide, and in the most continental part of central Norway. The rugged topography, with its many depressions, valleys, bogs, lakes and wetlands, creates natural fire barriers. Measured on an international scale, relatively small areas are therefore expected to burn in individual fires. Differences in frequency of lightning, distribution of fuels, and the varying climatic conditions create distinct frequency gradients with respect to the occurrence of natural fires (IFFN, 1998).

In Russia, frequency of fire depends on many factors: the spatial structure of landscapes, their ecological regimes, the fuel characteristics of forests and adjoining vegetation, typical fire weather during the burning

period, inter-annual climate variability (recurrence of extreme drought), population density, accessibility, level of forest fire protection, etc. (IFFN)

In central Spain, it was found that fires aggregated on southern slopes and that re-burned areas had low elevations and lower slopes, and were probably the most productive areas (Vazquez and Moreno, 2001).

Greece with the Mediterranean climatic conditions has intense forest fires. The elation of forest fires are owed to unfavourable meteorological conditions (increase in temperature, powerful winds), in the peculiarity of the vegetation (low vegetation that can easily be caught on fire) which covers the most part of the flammable regions, as well as to the relief that generally creates enormous problems so much in the sector of prevention but also in the sector of repression of forest fires. Compared to the other Mediterranean Countries (member states of the EU), Greece has the biggest mean burned area per fire, fact owed to the scattered extent of the Country (continental and islander area), to the wind factor that blows during the summer (August mainly), to the dry summer and to the vegetation that is similar only in the southern part of Italy (Sicily) and in no other circum-meridian Country of EU. In regard to weather conditions, the most significant parameter for fire ignition in the Lesvos Island (Greece) is the occurrence of rainfall in the last 24h followed by temperature, wind speed, and relative humidity. With respect to the vegetation and topography fire hazard, 10-h fuel moisture content is the most significant variable followed by fuel models, aspect, and elevation (Vasilakos *et al.*, 2008).

In Syria, the hilly and mountainous slopes covered by mature monospecific pine plantations, Mediterranean *maquis* mixed with olive tree, Mediterranean forest young monospecific pine plantations and the forested mountainous steep areas next to the agriculture lands appear as the most exposed to fire risk because of the human pressure but also because of the prevailing presence of *maquis* and clusters of natural forests. As a result, the sandy and gravel soil appears as the most exposed to fire risk. (COBASE 2006).

5.3 Spatial distribution of fire occurrence

The analysis of the Aragon's database (Spain) over 19 years (1983-2001) shows that the human-caused events were mainly concentrated in areas whereas the lightning-caused fires tented to occur in large wildland patches. The spatial distribution pattern of lightning-ignited wildland fires covered mainly the mountain regions included between 800 and 1600m. Fuel characteristics, in terms of moisture, bio/necro-mass quantity, horizontal/vertical structure, constituted key element explaining the spatial distribution of the lightning-caused fires. The spatial distribution pattern of wildland fires due to human causes was more spatially distributed than lightning: the highest density value appeared on the contact line between wild and agricultural lands, especially on the northern edge of the Iberian Ranges and the southern edge of the Pyrenees. A relationship between human-caused hotspot areas and the level of landscape heterogeneity was observed considering wildland and non wildland zones (Amatulli *et al.*, 2007). These results agree with several works conducted in Mediterranean areas (Leone *et al.*, 2003; Maselli *et al.*, 2003; de la Riva and Perez-Cabello, 2005; de la Riva *et al.*, 2006) where the edges of agriculture-wildland are considered to be one of the most susceptible areas to wildfire, as also happens in tropical forests (Holdsworth and Uhl, 1997; Cochrane and Schulze, 1999; Cochrane and Laureance, 2002). In fact, the level of landscape fragmentation increases strongly the fire susceptibility and the so-called *edge effect* (Leone *et al.*, 2003).

In France, spatial analysis of ignition points reveals the importance of roads (Alexandrian, 1995). Others studies show that the number of ignitions decreased with the distance to the constructions (Follin, 1999). Statistical studies made relations between the distance separating each ignition point from a network (Decarnin, 2002) but the ignition points were counted many times (being affected to several networks at the same time). A spatial analysis of the distribution of 606 fire ignitions points showed that the impact area of networks was: 150m for power lines, 100m for railway networks, 250m for roads and 175m for houses (Mangiavillano, 2004). Another analysis of the distribution of 388 fire ignition points showed the impact of the type of roads: 20% of the ignition points were located at less than 20m from any roads and only 5.4% were located at more than 2000m from the road; in particular, 59% of the ignition points were located at less than 570m from a local road (way, domestic roads), 32.7% at less than 555m from a departmental road and 2.8% at less than 390m from a national road (Lampin et *al.*, 2005; Lampin et *al.*, 2006). Finally, the spatial analysis of 227 fire ignition points on a 64 700ha study area showed the role of the wildland urban interface typology. The latter, depending on the combination of spatial criteria based on the house density and the fuel horizontal continuity, seemed to have an impact on the

fire ignition distribution: fire ignition density values increased from clustered dwellings (4.2 fire ignition points per 1000ha), to scattered dwellings (5.2 fire ignition points per 1000ha) and finally to isolated dwellings (9.5 fire ignition points per 1000ha). The mean fire ignition density value was 3.5 fire ignition points per 1000ha on the whole study area and 1.5 more in the wildland urban interfaces (5.3 fire ignition points per 1000ha) for the 1996-2007 period (Lampin-Maillet et *al.*, 2009). In the framework of the AIOLI research programme, the spatial analysis of ignition points was carried out for each type of causes: lightning, electrical network, railroad, motor vehicle, dump, arson, forest work, agricultural work, industrial work, private owner work, recreation, glowing object throw. However, this approach was based on the Promethée database which localised the ignition point within a 1 sqkm area and gave more accurate spatial information on its distance to the roads and houses (more or less 50m) (Jappiot et *al.*, 2006).

In a comparison between Greece and Switzerland, the spatial patterning of ignition points follows in most cases the spatial distribution of random points established using a complete random design for both study areas whereas the spatial arrangement of fire ignition points in Grison (Switzerland) in relation to the elevation where the distribution frequency indicates that human fire ignition points tend to be found within the altitude ranges that correspond to the inhabited and cultivated areas (Koutsias and Allgöwer, 2002).

In Canada, the variation in the factors driving fire activity also affects spatial fire patterns. The extent and configuration of flammable vegetation and non-flammable landscape features clearly influences patterns of burned area (Cumming 2001; Duncan and Schmalzer 2004). The clustering of fires is influenced by anthropogenic factors as humans have historically ignited over half of the large fires in Canada (Stocks *et al.* 2003). However, the fire clustering generally decreases with the degree of human influence. An examination of the spatial distribution of large Canadian fires (Figure 97) shows that the greatest fire activity and burned area occur by far in the boreal region of west-central Canada. This is due to a combination of fire-prone ecosystems, extreme weather (a continental climate), frequent lightning activity, and reduced levels of protection in the region.

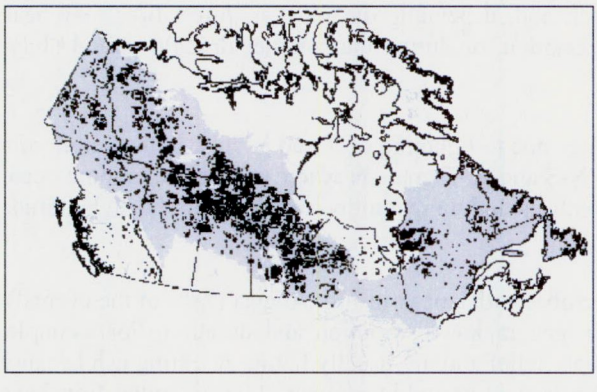


Figure 97: Greatest fire activity and area burned occur in boreal region of west central Canada (Stocks *et al.* 2003).

5.4 Temporal distribution of fire occurrence

In Greece (prefecture of Halkidiki), the study of fire occurrence pattern showed the main fire season for both human-caused and natural fires in Halkidiki was July, August and September while the most fire ignited between 12:00 and 14:00 (Koutsias and Allgöwer, 2002).

In Cyprus, between 2000 and 2008, June, July, May, August and October are the months during which the biggest number of forest fires is recorded (Ministry of agriculture department of forest).

In the northern Great Lakes Region (USA) and in Canada, April and May were the most significant months for fires (over 70% of all fires began during one of these two months) and a smaller peak occurred in October when the summer vegetation had senesced but winter snows had not begun (Cardille and Ventura, 2001; Stocks *et al.*, 2003). The number of lightning fires takes over during the late spring and summer period. As expected the seasonal trend in burned area was dominated by lightning fires during the summer months (Stocks *et al.*, 2003).

Then fires were less likely to have occurred in a forested area than in non-forest area probably due to the relative ease with which a fire can start in grassy or agricultural areas and to the differences in accessibility to human. In the end, the fire probability was significantly related to the land cover (Cardille and Ventura, 2001).

In Germany, the average number of fires and the average burned area indicate two peaks in April and August. This supports the earlier theses of Geiger (1948), Weck (1950) and Missbach (1982) that most fires occur in spring and in high summer.

In countries in which the agricultural burnings are still current, the temporal distribution is clearly linked to this practice. For instance, in Bulgaria in 2008, there were 2 peaks in the number of fires, the first in March and the second during August. Both of them were mainly connected with the burning of stubbles and vegetable residuals by the farmers. Generally, the highest fire occurrence was registered during the summer season and depended on the drought and the most frequent forest fires were recorded near fields or agricultural lands, recreational areas, routes, etc. with forests in the vicinity (Fire report, State Forestry Agency).

Most forest fires in Albania occur at the end of spring and in summer. The majority of forest fires occur during June–September reaching the maximum during July and August (in this period the soil surface maximum temperatures is round 65°C-70°C). However, there are some biotic and abiotic factors affecting the sustainable forestry, which is extremely important for the sustainable development. While some of these factors are originating from human being, some of them are arisen from the processes of fungus and insect damage, storm, snow, fires, etc. Human misuse of fire (accompanied with deforestation during the past years) and over-grazing practices were no doubt largely reasons for most of the forest destruction. Unfortunately unrestricted grazing and uncontrolled fires –caused accidentally and often due to agricultural burnings-, still occur throughout Albania (IFFN).

Sometimes, the peak of fire occurrence depends only on the vegetation dryness. An absolute majority of forest fires in Poland takes part in the period March-September, and, depending on the year, forest fires may peak either in early spring months before the greening of vegetation, or during the summer drought period (July-August).

In Sweden, Granström (1993) noted that in 1994, most fires due to lightning occurred in July, at the height of a long drought. The number of lightning ignitions follow a N-S and W-E gradient where the highest amount occur in the southeastern summerdry part of the country and the lowest lightning ignition frequency in the high altitude northern forests.

In the Alps, lightning-induced fires occur from May to October with a peak in July-August (78% of the events!). These fires differ from fires of anthropogenic origin in geographic distribution and duration. For example, lightning-induced fires occur at higher elevations on steeper relief and are usually harder to extinguish because of underground fires. In hot and dry summers, such as the drought-period in summer 2003, lightning-fires have become particularly frequent with significant higher burned area and fighting costs. (Conedera *et al.*, 2006; Langhart *et al.*, 1998). The main fire season for human fires in Grison is March and April with most fires starting in the early afternoon between 14:00 and 16:00 (Koutsias *et al.*, 2002). Another peak occurs in spring (April) and the main cause is negligence and the most dangerous days are Saturdays and Sundays (Langhart *et al.*, 1998).

In Algeria, before independence the occurrence of fires was distributed fairly balanced all over the year that maybe explained by the role the domanial forest of Bou-Taleb played to meet the needs of the local population, especially during the extreme exploitation phase during World War II. Currently most reported fires in Bou-Taleb (88.9%) take place in the hot summer months June to September, a period during which the forest is frequently visited for grazing, harvesting honey, and picking fruits. The remainder of fires takes place at the end of the spring and the beginning of the winter with 6.4% and 4.8% respectively of all cases. Most fires starts in July (41%), mainly during daytime. The concentration of fires happens between 09:00h and 18:00h with 50 fires equalling 92.6% of the total number. The majority of fires (43, equalling 79.6%) occurs between 11:00h and 17:00h. Only 4 fires (7.4%) occur at night between 21:00h and 08:00h in the morning. It must be assumed that fires started by carelessness start during daytime while night fires can be mainly arson fires (Ministry for Water Resources and Forestry, Algeria 1987).

In the Latakia region (Syria), the hilly and mountainous slopes that face south and southwest, during the summer period (with the high temperature, dry climatic condition, and south-western to southern winds blowing) have the highest fire risk, with major peaks in August and September (COBASE, 2006).

In the southern territories of Argentina (Patagonia) where the rainy season occurs in winter, wildfires start in late spring and last until early summer. Moving northward in the country, fires tend to occur in autumn and winter associated with the dry seasons (IFFN).

The fire season in Chile normally begins in November, reaches its peak in January and February, decreases in March, and ends in April. However, years with a dry winter or an early finishing or a later beginning of the rainy season may extend the fire season in some regions (IFFN).

5. Modelling works

Catry *et al.* (2007) underlined that the importance of knowing fire ignition characteristics is widely recognized (Vasconcelos *et al.*, 2001; Preisler *et al.*, 2004; Riva *et al.*, 2006; Robin *et al.*, 2006; Badia-Perpinyà and Pallares-Barbera, 2006). Fire ignition probability (or ignition risk) is often considered as an important factor, for example used in association with fire propagation risk to produce fire risk models (Finney, 2005, Roloff *et al.*, 2005; Jappiot *et al.*, 2006). These kinds of models offer two relevant contributions. The first is a predictive function of forest fire occurrence, measured by the number of fires per unit area or as probability of occurrence. The second is an explanatory function, which calculates the impact of each socio-economic factor on fire occurrence, identifying statistical associations and potential causal relations.

Quantifying the probability of large fire occurrence is necessary to understand the causes, patterns and consequences of ecosystem-level disturbance and change, the socio-political implications of wildland fire and fire management, fire risk and fire threat to humans and their communities.

Previous studies showed the relationship between fuel types, topography and socio-economics factors with forest fire occurrence (Chuvieco *et al.*, 1999). The ignition danger is related to the conditions of the fuel, both dead and live, as well as to the causal agents of fire. The most critical problem is to establish a coherent criterion to properly combine those variables. The human component of fire risk is quite complex to model. A good solution is to infer human sources of ignition from indirect indicators of its number, activity and distribution. Human activities are very dynamic in time and space, which makes intricate the estimation of specific spatial patterns or rather these are more difficult to determine, as in the case of pyromania or other very specific intentional motivations. However, human causes such as those related to recreational activities or agricultural burnings appear feasible to model by using some spatial variables related to the physical environment where those activities take place. The complexity of rating social behaviour explains why human factors are rarely included in fire danger models (Martinez *et al.*, 2009). Spatial analysis of human risk is quite complex, due to the difficulty of spatially correlating socio-economic activities in the biophysical and anthropogenic environment (Chen *et al.* 2003; Kalabokidis *et al.*, 2002).

5.1. Methods for data integration

The integration of danger variables in a single wildland fire ignition danger index may be accomplished by different techniques. The Deliverable D-08-05 of the Eufirelab research programme synthesizes the different methods to model wildland fire risk. In the previous years, most risk ignition analyses were based on indexes assessed using expert knowledge. Experts may assign danger levels and weights according to their own perception of fire danger in the area. Risk tables were created, as a combination of two variables with specific danger values. A single danger index was created by weighting the input variables. For example, in Salas and Chuvieco (1994), the ignition risk is defined by the human risk, vegetation, illumination and elevation maps.

Multicriteria evaluation techniques may be a good alternative to reduce the subjectivity of this assigning process. The weights of the different variables can also be calculated using regression analysis techniques. One of the most common approaches consists in using local adjustments, based on regression analysis (Anderson *et al.*, 2000; Carvacho, 1998; Castro & Chuvieco, 1998; Chou, 1992; Koutsias *et al.*, 2002, Leone *et al.*, 2002, Vasconcelos *et al.*, 2001, Vega-Garcia *et al.*, 1995). The objective is to describe the relationship between a dependant variable and explanatory variables. In the study of Sebastian *et al.* (2004), the objective was to identify the physiographic, socio-economics and environmental variables that better explain the fire occurrence at European scale. The annual average of the number of fires in each province was calculated over the period 1985-1994. A total of 37 independent or explicative variables were also collected.

The problem is that the variables are not homogeneous, neither spatially or temporally, for all the countries of Europe, and therefore it may be useful to derive many models. The most commonly applied models are simple and multiple regression, logistic regression and neuronal network. Vega-Garcia (1996) reviewed the methodologies applied to fire occurrence.

5.1.1. Dependant variable: fire occurrence patterns

Data on the spatial distribution of fire occurrence is one of the most common requirements to assess the relationship between fire danger index and actual fire occurrences (Preisler *et al.*, 2004).

Spatial and temporal patterns
In general, in the models, the dependant variable is annual average of fires, weighted by province. Estimated probabilities are used to estimate the number of fires in a given region or forest district (Preisler *et al.*, 2004). The average can be calculated over a long term period: 17 years in Chou *et al.* (1990); 5 years in Vega-Garcia *et al.* (1993). Other studies focused on the temporal dimension of fire occurrence (Martell *et al.*, 1987; Todd and Kourtz, 1991; Loftsgaarden and Andrews, 1992): daily, monthly or seasonal weather variables, fire danger rating, and day of the week. The dependant variable can also be a probability of a fire of a given size. For example, Preisler *et al.* (2004) defined two kinds of probabilities: the probability, p1, of a fire of size larger than 0.04ha occurring at a given location and a given day, and the probability of a fire becoming a large fire.

Fire occurrence maps
The dependant variable is generally generated from historical data of fire occurrence. Representation of fire occurrence pattern as a continuous surface allows the spatial analysis of the causal factors. Explaining the spatial distribution of fire patterns depends on the quality of fire ignition observations (De la Riva *et al.*, 2004). A good quality will allow the proposal and the test of hypotheses about underlying causal factors.

The kernel density interpolation can be used to spatially define historic fire occurrence. It produces continuous fire occurrence density surfaces (Silverman, 1986). Koutsias *et al.* (2004) applied the kernel approach to assess fire occurrence patterns at landscape level, and De la Riva *et al.* (2004) at municipality level. The dependant variable can also be derived from an empirical "ignition danger index" (Martinez *et al.*, 2009).

Dichotomous variable
In the case of logistic models, the dependent response variable was the bivariate. The dependent variable is dichotomous and can be expressed as 1 or 0 depending on whether the experimental question is true or false (Mendenhall and Sincich, 1996 in Koutsias, 2002).

Point pattern consist of the wildland fire ignition points and the control points are established generally using a random sampling design. Koutsias *et al.* (2002) also tested a random sampling design restricted by the constraint of distance to fire ignition points. Koutsias *et al.* (2002) proposed that maps of fire occurrence could include only human-caused fires.

In Catry *et al.* (2007), ignition and non-ignition points constituted the new fire ignition variable, coded in a numeric binary format (1 - presence of ignition; 0 - absence of ignition), and were overlayed with all the other variable maps in order to create a new database with the information from all layers.

In order to analyse fire causes, Catry *et al.* (2007) used a sub-set of the global database with 4587 ignitions investigated by the Portuguese Forest Services for which causes were successfully determined, and classified in three main categories: 1) intentional, 2) negligence/accidental, and 3) natural.

5.1.2. Logistic regression models

Logistic regression model estimates the probability of an event and can be used as an alternative classification method. It is one of the most popular mathematical modelling approaches that can be used to describe the relationship of several variables to a dichotomous dependant variable (De Vasconcelos, 2001). It may handle non linear effects. Usually, logistic regression values below 0.5 are assigned to non-occurrence of the dependant variable (i.e. fire ignition), while values above 0.5 are considered as predictors of occurrence (Vega-Garcia, 1995).

Martinez *et al.* (2004, 2009) have proposed a human caused fire occurrence prediction model with a long term scope, in order to explore the relationships between the density of human caused fires and a set of 26 variables. Other similar studies try to predict daily occurrences (Martell *et al.*, 1987). Kalabokidis *et al.* (2002) used logistic regression to study the interactions between fire occurrence and vegetation patterns. Preisler *et al.* (2004) built on the statistical models developed in Brillinger *et al.* (2003) to estimate the risk probabilities as functions of explanatory variables. Four fire danger indices were used in the analysis.

5.1.3. Linear regression (LR)

Linear regression was also used in fire ignition assessment to generate local risk models. The primary method used to delineate human risk was the correlation of the spatial distribution of fire ignition to the proximity of human activities (e.g., Chuvieco and Congalton 1989; Chuvieco and Salas 1996; Kalabokidis *et al.* 2007). The outcome is not a binary or dichotomous variable. It allows the prediction of the probability of ignition and the number of expected ignitions in a given area. Multiple regression uses iterative stepwise. The relationships are in fact usually assumed to be linear when using linear regression, while real world effects are generally more complex (Amatulli *et al.*, 2006). Chuvieco *et al.* (1999) applied linear regression analysis to estimate the number of large fires and Sebastian *et al.* (2001, 2004) proposed a Pan European approach.

5.1.4. Artificial neural networks (ANN)

The network works better for typical Mediterranean fire (occurring in summer).

Neural networks are a method for dealing with highly complex classification problems (Bishop, 1995; Haykin, 1994 in Alonso-Betanzos, 2003). Furthermore, they were demonstrated to be tolerant to input noise, a particularly important criterion for this research, where real, predicted and extrapolated data will be used as inputs. For the neural networks, the first step is to specify a series of independent variables as network inputs and a dependent variable as a network output. The data set containing the input and output variables is divided into two files: (1) training data subset; and (2) testing data subset. It is important to ensure that the training samples given to the network cover the range of possibilities and are representative of the frequency of occurrences of the variables (Masters, 1995 in Chen 2004). Training data may be defined by observations, experimental results and expert knowledge.

ANN has been used for decision support in various geographical and environmental problems (Chen, 2004). Chen applies ANN methodology for risk decision support in natural hazards. Alonso-Betanzos (2003) tested a neural network model for the forest fire prediction system. The system also includes a forest fire prediction model based on a neural network and using meteorological data as the basis for assessing fire risk.

A limitation of the neuronal network is that it provides no clue about the internal importance of each variable (De Vasconcelos, 2001). De Vasconcelos (2001) compared the results from logistic models and neuronal approach. The map resulting from the 2 models have similar spatial structure, but have different distribution of probability value, especially in the case of ignition due to negligence. Neuronal Network provides a smoother spatial structure. Chuvieco *et al.* (1999) also compared the two techniques for the estimation of the ignition of large fires, concluding that the omission errors were higher for the logistic regression.

5.2. Discussion

In Sebastian-Lopez works (2008), the variables unemployment, altitude and agricultural cover were also considered in the models developed by other authors (Chuvieco *et al.*, 1999). Socio-economic problems such as unemployment were also considered undoubtedly related to the fire frequency in Europe (Ferreira de Almeida *et al.*, 1992; Leone, 1999; Velez, 2000) Some variables can or cannot be considered sufficiently significant to be included in models, This was the case, for example, with the population density, road density and aspect included in the models of Chuvieco and Congalton (1989), Chou (1992) but not in Sebastian-Lopez (2008). The positive relationship between fire occurrence and the percentage of mixed forest (fuel type 8) attained in both models is probably related to the fact that, according to Corine Land Cover methodology (Bossard *et al.*, 2000), this class (mixed forests) is mainly composed of a tree canopy, but may include a dense shrub understorey and also small areas where herbaceous species predominate. The percentage of land covered by shrubs was the variable that achieved the highest explicative power in both models. Other highly explicative variables were

related to unemployment, relief (altitude), and agronomic productions (in monetary terms), in particular to cereal and cattle production (Sebastian-Lopez, 2008).

It has been hypothesized that higher wildfire occurrence observed in recent years (related to the number and size of fires) is linked to landscape homogenization caused by changes in land use (Duguy, 1998; Farina, 1998). Land abandonment implies an increase in shrublands and forest and a parallel reduction of grasslands and cultivated areas (Romero-Calcerrada and Perry, 2004). Woodland recovery simplifies the traditional landscape mosaic and increases overall fuel loads, but there is a potential shift in the nature of EU wildfire risk, as lifestyles and landscapes become similar to those found in other Mediterranean regions of the world with stronger economies, such as California. For example, Syphard *et al.* (2007a, b) also found that the fire frequency in California, where mean distance to low density housing has recently decreased, was well modelled by factors such as population density and distance to the wildland-urban interface (WUI). Because anthropogenic ignitions tend to be concentrated near human infrastructure, more fires now occur at the urban fringe than in the backcountry (Pyne, 2001; Keeley *et al.*, 2004). The influence of proximity to the WUI and other human infrastructure appears to vary markedly with region.

6. Conclusion

The knowledge of the forest fire causes, and then of the main driving factors of ignition, is a mandatory step towards an efficient policy of prevention. Indeed, when the cause is known, fires are easier to eradicate with the setting up of concrete actions allowing the decrease of their number. The problem is to know in which proportions

The forest fire causes are diverse and their distribution differs between countries, but also spatially and temporally within a same country. In Europe, and especially in the Mediterranean basin, fires are mostly human-caused. The main human cause is negligence or accident (Bulgaria: 80%, Cyprus: 57%, Lithuania: 85% among the highest frequencies in 2008). Intentional fires are less frequent in Europe but there are some countries in which this is the main cause (Spain: 61%, Poland: 48% for instance).

Compared to Canada or USA, fires due to natural causes (lightning) are not frequent in Europe (generally less than 10%) but their proportion can vary spatially within a same country and become dominant in a region. It is the case in the Northern countries (Sweden, Norway, Finland, Russian federation, etc) or in mountainous countries (Switzerland for instance). However, natural fires can involve huge damages if they occur in remote place, even if their number is low compared to human-induced fires.

However in Europe, there is still a great part of the fires due to unknown causes (Greece: >80%, Romania: 87% for instance). The improvement of the knowledge of the forest fire causes can be achieved at different levels depending on the countries. The development of an efficient method of cause investigation or the homogeneity in the databases and in the data recorded would be of the highest importance.

In most countries, it is difficult to get complete (on a point of view of causes recorded) fire cause datasets on long periods of time making difficult the analysis of temporal series. This can be due to the evolution of the database according to the time making possible the improvement of the classification or to changes in the institutions that gather the information. Moreover, it is necessary to be sure of the definition of each cause in the different countries to avoid confusion in merging different types of causes in a wrong group. Indeed, there are some countries where a same cause can be classify either in the group of causes due to negligence or in the group of cause due to arson. This work will be carried out in D3.

The global approaches of fire ignition modelling contribute to establish general guidelines for fire management and fire policies at international level. However, the management of specific fire prevention resources needs more local oriented analysis. Occurrence should be modelled as a multi-scale process (Dickson *et al.*, 2006). Pew (2001) proposed to identify zones with a similar probability of human-caused wildfire occurrence and to assess the size and causes in each zone. The separation of ignition risk by cause allows the identification of areas with specific types of problems. It is a key to a more informed allocation of fire prevention resources (De Vasconcelos, 2001).

7. References

References of books and scientific papers

Achard F., Eva H. D., Mollicone D., Beuchle R., 2008. The effect of climate anomalies and human ignition factor on wildfires in Russian boreal forests. *Philosophical Transactions of the Royal Society B-Biological Sciences* **363**, 2331-2339.

Alexandrian D. and Gouiran M., 1990. Les incendies de forêts en France. *Revue Forestière Française*. XLII. N° spécial, 34-41.

Alonso-Betanzosa A., Fontenla-Romeroa O., Guijarro-Berdinasa B., Hernandez-Pereiraa E., Paz Andradeb M.I., Jimenezc E., Legido Sotod J.L., Carballase T., 2003. An intelligent system for forest fire risk prediction and fire fighting management in Galicia. *Expert Systems with Applications* **25**, 545–554.

Amatulli G., Rodrigues M.J., Trombetti M., Lovreglio R., 2006. Assessing long-term fire risk at local scale by means of decision tree technique, *J. Geophys. Res.*, 111, G04S05, doi:10.1029/2005JG000133.

Amatulli G., Perez-Cabello F., de la Riva J., 2007. Mapping lightning/human-caused wildfires occurrence under ignition point location uncertainty. *Ecological modelling* **20**, 321-333.

Badia-Perpinyà A. and Pallares-Barbera M., 2006. Spatial distribution of ignitions in Mediterranean periurban and rural areas: the case of Catalonia *International Journal of Wildland Fire* **15**, 187–196.

Bonora L., Conese C, Lampin C., Martin P., Martinez J., Molina D., Salas J., 2002. Towards methods for investigating on wildland fire causes. Euro-Mediterranean Wildland Fire Laboratory, a "wall-less" Laboratory for Wildland Fire Sciences and Technologies in the Euro-Mediterranean Region. Deliverable D-05-02.

Bossard M., Feranec J., Otahel J., 2000. Corine land cover technical guide. Addendum 2000. Copenhagen, EEA, p 105.

Cardille J.A.,Ventura S.J.,Turner M.G., 2001. Environmental and social factors influencing wildfires in the upper Midwest, United States. *Ecological Applications* **11**, 111–127.

Cardille J. A., Ventura S. J., 2001. Occurrence of wildfire in the northern Great Lakes Region: Effects of land cover and ownership assessed at multiple scales. *International Journal of Wildland Fire* **10**, 145-154.

Catry F.X., Damasceno P., Silva J.S., Galante M. Moreira F., 2007. Spatial Distribution Patterns of Wildfire Ignitions in Portugal. Conference Wildfire 2007, Seville (Spain).

Chen K, Blong R, Jacobson C., 2003. Towards an integrated approach to natural hazards risk assessment using GIS: with reference to bushfires. *EnvironmentalManagement* **31**(4), 546–560.

Chen K., Jacobson C., Blong R., 2004. Artificial neural networks for risk decision support in natural hazards: A case study of assessing the probability of house survival from bushfires. *Environmental Modeling and Assessment* **9**, 189–199.

Chou Y.H., 1992. Management of wild fires with a geographical information system. *Int J Geogr Inf Syst* **6**, 123–140.

Chou Y., Minnich R., Chase R., 1993. Mapping probability of fire occurrence in San Jacinto Mountains, California, USA. *Environmental Manag*ement **17**, 129-140.

Chuvieco E. and Congalton R.G., 1989. Application of remote sensing and Geographic Information Systems to Forest fire hazard mapping, *Remote Sensing of Environment* **29**, 147-159.

Chuvieco E. and Salas F.J., 1996. Mapping the spatial distribution of forest fire danger using GIS, International *Journal of Geographical Information Systems* **10,** 333-345.

Chuvieco E., Salas F.J. Carvacho L., Rodríguez-Silva F., 1999. Integrated fire risk mapping. In Remote Sensing of Large Wildfires in the European Mediterranean Basin, Ed. Emilio Chuvieco, Berlin: Springer-Verlag, 61-84.

Cochrane M.A., Schulze M.D., 1999. Fire as a recurrent event in tropical forests of eastern Amazon: effects on forest structure, biomass and species composition. *Biotropica* **31**, 2–16.

Cochrane M.A., Laureance W.F., 2002. Fire as a large-scale edge effect in Amazonian forests. *J. Trop. Ecol.* **18**, 311–325.

Conedera M., Cesti G., Pezzatti G.B., Zumbrunnen T., Spinedi F; 2006. Lightning-induced fires in the Alpine region: An increasing problem V International Conference on Forest Fire Research D. X. Viegas (Ed.), p 9.

Cressie N.A.C., 1993. Statistics for Spatial Data. Wiley, New York.

Cumming S.G., 2001. Forest type and fire in the Alberta boreal mixedwood: what do fires burn? *Ecological Application* **11**, 97–110.

Cunningham A.A., Martell D.L., 1976. The use of subjective probability assessments to predict forest fire occurrence. *Canadian Journal of Forest Research* **6,** 348–356.

Decarnin E., 2002. Etude du risque incendie. Mise en place d'une méthodologie pour la création d'un indice de risque anthropique d'éclosion de feux de forêt. *Mémoire de DEA.* Structures et Dynamiques Spatiales, Université de Provence, p 52.

De la Riva J., Pérez F., Renault N.L., Koutsias N., 2004. Mapping forest fire occurrence at a regional scale. *Remote Sensing of Environment* **92**(3), 363-369.

De la Riva J., Perez-Cabello F., 2005. El factor humano en el riesgo de incendios forestales a escala municipal. Aplicación de técnicas SIG para su modelización. In La ciencia forestal: respuestas para la sostenibilidad. 4º Congreso Forestal Español. Sociedad Española de Ciencias Forestales, Madrid, p. 339.

De la Riva J., Perez-Cabello F., Chuvieco E., 2006. Wildland fire ignition danger spatial modelling using GIS and satellite data. In: EGU General Assembly—European Geosciences Union. *Geophysical Research Abstracts*, **8**, 10321.

Donoghue L.R., Main W.A., 1985. Some Factors Influencing Wildfire Occurrence and Measurement of Fire Prevention Effectiveness, *Journal of Environmental Management* **20** (1), 87-96.

Duguy B., 1998. Reconstruccion de los cambios en los usos del suelo y en la estructura del paisaje (1956–1994). Interaccion con los incendios. Caso de una zona piloto en la provincia de Alicante. *Ph.D. Thesis.* Centro Internacional de Altos Estudios Agronomicos Mediterra´neos, Instituto Agronomico Mediterraneo de Zaragoza, Zaragoza, Spain, p 208.

Duncan B.W., Schmalzer P.A., 2004. Anthropogenic influences on potential fire spread in a pyrogenic ecosystem of Florida, USA. *Landscape Ecology* **19**, 153–165.

Ferreira de Almeida A.M.S., Vilacae-Moura P.V.S., 1992. The relationship of forest fires to agro-forestry and socio-economic parameters in Portugal. *International Journal of Wildland Fire* **2**, 37–40.

Finney M.A., 2005. The challenge of quantitative risk analysis for wildland fire. *Forest Ecology and Management* **211,** 97-108.

Follin J.M., 1999. Evaluation des risques naturels anthropiques d'éclosion de feux de forêt à l'Ets des Bouches-du-Rhône. *Mémoire de géographie.* Université de Provence.

Granström A., 1993. Spatial and temporal variation in lightning ignitions in Sweden. *Journal of Vegetation Science* **4**, 737-744.

Henderson M., Kalabokidis K., Marmaras E., Konstantinidis P., Marangudakis M., 2005. Fire and society: a comparative analysis of wildfire in Greece and the United States. *Hum Ecol Rev* **12**(2), 169–182.

Holdsworth A.R., Uhl C., 1997. Fire in eastern Amazonian logged rain forest and potential for fire reduction. *Ecol. Appl.* **7**, 713–725.

Jappiot M., Lampin C., Curt T., Borgniet L., Chandioux O., Tatoni T., Dumas E., Alexandrian D., D'Avezac H., Valette J.C., Moro C., Petriccione M., 2006. Fire risk ignition: The integrated model "AIOLI". Forest *Ecology and Management*, 234S-S42.

Kalabokidis K.D., Koutsias N., Konstantinidis P., Vasilakos C., 2007. Multivariate analysis of landscape wildfire dynamics in a Mediterranean ecosystem of Greece. *Area* **39** (3), 392–402.

Kalabokidis K.D., Konstantinidis P., Vasilakos C., 2002. GIS analysis of physical and human impact on wildfire patterns. In: *IV International Conference on Forest Fire Research & Wildland Fire Safety. Coimbra. Portugal* (D.X. Viegas, Ed.) Millpress, Rotterdam, Netherlands.

Keeley J. E., Fotheringham C. J., Moritz M. A., 2004. Lessons from the 2003 wildfires in southern California. *Journal of Forestry* **102**, 26–31

Korovin G. N., 1996. Analysis of the distribution of forest fires in Russia. In: Fire in ecosystems of boreal Eurasia (J. G. Goldammer and V. V. Furyaev, eds.), 112-128. Kluwer Academic Publ., Dordrecht, p 528.

Koutsias N., Allgöwer B., Conedera M., 2002. What is common in wildland fire occurrence in Greece and Switzerland? – Statistics to study fire occurrence pattern. In: Proceedings of the 4th International Conference on Forest Fire Research, D.X. Viegas (ed.), Luso, Portugal, November, 18 – 23, *Millpress Science Publishers Rotterdam, Netherlands,* p 14.

Koutsias N., Kalabokidis K., Allgöwer B., 2004. Fire occurrence patterns at landscape level: beyond positional accuracy of ignition points with kernel density estimation methods. *Natural Resource Modeling* **17**(4), 359-375.

Lampin C., Molina D., Pilar M., Caballero D., 2002. The Interest of Socio-Economical Sciences in Wildland Fires: a State of the Art. Euro-Mediterranean Wildland Fire Laboratory, a "wall-less" Laboratory for Wildland Fire Sciences and Technologies in the Euro-Mediterranean Region Deliverable D-05-01.

Lampin C., Jappiot M., Morge D., Vennetier M., 2006. Statistical and spatial analysis of forest fire ignition points: a study case in South of France. *Forest Ecology and Management,* 234S-S12.

Lampin-Maillet C., Jappiot M., Long M., Morge D., Ferrier J.P., 2009. Characterization and mapping of dwelling types for forest fire prevention. *Computer Environment and Urban Systems,* **33,** 224–232.

Langhart R., Bachmann A., Allgöwer B., 1998. Spatial and Temporal Patterns of Fire Occurrence (Canton of Grison, Switzerland). In: Proceedings of the 3rd International Conference on Forest Fire Research / 14th Conference on Fire and Forest Meteorology, Luso, Portugal, November, 16 – 20, Vol.2, 2279-2292.

Lawson B.D., Armitage O.B., Dalrymple G.N., 1993. Ignition probabilities for simulated people-caused fires in British Columbia's lodgepole pine and white spruce-subalpine fir forests. In: Proceedings of the 12th Conference on Fire and Forest Meteorology. Society of American Foresters, Bethesda, MD, p 493-505.

Lekakis J.N., 1995. Social and Ecological Correlates of Rural Fires in Greece *Journal of Environmental Management,***43**, 41-47

Leone V., 1999. Los incendios en el Mediodıa Italiano. In: Araque Jimenez E (ed) Incendioshistoricos: una aproximacion multidisciplinar. Universidad Internacional de Andalucıa, Seville.

Leone V., Koutsias N., Martínez J., Vega-García C., Allgöwer B., Lovreglio R., 2003. The human factor in fire danger assessment. In: Chuvieco, E. (Ed.), Wildland Fire Danger Estimation and Mapping: The Role of Remote Sensing Data, World Sci., Hackensack, N.J., p 143–196.

Maingi J. K., Henry M. C., 2007. Factor influencing wildfire occurrence and distribution in eastern Kentucky, USA. *International Journal of Wildland Fire* **16,** 23-33.

Mangiavillano A., 2004. De l'éclosion du phénomène à l'émergence d'incendie : utilisation combine de l'analyse spatiale et de la physique du feu pour localiser les espaces émetteurs. *Mémoire de DEA de Géographie*, Université d'Avignon.

Martell D.L., Otukol S., Stocks B.J., 1987. A logistic model for predicting daily people-caused forest fire occurrence in Ontario. *Canadian Journal of Forest Research* **17**, 394-401.

Martínez, J., Chuvieco, E., Martín, M.P., 2004. Estimating human risk factors in Wildland fires in Spain using logistic regression. II International Symposium on Fire Economics, Planning and Policy: A Global Vision. Córdoba, Spain. 19-22 de Abril, 2004. p 15.

Martínez J., Vega-Garcia C., Chuvieco E., 2009. Human-caused wildfire risk rating for prevention planning in Spain. *Journal of Environmental Management*, **90**, 1241–1252.

Mol T., and Kucukosmanoglu A., 1997. Forest fires in Turkey. *In* Proc. XI. World Forestry Congress, Antalya, Turkey

Mollicone D., Eva H.D., Achard F., 2006. Human role in Russian wild fires. *Nature*, **440**, 436–437.

McRae R.H.D., 1992. Prediction of areas prone to lightning ignition. *International Journal of Wildland Fire* **2**, 123–130.

Moreira F., Rego F. C., Ferreira P. G., 2001. Temporal (1958-1995) pattern of change in a cultural landscape of northwestern Portugal: implications for fire occurrence. *Landscape Ecology* **16**, 557-567.

Pew K.L., Larsen C.P.S., 2001. GIS analysis of spatial and temporal patterns of human-caused wildfires in the temperate rainforest of Vancouver Island, Canada. *Forest Ecology and Management* **140**, 1–18.

Podur J., Martell D. L., Csillag F., 2003. Spatial patterns of lightning-caused forest fires in Ontario, 1976-1998. *Ecological Modelling* **164**, 1-20.

Preisler H.K., Brillinger D.R., Burgan R.E., Benoir J.W., 2004. Probability based models for estimation of wildfire risk. *International Journal of Wildland Fire* **13**, 133–142.

Prestemon J.P.and Butry D.T., 2005. Time to burn: modeling wildland arson as an autoregressive crime function. *American Journal of Agricultural Economics* **87,** 756–770.

Pyne S. J., 2001. Fire in America. Princeton University Press. Princeton, New Jersey, USA.

Pyne S.J., Andrews P.L., Laven R.D., 1996. 'Introduction toWildland Fire.'2nd edn. (JohnWiley & Sons: NewYork).

Renkin R.A., Despain D.G., 1992. Fuel moisture, forest type, and lightning-caused fire in Yellowstone National Park. *Canadian Journal of Forest Research* **22**, 37–45.

Robin J.G.; Carrega P.; Fox D., 2006. Modelling fire ignition in the Alpes-Maritimes Depertment, France, A comparison. In: Viegas, D.X. (Ed.); Proceedings of the 5th International Conference on Forest Fire Research. CD Rom. ADAI, Figueira da Foz, p 12.

Roloff G.J., Mealey S.P., Clay C., Barry J., Yanish C., Neuenschwander L., 2005. A process for modelling short and long-term risk in the southern Oregon Cascades. *Forest Ecology and Management* **211**, 166-190.

Romero-Calcerrada R. and Perry G.L.W., 2004. The role of land abandonment in landscape dynamics in the SPA 'Encinares del rio Alberche y Cofio', Central Spain, 1984–1999. *Landscape Urban Planning* **66**, 217–232.

Romero-Calcerrada R., Novillo J., Millington J. D. A., Gomez-Jimenez I., 2008. GIS analysis of spatial patterns of human-caused wildfire ignition risk in the SW of Madrid (Central Spain). *Landscape Ecology* **23**, 341–354.

Russell-Smith J., Ryan P.G., Durieu R., 1997. A LANDSAT MSS-derived fire history of Kakadu National Park, monsoonal northern Australia, 1980–94: seasonal extent, frequency and patchiness. *Journal of Applied Ecology* **34**, 748–766.

Salas F.J. and Chuvieco E., 1994. GIS applications to forest fire risk mapping. *Wildfire* **3**:7-13.

Sebastián-López A., 2004. Modelización a escala europea del riesgo de incendio forestal, desde la perspectiva dinámica y estructural. Universidad de Valladolid, Valladolid.

Sebastián-López A., Salvador R., San-Miguel-Ayanz J., 2001. Two models for a structural forest fire risk index at a regional scale. in 21st EARSeL Workshop Remote sensing and GIS applications to forest fire management: New Methods and Sensor, Paris. France.

Sebastian-Lopez A., Salvador-Civil R., Gonzalo-Jimenez J., SanMiguel-Ayanz J., 2008. Integration of socio-economic and environmental variables for modelling long-term fire danger in Southern Europe. *Eur J Forest Res.* **127**:149–163

Shetinsky E. A., 1994. Protection of forests and forest pyrology. *Ecology*, Moscow, p 209 [in Russian]

Shvidenko A., Nilsson S. Dixon R., Rojkov V., 1995. Burning biomass in the territories of the former Soviet Union: impact on the carbon budget. Idorjaras, *Quarterly Journal of the Hungarian Meteorological Service* **99** (3-4), 235-255.

Silverman B.W., 1986. Density Estimation for Statistics and Data Analysis. Chapman and Hall, London, England.

Stocks B.J., Mason J.A., Todd J.B., Bosch E.M., Wotton B.M., 2003. Large forest fires in Canada, 1959–1997. *Journal of Geophysical Research* **108**, FFR5-1–FFR5-12.

Sturtevand B.R., Cleland D.T., 2007. Human and biophisical factors influencing modern fire disturbance in northern Wisconsin. *International Journal of Wildland Fire* **16**, 398–413.

Syphard A.D., Clarke K.C., Franklin J., 2007a. Simulating fire frequency and urban growth in southern California coastal shrublands, USA. *Landscape Ecology* **22,** 431–445.

Syphard A.D., Radeloff V.C., Keeley J.E., Hawbaker T.J., Clayton M.K., Stewart S.I., Hammer R.B., 2007b. Human influence on California fire regimes. *Ecological Applications* **17**(5), 1388–1402.

Tabara D., Sauri D., Cerdan R., 2003. Forest fire risk management and public participation in changing socio-environmental conditions: A case study in a Mediterranean region. *Risk Analysis* **23**, 249-260.

Van Wagtendonk J.W., 1991. Spatial analysis of lightning strikes in Yosemite National Park. In: Proceedings of the Eleventh Conference on Fire and Forest Meteorology, Royal Meteorological Society, Boston, 605–611.

Van Wilgen B.W., Biggs H.C., Potgieter A.L.F., 1998. Fire management and research in the Kruger National Park, with suggestions on the detection of thresholds of potential concern. *Koedoe* **41**, 69-87.

Van Wilgen B.W., Biggs H.C., O'Regan S., Mare N., 2000. A fire history of the savanna ecosystems in the Kruger National Park, South Africa, between 1941 and 1996. *South African Journal of Science* **96**, 167-178.

Vasconcelos M.J.P., Silva S., Tomé M., Alvim M., Pereira J.M.C., 2001. Spatial prediction of fire ignition probabilities: comparing logistic regression and neural networks. *Photogrammetric Engineering and Remote Sensing* **67** (1), 73-83.

Vasilakos C., Kalabokidis K., Hatzopoulos J., Kallos G., Matsinos J., 2007, Integrating new methods and tools in fire danger rating. *International Journal of Wildland Fire* **16** (3), 306–316.

Vasilakos C., Kalabokidis K., Hatzopoulos J., Matsinos I., 2008. Identifying wildland fire ignition factors through sensitivity analysis of a neural network. *Natural hazards,* 1-19.

Vazquez A., Moreno J.M., 2001. Spatial distribution of forest fires in Sierra de Gredos (Central Spain). *Forest Ecology and Management* **147**, 55–65.

Vega Garcia C., Woodard P., Lee B., 1993. Geographic and temporal factors that seem to explain human-caused fire occurrence in Whitecourt Forest, Alberta. In: Proceedings of Symposium on GIS'93 International. Vancouver, Canada, Vol. 1, 115-119.

Vega-García C., Woodard T., Adamowicz W.L., Lee B., 1995. A logit model for predicting the daily occurrence of human caused forest fires. *International Journal of Wildland Fire* **5** (2), 101-111.

Velez R., 2000. La prevencion. In: Garcıa-Brage A (ed) La defensa contra incendios forestales fundamentos y experiencias. McGraw-Hill/Interamericana de Espana, Madrid.

Vigilante T., Bowman D.M.J.S., Fisher R., Russell-Smith J., Yates C., 2004. Contemporary landscape burning patterns in the far North Kimberley region of north-west Australia: human influences and environmental determinants. *Journal of Biogeography* **31**, 1317–1333.

Weber M.G., Stocks B.J., 1998. Forest fires and sustainability in the boreal forests of Canada. *Ambio* **27**, 545–550.

Wierzchowski J., Heathcott M., and Flannigan M.D., 2002. Lightning and lightning fire, central cordillera, Canada. *International Journal of Wildland Fire*, **11**, 41–51

Yang J., He H.S., Shifley S.R., Gustafson E.J., 2007. Spatial patterns of modern period human-caused fire occurrence in the Missouri Ozark Highlands. *Forest Science* **53**, 1–15.

ZhaiY., Munn I.A., Evans D.L., 2003. Modeling forest fire probabilities in the south central United States using FIA data. *Southern Journal of Applied Forestry* **27**, 11–17.

Technical studies and reports

France

Alexandrian, D., 1995. Livre blanc "Routes et incendies" – Le cas du département des Bouches-du-Rhône, CETE Méditerranée.

Grelu J., 2003. Evaluation de la politique de prévention des incendies de forêt dans les régions méridionales. Travaux préalables à l'évaluation. *Rapport technique : analyse des conditions dans lesquelles la base Prométhée est alimentée, propositions our la région méditerranéenne et extension éventuelle à la région Aquitaine. Conseil général du génie rural, des eaux et des forêts,* p 6.

Lacomblez C., Chavent M., Liquet B., Patouille B., 2003. *Evaluation* de la politique de prévention du ministère de l'agriculture dans les zones méridionales ; traitement statistique des informations sur les feux de forêt Rapport de synthèse. Mise en forme, nettoyage et limites des données. UMR CNRS 5466, Université Bordeaux, p 71.

Lampin C., Jappiot M., Morge D., Borgniet L., 2005. Amélioration de la connaissance de l'origine des feux de forêt dans les 15 départements du Sud-Est. DPFM 2003/252 - Proposition n°03-08-22 du 22 août 2003.

Agence MTDA, 2005.Amélioration de la connaissance de l'origine des feux de forêt - Étude statistique des données Prométhée sur l'ensemble de la période et l'ensemble des départements de la zone de défense sud. Délégation à la Protection de la Forêt Méditerranéenne, p 28.

Greece

International Forest Fire News (IFFN) No. 4 - December 1990, p. 6-7

Kailidis, D., and G. Xanthopoulos. 1991. The forest fire problem in Greece. Aristotelian University of Thessaloniki, Greece, Department of Forestry and Natural Environment, Forest Protection Laboratory. No. 3. 10 p.

International Forest Fire News (IFFN) No. 10 - January 1994, p. 11-12

Markalas, S., and D. Pantelis. 1996. Forest fires in Greece in 1993. Aristotelian Univ. of Thessaloniki, Department of Forestry and the Natural Environment, Forest Protection Laboratory. No 3. 40 p. (in Greek).

International Forest Fire News (IFFN) No. 23 December 2000, p. 76-84

Italy

International Forest Fire News (IFFN) No. 4 - December 1990, p. 8

International Forest Fire News (IFFN) No. 17 - July 1997, p. 5-9

International Forest Fire News (IFFN) No. 21 - September 1999,p. 60-70

Portugal

Bento Gonçalves, A. J. (2006) - "Geografia dos incêndios em espaços Silvestres de Montanha – o caso da serra da Cabreira". Tese de Doutoramento, Instituto de Ciências Sociais da Universidade do Minho, Braga, 438 p. + VI anexos (Portuguese).

Peixoto da Eira, J. M and Natário, R. M. (1995) -I Study of the causes of forest fires in seven communes in Central Portugal. *Options MéditerranBenness, Sér. A /nO25,1995 .Les incendies de forêt en région méditerranéen, p. 79-98.*

Galante, M. (2007) – Forest Fires Causes in Portugal, Project "Forest Focus" 2004.PO.C1.05. Technical report (in Portuguese).

Galante, M. (2005) – As causas dos incêndios florestais em Portugal continental. *In* Actas do 5.º Congresso Florestal Nacional. (in Portuguese).

APIF (2005) - Estudo Técnico PNDFCI I -Diagnóstico, Visão e Objectivos Estratégicos. (in Portuguese).

Spain

Vélez, Ricardo (1986) : *Incendios forestales y su relación con el medio rural.* Revista de Estudios Agrosociales. 136, p 195-224.

Vélez, Ricardo (1990): Les incendies de forêt dans la région méditerranéenne : panorama régional. Unasylva, 41, p 3-9

FAB CONSULTORES (1990): *Estudio sobre la causalidad de los incendios forestales en la Comunidad Autonoma de las Islas Baleares.* Conselleria d'Agricultura I Pesca. Govern Balear

ICONA (1993). *Manual de operaciones contra incendios forestales.*

Rubio, JL (1994): *Evolución de los incendios forestales en la Comunidad valenciana. Causas. Consecuencias.* En Actas de las Jornadas Multidisciplinares sobre Incendios Forestales. Un Futuro con Bosques. Univ. Pol. Valencia. 20-21/oct/94

Vélez, Ricardo (1994): *Causas y efectos del riesgo de incendios forestales.* En Actas de las Jornadas Multidisciplinares sobre Incendios Forestales. Un Futuro con Bosques. Univ. Pol. Valencia. 20-21/oct/94.

ICONA (1995): *Motivaciones de los incendios forestales intencionados.* Madrid, ICONA Ministerio de Agricultura, Pesca y Alimentación.

FAB CONSULTORES (1995): *Motivaciones de incendios forestales. El uso del fuego en quemas con finalidad ganadera o agrícola*

Guitán, L. y Alverti, A. (1996): *Los incendios históricos en el Noreste de la Península Ibérica y sus causas.* Trabajo inédito encargado por la Dirección General de Conservación de la Naturaleza

Ministerio de Medio Ambiente (1996): *Los incendios forestales en España durante el decenio 1986-95*
ICONA (1968 – 1995): *Los incendios forestales en España. Publicación anual.* Madrid, Instituto Nacional para la Conservación de la Naturaleza. Ministerio de Agricultura.
Ministerio de Medio Ambiente (1997): *Apuntes para la codificación en oficina de el Parte de Incendio Forestal.* Madrid, Comité de Lucha Contra Incendios Forestales.
Gómez-Mendoza J *et al.* (1997): *Estudio sobre la presencia histórica de incendios forestales en España y sus causas (1830-1970)*
Ministerio de Medio Ambiente (1997): *Manual de investigación de las causas que provocan los incendios forestales.*
Ministerio de Medio Ambiente. (1998): *Los incendios forestales en España durante 1997*
Vázquez, A. and Moreno J.M. (1998): *Patterns of lightning, and people-caused fires in Peninsular Spain.* International Journal of Wildland Fire. 8 (2): 103-115.
Vélez, Ricardo (1999*): El período 1848-1997 en la defensa contra incendios forestales en España. Los incendios históricos. Una aproximación multidisciplinar.* (E. Araque, Ed.), Universidad Internacional de Andalucía. Caja Rural de Jaén: 13-38.
Vélez, Ricardo (coord.): *La defensa contra incendios forestales. Fundamentos y experiencias.* McGraw-Hill/Interamericana de España S.A.U. 2000
Porrero Rodríguez, M. A. (2001): *Incendios forestales 1.Investigación de causas.* Ediciones Mundi-Prensa
Solana A (2001): *La investigación de causas de los incendios forestales en la Comunidad Valenciana.* Foresta 13:118-119 1575-2356 – 2001
Ministerio de Medio Ambiente (2002): *Los incendios forestales en España. Decenio 1991-2000.*
APAS, Asociación para la Promoción de Actividades Socioculturales (2003): *Estudio Sociólogico sobre la Percepción de la Población Española hacia los Incendio Forestales (internal report)*
Ministerio de Medio Ambiente: *Estudio sobre motivaciones de los Incendios Forestales Intencionados en España.* Expte. Nº 50920029 (15DGB-2005)
Dolz Reuss M.L. and Franco Irastorza I. (2005): *State of the art of forest fire causes in Spain.* In proc. of the II International Conference on Prevention Strategies of Fires in Southern Europe: Barcelona, 9-11 may 2005
Juan Barroso Fernández, Víctor González Báscones (2007): *Motivaciones de incendios forestales intencionados en España.* In proc. of the IV International Wildfire Conference, Seville, Spain, 13-17 May 2007
Juan Barroso Fernández, Julián Martín Caminero, David Pérez Ramos (2007): *Utilidad de la Investigación de Causas en la prevención de incendios forestales.* In proc. of the IV International Wildfire Conference, Seville, Spain, 13-17 May 2007
Juan Carlos Mérida, Elisa Primo, José Eleazar Cubo y Pedro Javier Parra (2007): *Las Bases de Datos de Incendios Forestales como herramienta de planificación: utilización en España por el Ministerio de Medio Ambiente*
Ministerio de Medio Ambiente (2007): *Los incendios forestales en España, durante el año 2006*
Ministerio de Medio Ambiente (2007): *Los incendios forestales en España, decenio 1996-2005*
Ministerio de Medio Ambiente (2008): *Los incendios forestales en España, año 2007*
Ministerio de Medio Ambiente, Medio Rural y Marino (2009): *Los incendios forestales en España, durante el año 2008. Avance informativo (1 de Enero – 31 de Diciembre)*

Austria
International Forest Fire News (IFFN) No. 4 - December 1990, p. 3 Austria

Bulgaria
International Forest Fire News (IFFN) No. 19 - September 1998, p. 50-51
International Forest Fire News (IFFN) No. 22 - April 2000, p. 19-20
International Forest Fire News (IFFN) No. 28 (January – June 2003) p. 82-87
Fire report, State Forestry Agency, 2008.

Croatia
International Forest Fire News (IFFN) No. 9 – July 1993, p. 13-15
International Forest Fire News (IFFN) No. 33 (2005), p 26-37

Cyprus
International Forest Fire News (IFFN) No. 12 - January 1995, p. 5-9
International Forest Fire News (IFFN) No. 23 - December 2000, p. 71-76

Estonia
International Forest Fire News (IFFN) No. 24 - April 2001, p. 14-17

Finland
International Forest Fire News (IFFN) No. 24 - April 2001, p. 17-22

Germany
International Forest Fire News (IFFN) No. 7 - August 1992, p. 17-21
International Forest Fire News (IFFN) No. 24 - April 2001, p. 22-30
Geiger, R. 1948. Neue Unterlagen für eine Waldbrandbekämpfung 2.Teil. Witterungsbedingungen für Großwaldbrände. Mitteilungen des Reichsinstitutes für Forst- und Holzwirtschaft Nr. 5
Weck (1950 Weck, J. 1950. Waldbrand, seine Vorbeugung und Bekämpfung. Brandschutz-Fachbuchreihe 19, W. Kohlhammer Verlag.
Missbach (1982 Missbach, K. 1990. Zur Auswertung der Waldbrandstatistik der DDR. Forstwirtschaft Berlin 40, 3

Hungary
International Forest Fire News (IFFN) No. 33 - 2005, p. 44-50

Latvia
International Forest Fire News (IFFN) No. 24 - April 2001, p. 31-34

Lithuania
International Forest Fire News (IFFN) No. 13 - July 1995, p. 18
International Forest Fire News (IFFN) No. 24 - April 2001, p. 35-40
International Forest Fire News (IFFN) No. 30 (January – June 2004), p 99-102

Macedonia (FYROM)
International Forest Fire News (IFFN) No. 28 (January – June 2003) p. 92-102

Poland
Instrukcja ochrony przeciwpożarowej obszarów leśnych, 1976, PWRiL, Warsaw.

Instrukcja ochrony przeciwpożarowej obszarów leśnych, 1996, MOŚZNiL, DGLP Warsaw.

Piwnicki J., Ubysz B., Szczygieł R. & Kwiatkowski M., 2008. The effectiveness of forest fire prevention by the application of fuel breaks alongside public roads. Report from forest fires studies (C1 activities).
Rozporządzenie Ministra Spraw Wewnętrznych i Administracji z dnia 29 grudnia 1999 r. w sprawie szczegółowych zasad organizacji krajowego systemu ratowniczo-gaśniczego (Journal of Laws, 1999, no. 111, item 1311).

Rozporządzenie Ministra Środowiska z dnia 22 marca 2006 r. w sprawie szczegółowych zasad zabezpieczenia przeciwpożarowego lasów (Journal of Laws, No. 58, item 405).

Wiler K., 2000. Ochrona przeciwpożarowa lasów. SA PSP Poznań.

Wiler K., 2007. Ochrona lasów przed pożarami. Centrum Informacyjne Lasów Państwowych, Warsaw.

Romania
NEDIES project. 2003. Lessons Learnt from Forest Fire Disasters. Alessandro G. Colombo and Ana Lisa Vetere Arellano (eds) The experience in the management of forest fires in Romania 62S. Mara (Romania) : 62-73

Slovenia
Dolgan-Petrič, M., 1989. Forest fires in the Karst forest management unit in Slovenia.- Geografski vestnik, vol. 61, p. 71-82
Gams, I., 1997. Forest fires in the Karst and the role of Austrian pine plantations.- Ujma, no. 11, p. 113-117.
Jakša, J., 1997. Size and consequences of forest fires in Slovenia between 1991 and 1996 and the place of forestry in fire suppression.-Gozdarski vestnik. Vol. 55, no. 9, p. 386-395.
Jakša, J., 2002. Forest fires.- Nesreče in varstvo pred njimi.- Ljubljana, Uprava RS za zaščito in reševanje Ministrstva za obrambo, p. 341-345.
Jakša, J., 2006. Die Waldbrände in der Republik Slowenien.-Forst und Holz.-Jahr.61, 5, p. 179-181.
Jakša, J., 2006. Forest fires.-Gozdarski vestnik. Vol. 64, no. 9, p. 97-112.
Jakša, J., 1997. Forest fires in Slovenia.- Ujma, no. 11, p. 63-69.

Jurc, M., Kobler, A., Urbančič,M., 2001. Forest fires in Slovenia: final report of the research project in the year 2001.- Ljubljana, Biotehniška fakulteta, Oddelek za gozdarstvo in obnovljive gozdne vire, Gozdarski inštitut Slovenije, 70 p.
Kobler, A., 2001. Spatial model of forest fire hazard: final report of the research subproject.- Ljubljana, Biotehniška fakulteta, Oddelek za gozdarstvo in obnovljive gozdne vire, Gozdarski inštitut Slovenije, 112 p.
Kocjan, B.,1994. Methods for the assessment of forest fire hazards, and measures.- Varstvo pred požari v naravi, Bled '93.- Ljubljana, Republiška uprava za zaščito in reševanje pri Ministrstvu za obrambo, p. 61-66.
Košir, Ž., 1997. Ecological consequences of forest fires and exposure of forest vegetation to fire risks.- Ujma, št. 11, p. 107-112.
Krupenko, G., 2006. Analysis of fire risk.- Ujma, no. 20, p. 160-169.
Mancini, T., 1994. Forests and forest fires - the subject of statistical observation.-Varstvo pred požari v naravi, Bled '93.- Ljubljana, Republiška uprava za zaščito in reševanje pri Ministrstvu za obrambo, p. 229-242.
Pečenko, A., 1994. Fires in nature during 1992.-Varstvo pred požari v naravi, Bled '93.- Ljubljana, Republiška uprava za zaščito in reševanje pri Ministrstvu za obrambo, p. 1-10.
Pečenko, A., 1994. Determination of fire hazard grades in the natural environment in Slovenia.- Ujma, no. 8, p. 193-196.
Prebevšek, M.,1994. Fire safety as an integral part of forest management.-Varstvo pred požari v naravi, Bled '93.- Ljubljana, Republiška uprava za zaščito in reševanje pri Ministrstvu za obrambo, p. 61-66.
International Forest Fire News (IFFN) No. 27 - July 2002, p. 38-64

Sweden

International Forest Fire News (IFFN) No. 18 - January 1998, p. 75-77
Engström A., 2000. Nutidens skogsbränder. En analys av situationen i Mellan-norrland under 1990-talet (Summary: Forest fires of today. An analysis of the situation within a section of northern Sweden during 1990-1998). 14, Rapporter och Uppsatser. Department of Forest Vegetation Ecology, Umeå.
International Forest Fire News (IFFN) No. 30 (January – June 2004, 80-83
Granström A., 2008. Forest fires in a changing climate. Review of the current knowledge from a Swedish perspective. Review for the Swedish Contingencies Agency. p 31.

Turkey

Colin P.Y., Veillon S., 1999. Tournée d'étude en Turquie. Guide technique international. Protection des forêts contre l'incendie. Rapport *Cemagref.* p 29.
International Forest Fire News (IFFN) No. 28 (January – June 2003) p. 57-65
International Forest Fire News (IFFN) No. 33 - 2005, p. 51-61

United Kingdom

Bruce M.A., 2000. Country report for the United Kingdom. BALTEX FIRE 2000. The second Baltic seminar and exercise in Forest Fire and Information and Resources Exchange 2000.
International Forest Fire News (IFFN) No. 34 - 2006, p. 94-98
OPDM, 2005. Fire statistics United Kingdom 2003. Office of the deputy prime Minister, London.
OPDM, 2008. Fire statistics United Kingdom 2006. National Statistics. Communities and local government. p121.
Gazzard R., 2009. Data Fields. A Framework for Data Sections, Groups, Fields, Categories and Types for Wildfire and Prescribed Burning Data within Great Britain and Northern Ireland. Final Draft Version 1.03. United Kingdom Vegetation Standard. P134.

Albania

International Forest Fire News (IFFN) No. 33 (January – June 2005) p. 17-25
International Forest Fire News (IFFN) No. 28 (January – June 2003) p. 73-81

Norway

International Forest Fire News (IFFN) No. 18 - January 1998, p. 72-74

Russian federation

International Forest Fire News (IFFN) No. 7 - August 1992, p. 8-12
International Forest Fire News (IFFN) No. 22 - April 2000, p. 63-66
International Forest Fire News (IFFN) No. 24 - April 2001, p. 41-59
International Forest Fire News (IFFN) No. 32 - 2005, p. 67-69

Israel

International Forest Fire News (IFFN) No. 15 - September 1996, p. 2-6
International Forest Fire News (IFFN) No. 29 (July – December 2003, 72-88

Lebanon
International Forest Fire News (IFFN) No. 23 - December 2000, p. 87

Morocco
Brochiero F., Colin P.Y., 1998. Tournée d'étude au Maroc. Guide technique international. Protection des forêts contre l'incendie. Rapport *Cemagref.* p 42.
International Forest Fire News (IFFN) No. 25, July 2001, p. 14-22

Syria
COBASE 2006. Risk and Sustainability Study and proposals on "The Impact of Desertification, Watershed Management, and Wild Fires on Rural Development and Poverty in one Coastal Area of Syria" (Latakia Governorate) *A quest for synergies in the implementation of Rio Convention and related instruments.* Participatory and Integrated Forest Fires Management Plan GCP/SYR/010/ITA. p50.

Tunisia
Mariel A., Brochiero F., 1998. Tournée d'étude en Tunisie. Guide technique international. Protection des forêts contre l'incendie. Rapport *Cemagref.* p 22.

Argentina
International Forest Fire News (IFFN) No. 5 - June 1991, p. 2-3
International Forest Fire News (IFFN) No. 9 - July 1993, p. 2-5
International Forest Fire News (IFFN) No. 15 - September 1996, p. 22-23
International Forest Fire News (IFFN) No. 23 - December 2000, p. 54-57
International Forest Fire News (IFFN) No. 28 (January – June 2003) p. 37-40

Australia
Davis C., 1997. Analysis of fire causes on or threatening public land in Victoria. 1976/77-1995/96. Research report N°49. Fire management branch. Department of Natural resources and Environment. P 34.

Canada
Van Wagner C.E., 1987. Development and Structure of the Canadian Forest Fire Index System. Canadian Forestry Service, Tech. Rep. 35, Ottawa.
International Forest Fire News (IFFN) No. 27 - July 2002, p. 2-5
Baxter G., 2002. Analysis of the Occurrence and Cause of Fires in Slash Fuels in Alberta for the Period 1961-2000. Wildland Fire Operations Research Centre Forest Engineering Research Institute of Canada. Internal Report IR-2002-06-13. p20.

Chile
International Forest Fire News (IFFN) No. 11 - July 1994, p. 4-6

South Africa
International Forest Fire News (IFFN) No. 20 - March 1999, p. 73-78
International Forest Fire News (IFFN) No. 25, July 2001, p. 105-111

USA
Altobellis A.T., 1983. A survey of rural population density and forest fire occurrence in the South, 1956-1970: USDA Forest Service, Southern Forest Experiment Station, New Orleans. Research Note SO-294.
International Forest Fire News (IFFN) No. 12 - January 1995, p. 17-24
International Forest Fire News (IFFN) No. 27 - July 2002, p. 6-13

Europe
EFIMED, 2009. Living with wildfires: What Science can tell us? A contribution to the Science-Policy dialogue. EFI Discussion paper 15, p 86.

CIHEAM-IAMM, 1995. Les incendies de forêt en région méditerranéenne : constitution et utilisation des bases de données (Forest fire in the Mediterranean region: Constitution and use of databases). *Séminaire sur les*

Incendies de Forêt en Région Méditerranéenne, Chevrou R. (ed.), Delabraze P. (ed.), Malagnoux M. (ed.), Velez R. (ed.), 1993/11/30-1993/12/04, Montpellier (France), p 191
CIHEAM-FAO, 1999. Les bases de données sur les feux de forêts en région méditerranéenne : utilisations et enseignements. Comité silva Mediterranea. Atelier régional de Tétouan (Maroc), p 227.

Colin P.Y., Jappiot M., Mariel A., 2001. Protection des forêts contre l'incendie. Fiches techniques pour les pays du basin méditerraéen. Cahier FAO Conservation. p 149.

European Commission, 2001, Forest fires in Southern Europe: Bulletin of the 2000 fire campaign, SPI 01.85, Office for Official Publications of the European Communities, Luxembourg. p 8
European Commission, 2001, Forest fires in Southern Europe: Report No. 1, July 2001, SPI 01.95, Office for Official Publications of the European Communities, Luxembourg. p. 40.
European Commission, 2002, Forest fires in Europe: 2001 fire campaign, SPI 02.72, Office for Official Publications of the European Communities, Luxembourg. p 27.
European Commission, 2003, Forest fires in Europe: 2002 fire campaign, SPI 03.83, Office for Official Publications of the European Communities, Luxembourg. p 35.
European Commission, 2004, Forest fires in Europe: 2003 fire campaign, SPI 04.124, Office for Official Publications of the European Communities, Luxembourg. p 51.
European Commission, 2005, Forest fires in Europe: 2004 fire campaign, SPI 05.147, Office for Official Publications of the European Communities, Luxembourg. p 45.
European Commission, 2006, Forest fires in Europe: 2005 fire campaign, EUR 22312 EN, Office for Official Publications of the European Communities, Luxembourg. p 53.
European Commission, 2007, Forest fires in Europe: 2006 fire campaign, EUR 22931 EN, Office for Official Publications of the European Communities, Luxembourg. p 77.
European Communities, 2008, Forest fires in Europe: 2007 fire campaign, EUR 23492 EN, Office for Official Publications of the European Communities, Luxembourg. p 77.

UNECE/FAO, 2000. Forest Resources of Europe, CIS, North America, Australia, Japan and New Zealand. Main report. Geneva Timber and Forest Study Papers, No. 17. United Nations, New York and Geneva. 445 p.

United Nations Economic Commission for Europe and Food and Agriculture Organization of the United Nations, 1997, Timber Bulletin. Forest fire statistics – 1994-1996.
United Nations Economic Commission for Europe and Food and Agriculture Organization of the United Nations, 1998, Timber Bulletin. Forest fire statistics – 1995-1997. LI (2). P 18
United Nations Economic Commission for Europe and Food and Agriculture Organization of the United Nations, 1999, Timber Bulletin. Forest fire statistics – 1996-1998. LII (4). P 18
United Nations Economic Commission for Europe and Food and Agriculture Organization of the United Nations, 2001, Timber Bulletin. Forest fire statistics – 1998-2000. LIV (4). P 18
United Nations Economic Commission for Europe and Food and Agriculture Organization of the United Nations, 2002, Timber Bulletin. Forest fire statistics – 1999-2001. LV (4), p 18.

Velez, R. 2001. The causes of forest fires in the Mediterranean basin. Risk management and sustainable forestry. Eighth Annual Conference of the European Forestry Institute, 8 September 2001, Bordeaux, France.

APPENDIX

Additional information on fire causes for European countries and for countries elsewhere in the world.

- **EU member states and new candidates**

HR

CROATIA

Statistics on fire causes

The data on fire causes in the republic of Croatia in the 1980s are not available because included in the dataset of the Former Republic of Yougoslavia. The data on the period 1990-1999 are included in the database of UNECE timber committee.

In the 1980s and 1990s, the main part of human-caused fires was due to negligence, (especially agricultural activities or transport and communication, UNECE Timber Bulletin) and about 50% were ascribed to unknown or doubtful causes. The number of fires due to natural causes was very low (Fig. 98). The gap in data recording for years 1991 and 1992 was due to war.

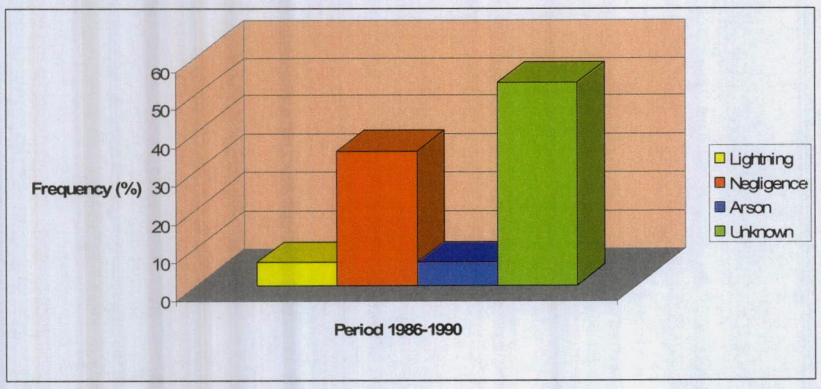


Figure 98: Distribution of the fire frequency by causes in Croatia during the period 1986-1990 *(Source: IFFN).*

CYPRUS

Information on the causes recorded

Forest fires are usually the result of:

- Negligence and accident:
  - Burning grass – gorse or stubble by farmers without taking the necessary precautionary measures
  - Careless visitors and picnickers (recreational activities)
  - Burning cigarette ends and matches used by careless smokers
  - Military exercises with ammunition or explosives of any kind
  - Hunting during the summer period
  - Burning of rubbish at non organized rubbish dumps
  - Various activities by the owners of country houses
- Lightning (natural causes)
- Arson

Statistics on fire causes

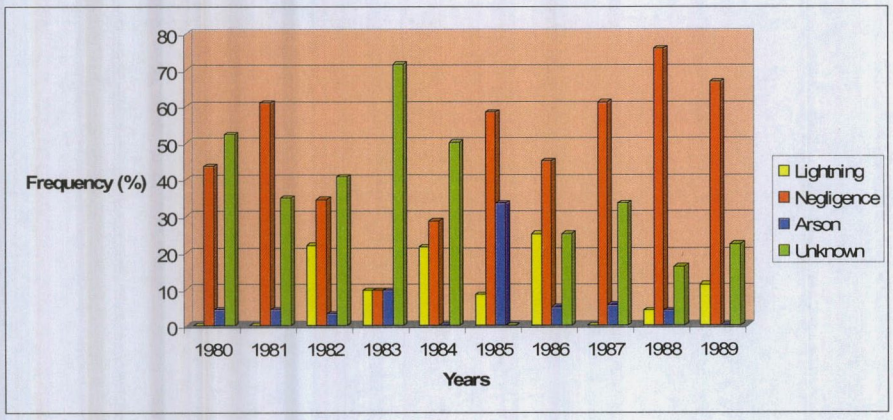


Figure 99: Distribution of the fire frequency by causes in Cyprus from 1980 to 1989 *(Source: IFFN).*

Figure 99 presents the statistics on fire causes for the decade 1980-1989. Between 1980 and 1984, the proportion of fires due to unknown causes was the most important (except in 1981). From 1985, negligence was the main fire cause (>40%, up to 76% in 1988). In 1985, a rise in the number of fires due to arson was noted (33% instead of less than 10% during the rest of the period). Fire frequency due to natural causes was the highest between 1982 and 1986, sometimes reaching 20%. Table 7 shows the number of fires according to each human cause during this period and it shows that "Military exercises" was the main accidental cause.

Table 7: Number of forest fires for each human cause in Cyprus from 1980 to 1989 ***(Source: IFFN).***

Year	Human causes
1980	Agricultural activities (1), Military exercises (1), N/A (9)
1981	Military exercises (3), N/A (12)
1982	Burning of rubbish (1), N/A (11)
1983	Military exercises (1), N/A (3)
1984	Military exercises (1), N/A (3)
1985	Agricultural activities (3), Visitors (1), Military exercises (2), Other (3), N/A (2)
1986	Agricultural activities (1), Hunters (2), Visitors (2), Military exercises (2), Other (1), N/A (2)

1987	Agricultural activities (1), Hunters (2), Visitors (2), Military exercises (2), N/A (5)
1988	Agricultural activities (1), Visitors (2), Military exercises (3), Other (1), N/A (13)
1989	Agricultural activities (1), Hunters (1), Visitors (2), Military exercises (2), Burning of rubbish (1), Forest works (1), Other (1), N/A (3)
TOTAL	**Agricultural activities (8), Hunters (5), Visitors (9), Military exercises (17), Burning of rubbish (2), Forest works (1), Other (6), N/A (63)**

N/A: Causes not Available.

Figure 100 presents the statistics on fire causes for the decade 1990-1999. Negligence was the main cause of fires between 1991 and 1993 (up to 75%) and in 1998 whereas lightning was recorded to be the main cause of fire in 1994 (53%). The proportion of fires due to unknown causes was the highest in 1990 and from 1995 to 1999 (except in 1998). Table 8 shows the number of fires according to each human cause during this period. "Agricultural activities" was then the main accidental cause. The proportion of fires due to the army decreased a lot and "visitors" have the same impact than in the previous period.

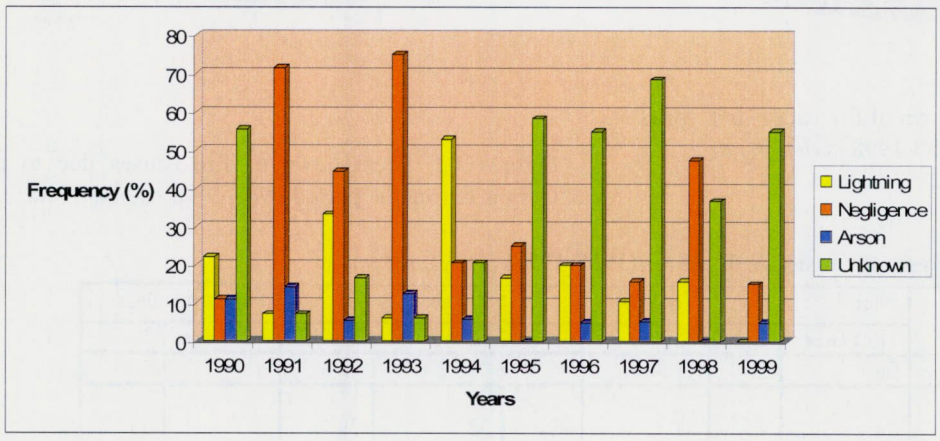


Figure 100: Distribution of fire frequency by causes in Cyprus from 1990 to 1999 *(Source: IFFN)*.

Table 8: Number of forest fires for each human cause in Cyprus from 1990 to 1999 ***(Source: IFFN).***

Year	Human causes
1990	Agricultural activities (2)
1991	Agricultural activities (1), Hunters (2), Visitors (2), Burning of rubbish (1), Forest works (2), N/A (4)
1992	Hunters (5), Visitors (1), Military exercises (1), Other (1), N/A (1)
1993	Agricultural activities (3), Hunters (1), Visitors (2), Other (2), N/A (6)
1994	Agricultural activities (2), Military exercises (1), Other (4), N/A (2)
1995	Agricultural activities (2), Visitors (1) Military exercises (2), Forest work (1)
1996	Agricultural activities (2), Burning of rubbish (1), Other (2)
1997	Agricultural activities (1), Forest works (1), Other (2)
1998	Agricultural activities (3), Hunters (1), Military exercises (1), Other (4)
1999	Visitors (2), Military exercises (1), Other (1)
TOTAL	**Agricultural activities (16), Hunters (9), Visitors (8), Military exercises (6), Burning of rubbish (2), Forest works (4), Other (16), N/A (13)**

N/A: Causes not Available.

The comparison of the two decades shows that the proportion of fires due to unknown causes did not change (36-38%) whereas, on the one hand, the frequency of fires due to natural causes increased from 10% to 24% and on the other hand, the frequency of fires caused by negligence decreased from 48% to 33% during this period. The proportion of fires due to arson did not change (6%).

Figures 101 and 102 present the frequency of forest fires causes and the break-down of forest fires caused by negligence/accident between 1985 and 1998. Negligence was the main cause of fires (43%) but 30% of the fires had unknown causes. "Farmers and shepherds", on the one hand, and "Military exercises" on the other hand, were responsible of a great number of fires during this period (15% and 14% respectively). An important number of fires did not have a cause recorded ("Missing": 14%).

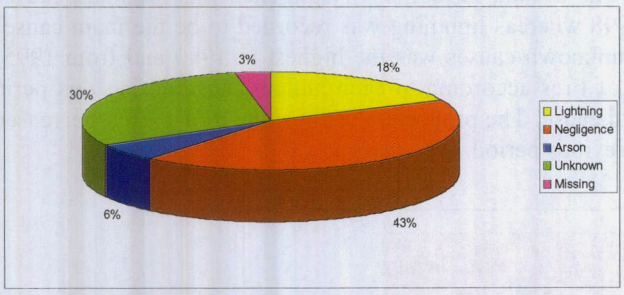


Figure 101: break-down of fire causes in Cyprus during the period 1985-1998 *(Source: IFFN).*

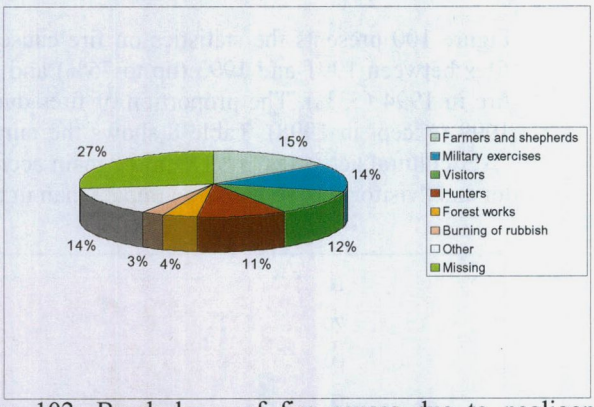


Figure 102: Break-down of fire causes due to negligence Cyprus during the period 1985-1998 *(Source: IFFN).*

Table 9 : Basic analysis of causes by divisions (1985-1998) ***(Source: IFFN).***

Division / Causes	Nicosia		Troodos		Pafos		Forestry college	
	N of fires	%	N of fires	%	N of fires	%	N of fires	%
Total no of fires	56	20	112	41	99	36	9	3
1.Cause								
Negligence	24	43	54	48	38	39	3	33
Intentional	3	5	8	7	3	3	2	23
Natural	2	4	10	9	35	35	3	33
From occupied areas	-	-	-	-	3	3	-	-
Unknown	27	48	34	30	20	20	1	11
Missing	-	-	6	6	-	-	-	-
2.By known causes								
Human	27	93	62	86	41	54	5	63
Natural	2	7	10	14	35	46	3	37
3.By human causes								
Negligence	24	89	54	87	38	93	3	60
Intentional	3	11	8	13	3	7	2	40
4.By negligence								
Farmers/shepherds	6	25	6	11	4	10	2	67
Hunters	-	-	9	17	4	10	-	-
Visitors	2	8	8	15	4	10	-	-
Military exercises	2	8	-	-	14	37	-	-
Burning of rubbish	2	8	2	4	-	-	-	-
Forest works	-	-	2	4	3	8	-	-
Other	3	13	11	20	3	8	-	-
Missing	9	38	16	29	6	17	1	33

According to table 9, a geographical variation in the frequency of the fire causes has been highlighted, the Forestry College division having the highest frequency of fires due to arson and lightning but the lowest proportion of fires due to unknown causes in contrast of the division of Nicosia. Trodos and Palos presented the highest number of fires.

The comparison of the frequency of fire causes between the periods 2000-2003 and 1985-1998 shows that, among the causes due to negligence, the frequency of fires due to agricultural activities and recreation increased in contrast of the frequency of fires due to military exercises and hunters (Fig. 103).

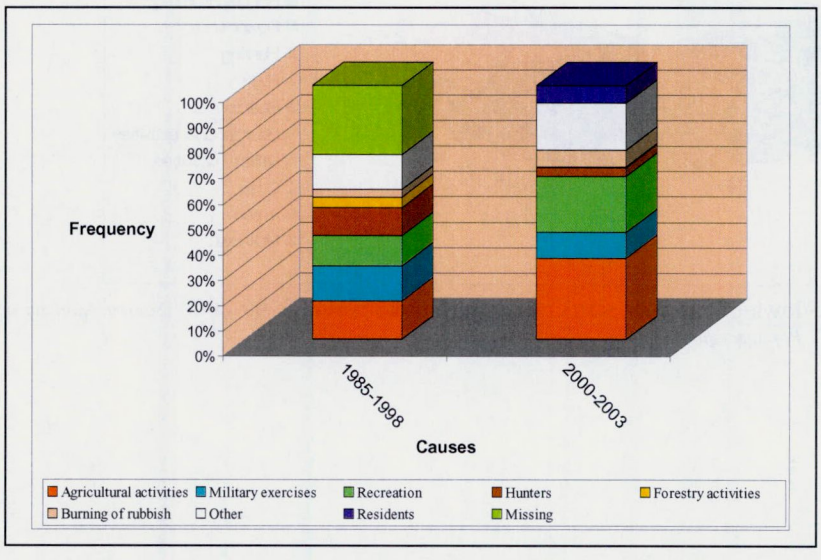


Figure 103: Break-down of the fire causes due to negligence in Cyprus during the periods 1985-1998 and 2000-2003 *(Source: IFFN).*

Figure 104 presents the results for the period 2000-2008 (Department of forest). Most forest fires in Cyprus start outside the forests or near their boundaries and less frequently within the forests. The analysis of the fire incidents for the period 2000–2008 indicates that the biggest percentage of forest fires in Cyprus and especially the most destructive ones are of human origin, especially due to negligence:

- Agricultural activities for the main part (22%): Fires set by villagers in their own lands to burn grass, gorse or stubble without taking the necessary precautionary measures
- Recreational activities is the second cause of fires due to negligence (14%): Fires caused by visitors, campers and picnickers who are careless with cooking and grilling fires, burning cigarette butts and matches, etc.
- Military activities: Troops exercising with ammunition or explosives of any kind
- Burning of rubbish: Fires escaping from non-organised rubbish dumps
- Forestry operations: Fires caused by people or machines engaged in any activity associated with forest engineering and forest production,
- Power lines
- Residence: The rise of the number of the country residences, composes a new cause of forest fires,
- Hunting during the summer period
- Other causes: These include e.g. use of different tools and machinery, etc.
- Arson

Natural and unknown causes represent 11% and 15% of the fires.

The cause of 15% of the forest fires remains unknown. The percentage of forest fires that were deliberately set is 14%. Lightnings are responsible for a percentage of 11% of the total number of forest fires.

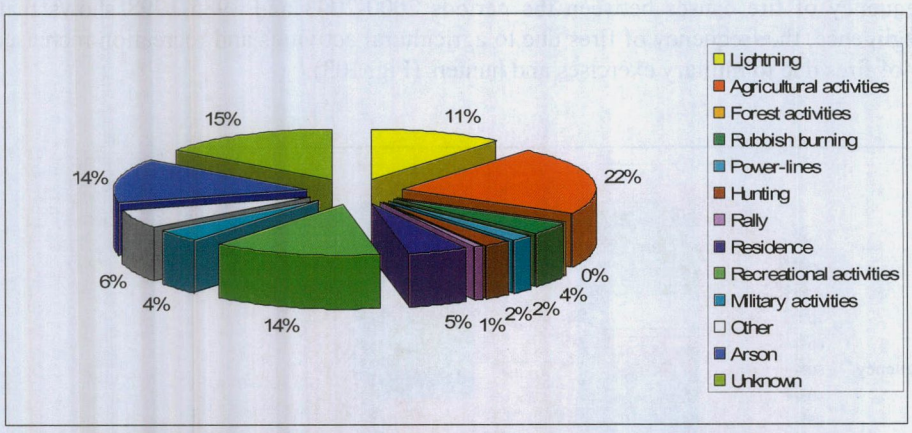


Figure 104: Break-down of fire causes in Cyprus during the period 2000-2008 *(Source: Ministry of agriculture, department of forest, C. Papageorgiou).*

ESTONIA

Statistics on fire causes

In the 1990s, the main cause of fire was negligence/accident (52% due to general public), and 14% of fire were due to arson (Fig. 105).

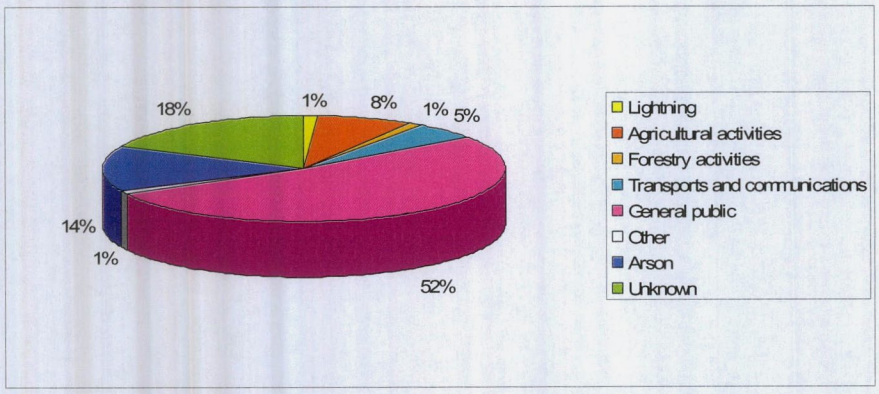


Figure 105: Break-down of fire causes in Estonia during the 1990s *(Source: IFFN).*

Statistics on fire causes

Analysis of the Prométhée Database

Before 1997, the database was not correctly filled in. Indeed, the nature of the cause was missing for a lot of fires and they appeared in the category "other" in figure 106. In this category, most fires were supposed to be due to arson as the proportion recorded was very low, and the comparison with the next decade is difficult. However, the proportion of fires due to unknown causes was very high (>50% and up to 80%) except in 1996 when it dropped to 30%. Lightning caused less than 5% of the fire and negligence represented around 20% of the fires in the 1980s before a drop between 1989 and 1995.

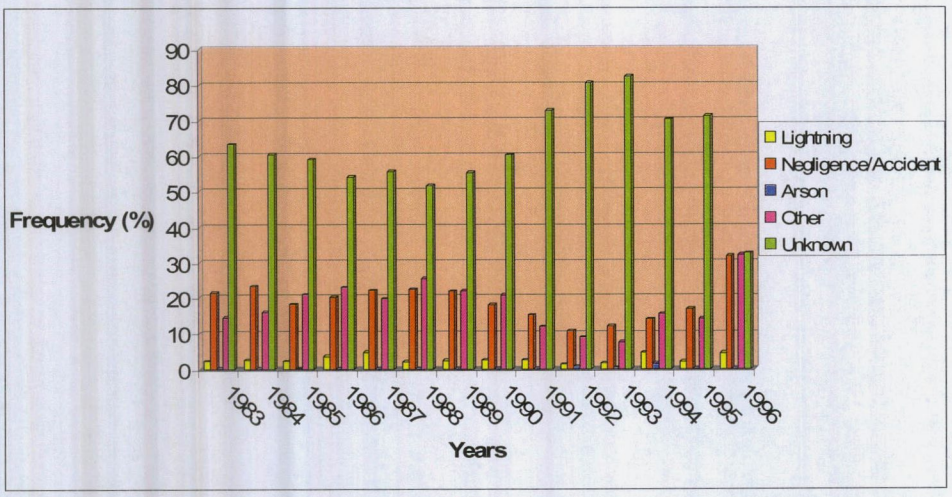


Figure 106: Distribution of the fire frequency by causes in southeastern France from 1983 to 1996 (*Source: Prométhée*).

Figure 107 shows the break-down of fire causes due to negligence in France and their distribution between 1997 and 2008. Since 1998, the main cause of accidental fires has been the individual works, surpassing the agricultural works. The frequency of fire due to forest works also decreased over this period.

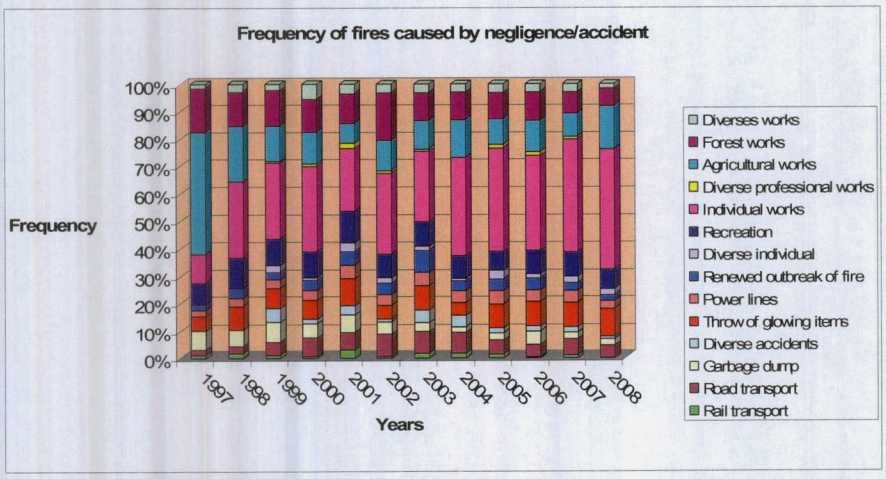


Figure 107: Distribution of forest fire by causes due to negligence in southeastern France from 1997 to 2008 (*Source: Prométhée*)

Figure 108 shows the break-down of fire causes due to arson in France and their distribution between 1997 and 2008. Until 1998, the main cause of arson was pyromania. Since 1999, a category named "diverse arson" has

been added and has become the main cause of intentional fires. The frequency of fires due to interest has slightly increased since 2006.

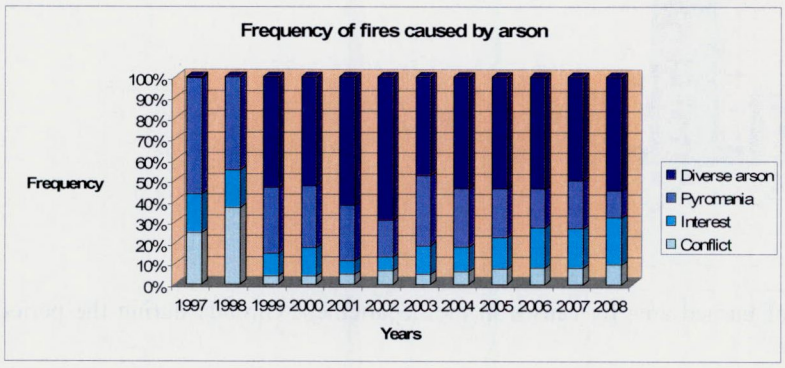


Figure 108: Distribution of the fire frequency by causes due to arson in southeastern France from 1997 to 2008 (*Source: Prométhée*)

Analysis of the Aquitaine Database

Data are given for the period 2001-2006 for the whole region Aquitaine and for the period 1995-2006 for the département Gironde, one of the départements composing this region. Details by year are available only for the 3 last years (2006-2008).
Figure 109 shows that during the period 2001-2006, the highest proportion of fires was due to unknown causes (60%) and 17% of the fires were due to lightning what was higher than in the rest of the country. Natural causes had practically the same proportion than the fires due to negligence (19%). Arson was not frequent (4%).

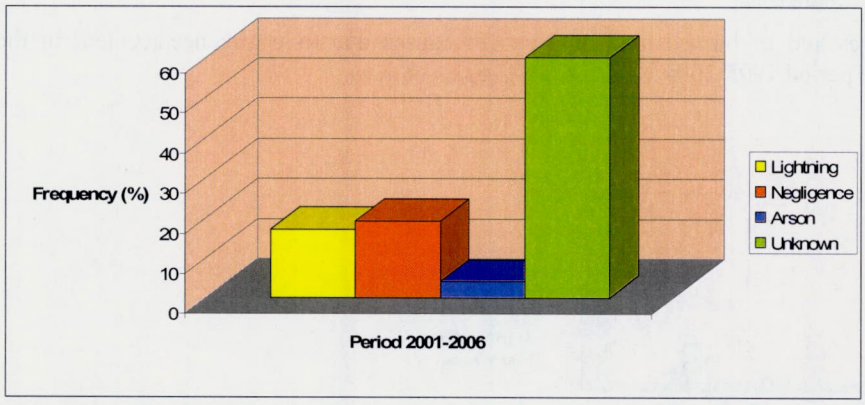


Figure 109: Distribution of the fire frequency by causes in southwestern France during the period 2001-2006 *(Source: PPFCI Aquitaine)*

Figures 110 to 112 show data obtained in the département Gironde during the period 1995-2006. The proportion of unknown causes was the same than for the whole region but the proportion of fires due to lightning was much smaller (<10%) and the one due to negligence were higher. The burned area follows the same trend than the fire frequency according to the causes (Fig. 110). The types of causes due to negligence have been detailed and divided into two periods: 1995-2004 and 2005-2006 (Fig. 111 and 112). Indeed, during the last period, the previous type of cause "Burnings and forest works" was split into two new types "Individual works" and "Forest works". The same trend was highlighted in both periods. There was a type "Unknown" classified in the causes due to negligence/accident and its proportion was by far the highest as well in term of number of fires as in term of burned area. "Burnings and forest works" represented 20% of the fires during the period 1995-2004 but this was mainly due to "Individual works" as shown during the period 2005-2006.

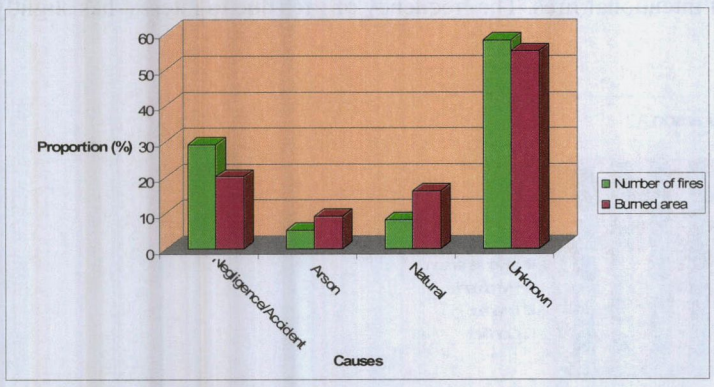


Figure 110: Proportions of fires and of burned area by causes in the département Gironde during the period 1995-2006 *(Source: Atlas feu de forêt Gironde)*.

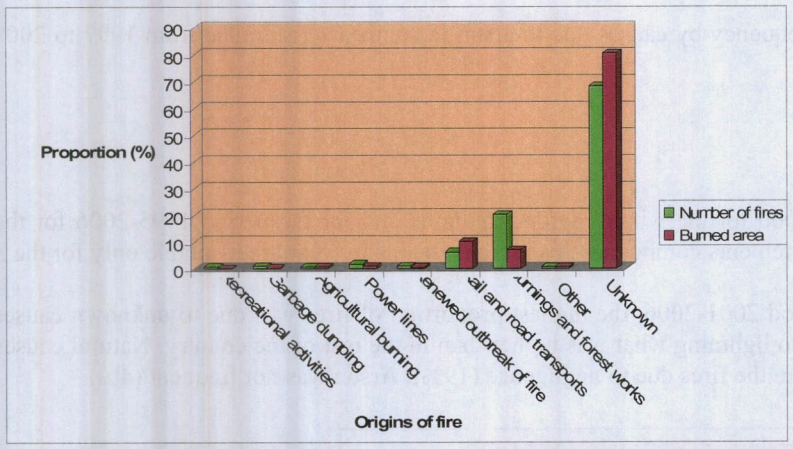


Figure 111: Proportions of fires and of burned area by types of causes due to negligence/accident in the département Gironde during the period 1995-2004 *(Source: Atlas feu de forêt Gironde)*.

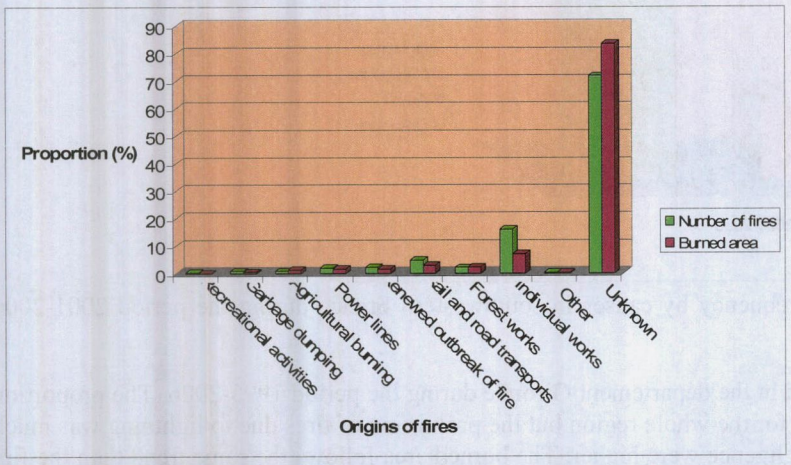


Figure 112: Proportions of fires and of burned area by types of causes due to negligence/accident in the département Gironde during the period 2005-2006 *(Source: Atlas feu de forêt Gironde)*.

GERMANY

Statistics on fire causes

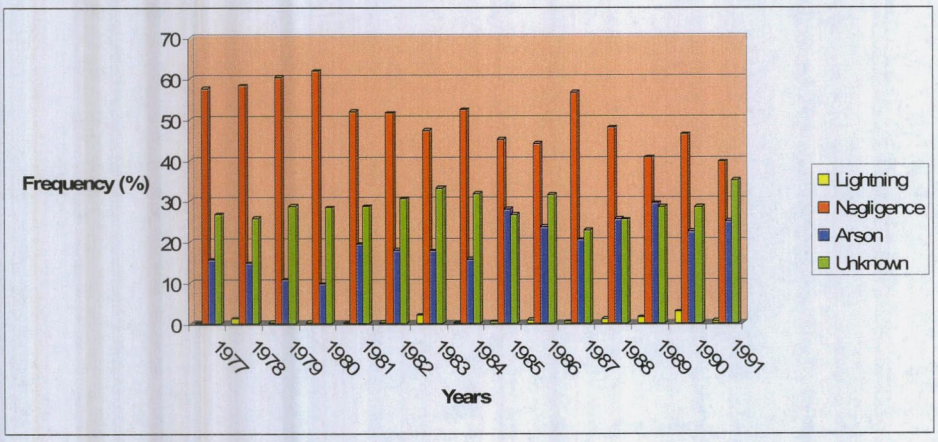


Figure113: Distribution of the fire frequency by causes in Germany from 1977 to 1991 *(Source: Bundesministerium für Ernährung, Landwirtschaft und Forsten 1992).*

Figure 113 shows that, between 1977 and 1991, the proportion of fires due to negligence decreased (>55% between 1977 and 1979, then around 50% and under 40% in 1991) while the proportion of fires due to lightning slightly increased from time to time. Arson was frequent in Germany, generally over 10% and up to 30% in 1989. The frequence of fires due to unknown causes also increased from 27% to 35% during this period.

Since 1991, only 2% of all fires were caused by lightning. The identification of fire causes was unsatisfactory because the average percentage of unknown causes was 39% from 1991 to 1999. Negligence held second place with 25% in the period 1991–1999. Negligence had a higher percentage in West Germany, decreasing from 50% to 30% between 1961 and 1990. There has been a steady increase of arson in West Germany since 1961, with an average percentage of 22% in the period 1991–1999 in the whole of reunified Germany. The reduction of military training and the electrification of railways, especially in East Germany, explained the decrease of the "other causes" to 10%. The four most important "other causes" were the railway, public ways, agriculture and forestry.

GREECE

GR

Statistics on fire causes

In Greece fire statistics were collected since the 1950s. Their reliability improved after 1981. However, in 1998 when the responsibility for firefighting passed from the Forest Service to the Fire Service, many problems began to appear. The reliability of statistics dropped in regard to burned area and number of fires. Furthermore, there were serious problems with knowledge of fire causes (unknown causes on certain occasions exceed 80%).

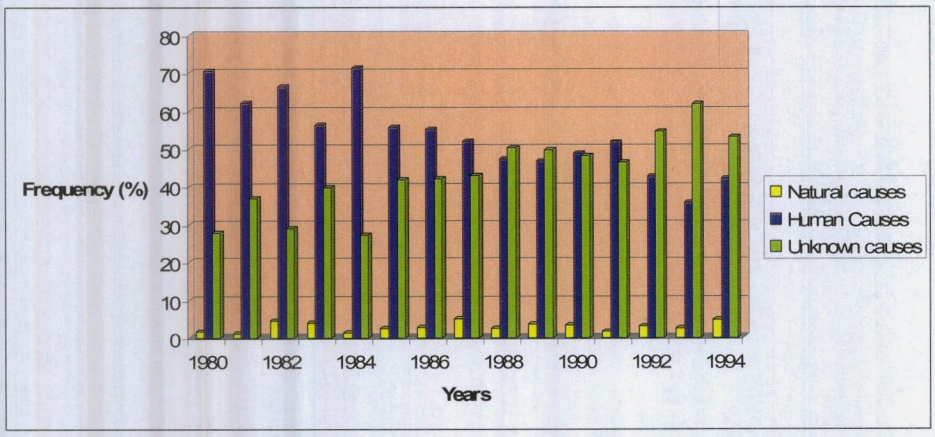


Figure 114: Distribution of fire frequency by causes in Greece between 1980 and 1994 *(Source: Forest Service of Greece, IFFN).*

Figure 114 shows that, between the 1980s and the 1990s, the frequency of human causes decreased in contrast of the proportion of unknown causes. The data recorded did not reflect reality since it was commonly accepted that at least, half of the fires attributed to unknown causes were the result of arson. They were listed as fires of unknown causes either because the arsonist was not arrested or because conclusive evidence of arson was not found. This was because all arson fires were ignited in remote, inaccessible areas and when weather conditions were severe. In Greece, it was estimated that more than 30% of the number of forest fires, responsible for over 60% of the annually burned area, were the result of arson.

Figure 115 shows the frequency of fires by causes in Greece during the period 1968-1993. Few forest fires in Greece were due to natural causes. Lightning-caused fires accounted for less than 3% of the total number of fires. The rest of the fires with known causes were categorized as accidental, due to negligence or deliberately started. The main cause was negligence but the proportion of fires due to arson and to unknown causes were also important (29% each). A large number of fires were reported due to "unknown causes", most of them were suspected to be deliberately set, a majority probably started for rangeland improvement. A significant number of the "unknown causes" fires may also be lightning caused, since determination of this cause can be quite tricky when a fire remains dormant and undetected for some time after a storm and then starts spreading when conditions become favourable.

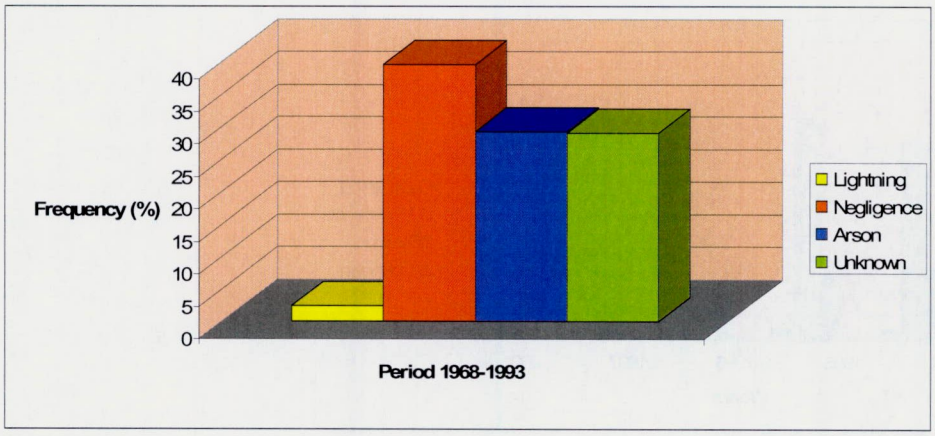


Figure 115: Distribution of the fire frequency by causes in Greece during the period 1968-1993 *(Source: IFFN)*.

Figure 116 presents average values for 1968-1993 with details on the cause due to negligence and accident (Kailidis and Xanthopoulos 1991, Markalas and Pantelis 1996). In terms of importance, arson fires for land use change, fires from burning garbage dumps and power line fires were considered to be the worst since they usually occurred on days with high wind. Shepherd fires were also a problem, both due to the cost of fighting them and to the fact that even when firefighting efforts were successful the shepherds merely waited for more difficult conditions and tried again. Forest fires due to agricultural burnings and to cigarettes were the most frequent over this period (41% and 22% respectively).

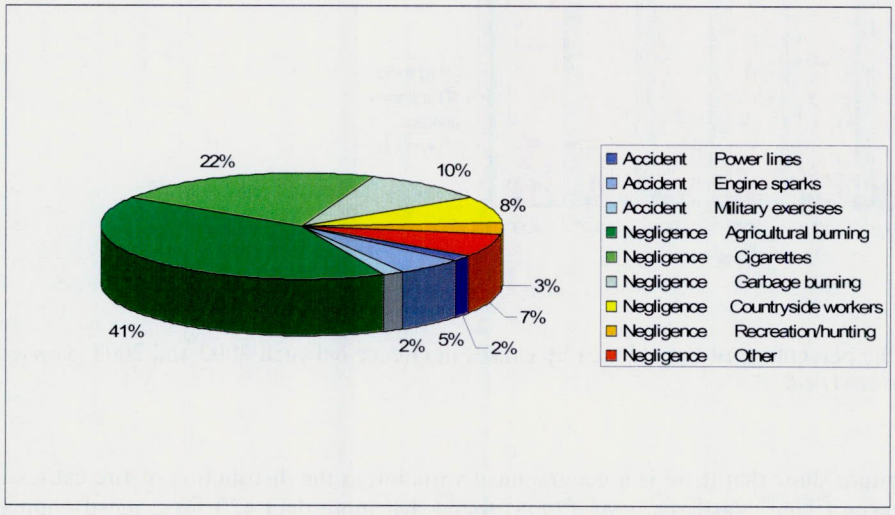


Figure 116: Break-down of the forest fire causes due to negligence in Greece during the period 1968-1993.

Between 1994 and 2001, the proportion of fires due to unknown causes was the highest (>50%). During this period, the proportion of fires due to negligence (mainly due to agricultural activities and Forest activities, UNECE Timber Bulletin) seemed to decrease in contrast of the proportion of fires due to unknown causes. A few fires due to arson were recorded in 2001 but the main part may have been included in the unknown causes. Lightning was not a frequent cause of fire (<5%) (Fig. 117).

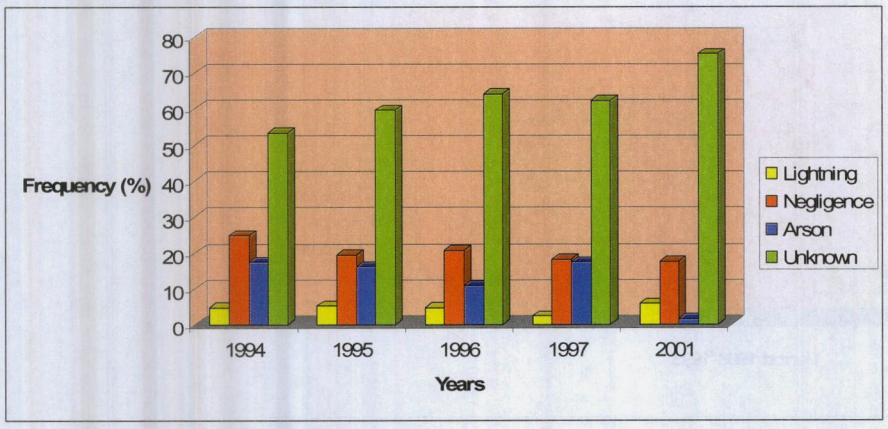


Figure 117: Distribution of the fire frequency by causes in Greece from 1994 to 2001. No data available from 1998 to 2000 *(Source: Timber Bulletin)*.

Between 2002 and 2008, the highest proportion of burned area was also due to the unknown causes. However, when the cause is known, arson and negligence were the causes responsible of the largest burned area depending on the year (Fig. 118).

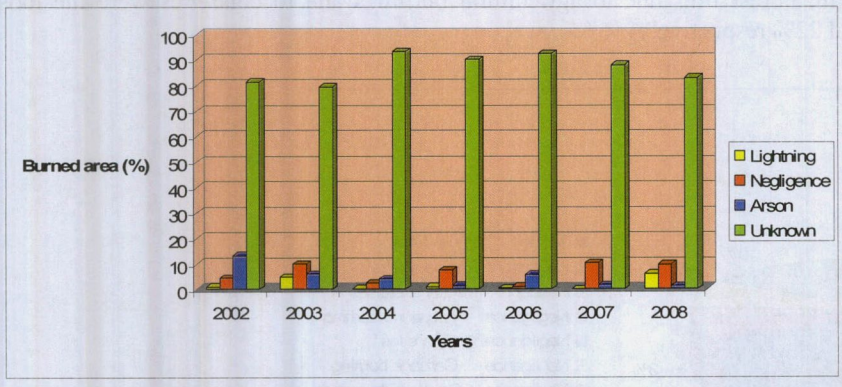


Figure 118: Distribution of the percentage of burned area by causes in Greece between 2002 and 2008 *(Source: T. Pallas, Ministry of rural development and food)*.

Different studies in the literature show that there is a geographical variation in the distribution of fire causes in Greece. For instance, in Lesvos Island, Vasilikos *et al.* (2008) found that more than 420 fires, mostly human caused, occurred in the period 1970–2001 resulting in approximately 80km^2 of burned area in Lesvos Island. Even though the number of fires has increased in recent years, the burned area has declined due to the active fire suppression undertaken by the Greek Fire Brigade using effective tactics and sometimes heavy equipment. During the study period, 62% of wildfires of known causes (approximately 55% of all fires) were due to human negligence; 16% arson, 10% lightning caused, 6.5% military activities, 2.8% garbage disposal related, and 1.7% from electric power lines. (Vasilakos *et al.*, 2008).

ITALY

Information on the causes recorded

Natural causes
Fires caused by lightening or volcanic eruption

Accidental causes
Fires caused by spark from wheels of trains or certain locomotives and others.

Negligence
Fires caused by cigarette stubs or matches along different types of ways or areas.
Fires caused by agricultural and forest activities
Fires caused by other forms of negligence (recreation, army, etc.).

Arson
Fires caused in connection with profit seeking
Fires due to manifestations of protest, resentment or insensitivity toward forests
Fires due to dubious causes

Dubious causes
Causes in which the motives that gave rise to the fire are not identifiable

Starting from 2003 the CFS, in collaboration with the National Forestry Direction, have developed a prototypal methodology to carry out an investigative analysis of real causes of fire. With the support of N.I.A.B. (Nucleo Investigativo Antincendi Boschivi – Investigative Corp of Fire Prevention), the MEFmethod (Method of Physical Evidences) has been adapted to investigate fire events evolution by the evidences, in order to define and classify the causes. The steps that define this experimental method are:

- Definition of fire behaviour and ignition zone determination
- Ignition point research
- Research of physic evidences of trigger
- Comparison between evidences and testimonies
- Definition of causes

At the present this procedure is applied just in case of serious fire events, characterized by large surfaces, infrastructures involved and high values of forest interested.

Statistics on fire causes

The analysis of the causes of fires in 1990 and 1998 confirms the high incidence of human responsibility for the destruction of wooded areas struck by fires (73.7% of the burned area and 51% of the number of fires are due to deliberate action). The analysis of accidental causes in 1998 shows that most fires that occurred for these reasons were due to agricultural activity, followed by cigarettes and matches, which contributed significantly to the ignition of fires. Recreational activities had a modest effect, confirming that civic sense is continuously increasing among citizens (Fig. 119).

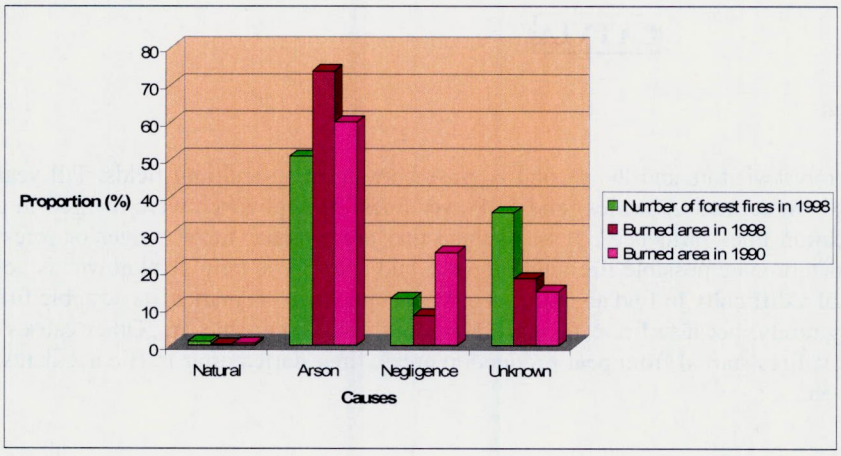


Figure 119: Distribution of the fire frequency and burned area in Italy in 1990 and 1998 *(Source: IFFN).*

There is a geographical variation of the fire causes frequency in Italy. Fires are present, to a considerable degree, even in some central and northern regions (Lazio, Toscana and Liguria), far from marginal conditions. As a matter of fact, in these regions abandoned agricultural lands are quite often occupied by shepherds, emigrating with their flocks from Sardegna, where a shortage of rangelands is becoming a serious problem in relation to the increasing number of sheeps, which still represent one of the pillars of local economy. Fires in the northern regions of Italy are, on the contrary, without the character of severity of the southern group. In this case, fires, often winter fires, are mainly non-voluntary, often related to dry winters and large amounts of cured fuels, and though their number can be considerable, surfaces are normally rather reduced.

Information on the causes recorded

The main cause is negligence of forest visitors and the second is grass burning in agricultural fields. Till year 2008 the categories 3 (railways).;4 (motorized vehicules) and 5 (Power lines) of negligence were merged in a common category as „Communication lines influence". It is assumed that professional forest ranger or forest engineer must be able at least to determinate possible fire ignition place and cause. The term „Unknown" is not used as forest fire causes. In case of a difficulty to find an evidence, „Man negligence" is marked as possible fire cause, but such cases happen very rarely, because fire causes are more or less determinable. In „Other causes" category there would be only forest fires started from peat production areas, fires started after traffic accidents, shooting in forest, structural fires, etc.

Statistics on fire causes

An analysis of fires (Fig. 120), during the 1980s and 1990s, shows that negligence was the main cause of fires (71%), mainly due to recreational activities (UNECE Timber bulletin). Indeed, a lot of fires were started by people visiting the forest. "Agricultural activities", by the burning of agricultural residues (straw, last year grass, etc.) was one of the main accidental causes (9%) with "Transports" (7%). Fires due to arson represented 7% of the fires.

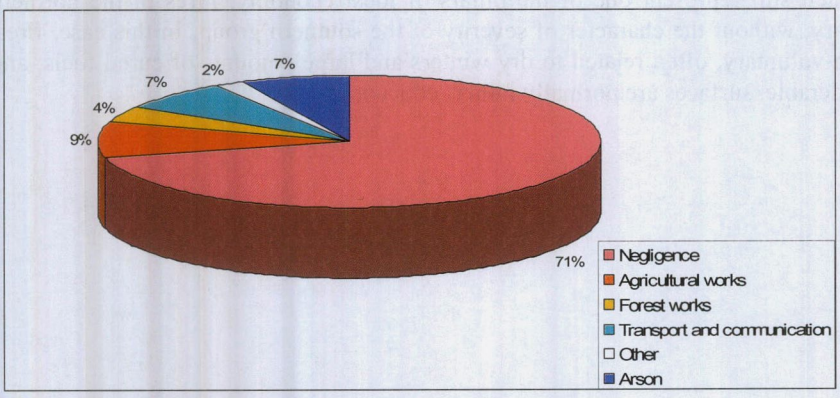


Figure 120 Break-down of forest fire causes (accidental causes detailed) in Latvia, during the period 1980-1999 *(Source: IFFN).*

Figure 121 shows that in 2008, negligence, especially recreational activities (negligence of forest visitors 89%), were still the main cause of fire in Latvia. The proportion of fires due to agricultural activities decreased compared to the previous period.

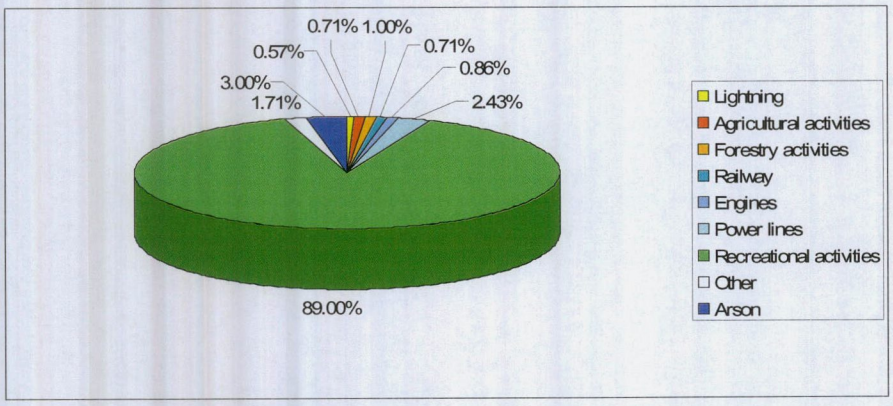


Figure 121: Break-down of fire causes in Latvia in 2008 *(Source: State Forest Service, A. Sumanis).*

LITHUANIA

LT

Statistics on fire causes

Figure 122 shows that negligence was the main cause of fire (>70%) in Lithuania between 1994 and 1999. The proportion of fires due to arson was constant (around 10-15%) over this period and the proportion of fires due to unknown causes decreased a little from 10% in 1994 to 5% in 1999. Natural causes were less frequent by far.

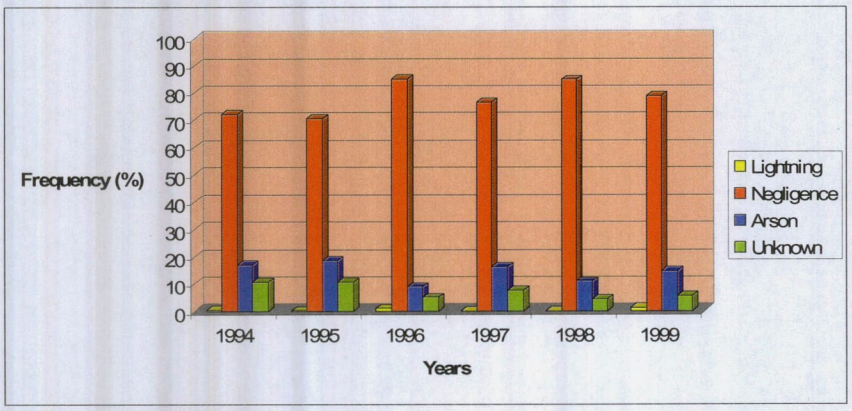


Figure 122: Distribution of fire frequency by causes in Lithuania from 1994 to 1999 *(Source: Timber Bulletin).*

In Lithuania, from 1994 to 2001, most forest fires caused by negligence were mainly due to general public and agricultural activities (UNECE Timber bulletin).

Information on the causes recorded

Carelessness of adults

This group encompasses all fires caused by adult persons, resulting from prohibited acts that may be subject to the regulations of penal code and code of petty offences as well as sanctions defined in detailed laws concerning e.g. wildlife protection. These fires include:

1. Fires caused while practising tourism and picking fruits of the forest. These fires are the outcome of throwing aside burning matches, cigarette ends or burning tobacco from a pipe. Not-extinguished bonfires as well as fire starting as a result of using a barbecue and similar devices for heating up the food are also among fire causes. Special instances in this group encompass: starting a fire in the period of dry early spring, while picking mushrooms or during collecting antlers cast by stags and roe deer. In June the fire can be started not only by weekend tourists but also by teenagers, who treat forest as a place of playing truant. At the turn of June and July fire can by broken by pickers of early mushrooms and blueberries. During summer school break and holiday period there is a natural escalation of fire occurrences resulting from mass recreation, tourism and picking fruits of the forest. Harvest period is also a fire season. In the time of dry autumn fire is started mainly by pickers of mushrooms, mountain cranberries and other forest fruits and herbs. Growing recreation base is also conductive to increased recreation and tourist movement in autumn.

2. Fires resulting from economic activity of owners and users of the forest are caused by:
   - burning of post-exploitation brushwood and branches,
   - burning of trees attacked by pest,
   - burning off plant remains (post-exploitation) to facilitate productiveness of the surface,
   - burning of bonfires by forest workers for warming up or heating up the food.

3. Remaining fires are caused by:
   - construction or refurbishment works on engineering structures located in forests that require usage of fire (e.g. welding, heating up of certain materials, e.g. glue),
   - setting off fireworks,
   - other activities, which cannot be classified in the groups mentioned above.

Carelessness of minors

The causes of fires started by young people (at the age of up to 15) most often include recklessness and inability to properly assess risk when playing with fire:

- fires caused by carelessness of minors, which in many cases are similar to the fires caused by carelessness of adults. They usually take place as the outcome of playing with matches, lighters and other sources of fire (smoking of cigarettes), carrying burning torches, glowing torches, etc.
- fires caused by burning of bonfires by minors (most common cause in this group). These fires are the result of the inability to properly assess risk and of starting bonfires for fun (often on flammable ground) as well as not completely extinguishing them. Places for starting bonfires are most often chosen in areas inaccessible and invisible for adults.

Machines and equipment

Failure of power lines

Fires caused by failure of power lines are the outcome of:

- spontaneous breaking of live wire and its falling on flammable ground cover,
- a tree or other object falling on the wire and causing short-circuit,
- fire of a switching station or transformer station in the terrain containing depositions of flammable biomass or located in the forest.

Road transport

Fires caused by the road transport are the outcome of:

- autogenous ejecting of glowing carbon deposits from tractors and other vehicles exhaust manifold,
- stopping a vehicle equipped with catalyst on dry grass or heather,
- using vehicles with faulty exhaust system,
- spontaneous combustion of a vehicle or combustion as a result of vehicle collision,
- seizure of bearings or other mechanisms.

Rail transport

Rail transport becomes the cause of forest fire when the following events take place:

- autogenous ejecting of glowing carbon deposits from exhaust manifold of (old type) diesel type locomotives,
- seizure of wagon axle,
- sparking of brake lining,
- breaking of electric traction,
- catching fire by the distance piece between rail and railroad tie in electric traction,
- fire of locomotive or railway car,
- starting a fire by the passengers,
- starting a fire by spark from a steam engine,
- glowing coals falling out of malfunctioning fire grate,
- slagging of steam locomotive (intentional removal of glowing slag)

Generally the last three causes can be treated as historical, because nowadays old steam locomotive are only occasionally in use.

Atmospheric discharges (Lightning)

At our latitude forest fires caused by atmospheric discharges are rare. Storms almost always bring rainfall and as a consequence any glow is extinguished. Nevertheless, individual fires of old, rotten trees and forests are sometimes recorded on the fringes of rainfall area. Fires resulting from this cause are usually revealed on the following day (or sometimes later) when top ground cover dries.

Breakovers from non-forest land

Fires caused by breakovers from non-forest land are fires that first broke on terrains or in structures located outside the forest, and then are spread by wind onto the forest. Original cause of such a fire can be any one recorded by the fire practice. Most often such fires result from:

- preparation of long-standing farming wastelands for resumption of tillage;
- burning off of remaining vegetation, e.g. straw;
- spring burning off of meadows and pastures;
- spring tidying of escarpments, ditches, gardens and baulks with fire.

Until recently it was an important cause of forest and other structures fires, today it is becoming less significant thanks to better profitability of agricultural production, growing need of aesthetic appearance houses surroundings, mowing of roadside ditches, etc. The number of fires in this group depends on the duration of dry early spring (in individual years it can last from one to three months), length of field and forest boundary, the level of farming culture in a given region and the quality of soil.

Arson

At present arsons have the greatest share in the total number of fires. Arsons usually have their motives. Most often these are:

- intention to acquire an income for the work taken up in connection with fire extinguishing, supervision or removing the effects of fire and tidying up of the burnt down area;
- the desire to distinguish oneself in the community by notifying about the fires or by extinguishing them;
- causing a show to watch the firefighting effort;
- removing traces of a crime;
- taking revenge on forest service employees or other persons administering the forest.

This group encompasses also fires caused by mentally ill persons. These are distinguished by the lack of a logical motive of the arson. Financial gain is the main reason of fire-raising, and originally such behaviour is caused by great unemployment rate prevalent in the poorly urbanized regions with considerable forestation rate. Until social and economic transformation arsons of forests were sporadic. In the previous years among fire

perpetrators there were most often children who wanted to make a "show", members of Voluntary Fire Brigades who wanted to demonstrate their courage and dedication, as well as forest workers who set fire in order to acquire additional pay for tidying up of the burnt area. Fires caused by revenge or mental illness of the arsonist occurred occasionally.

Other and unidentified causes

The group of other causes includes fires the causes of which cannot be classified in any of the previous groups. In this group there are fires resulting from disasters, military exercises, etc. The group of unidentified causes encompasses all the fires the causes of which cannot be found.

Statistics on fire causes

Negligence and arson were the main causes of fire in Poland between 1994 and 2007 (negligence in 1994-1997 and arson in 1998 and 2005-2007), except in 1999 and 2000 when the proportion of fires due to unknown causes was the highest. A lot of fires could be due to arson according to the general trend of the period (Fig. 123). Between 1994 and 2000, negligence was mainly due to agricultural activities and general public (UNECE Timber bulletin).

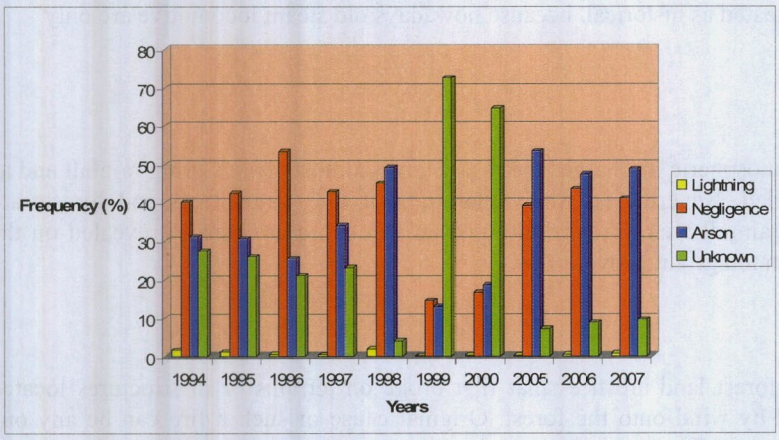


Figure 123: Distribution of the fire frequency by causes in Poland from 1994 to 2007. No data available between 2001 and 2004 *(Sources: Forest Fires in Europe, Timber Bulletin).*

Causes of forest fires during the period 1990-2004 in the 'State Forests' National Forest Holding (Poland) are presented in figure 124 (Piwnicki *et al.* 2008). Arson was the main cause as well in term of number of fire as in term of burned area. Rail transports caused a high percentage of burned area in spite of a small number of fires. The proportion of fires and burned area due to carelessness of adults and unknown causes was high especially concerning the fire frequency (up to 25% each) Lightning was not a significant cause (Fig. 124).

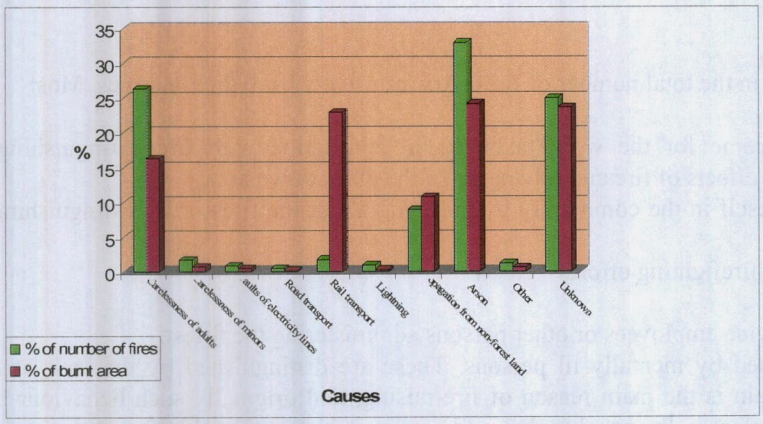


Figure 124: Distribution of the fire frequency and the percentage of burned area by causes in Poland during the period 1990-2004 *(Source: Piwnicki et al. 2008).*

Figure 125 presents the distribution of the fire frequency by fire causes recorded by the National Headquarters of the State Fire Service in Poland between 1993 and 2008. Over this period, the trend was the same than the one highlighted in figure 43 with data recorded by the National Forest Holding. However, the frequency of fires due to unknown causes was higher in the latter (between 20 and 30% between 1993 and 2008). The burned area followed the same trend than the fire frequency (Fig. 126) and the remark concerning the comparison between the two datasets is the same.

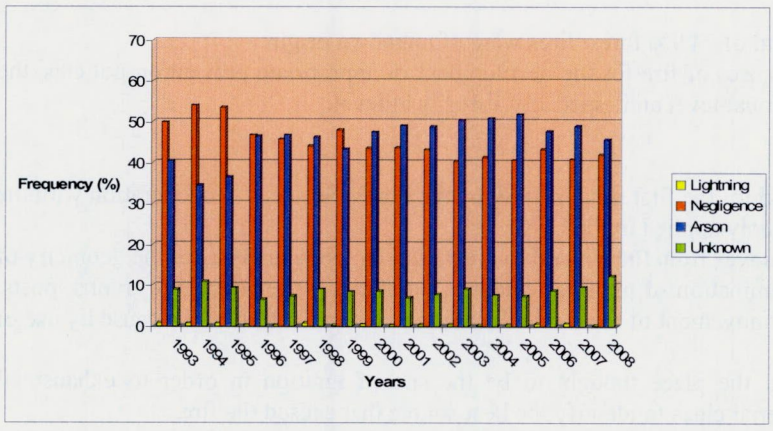


Figure 125: Distribution of the fire frequency by causes in Poland from 1993 to 2008 *(Source: National Headquarters of the State Fire Service).*

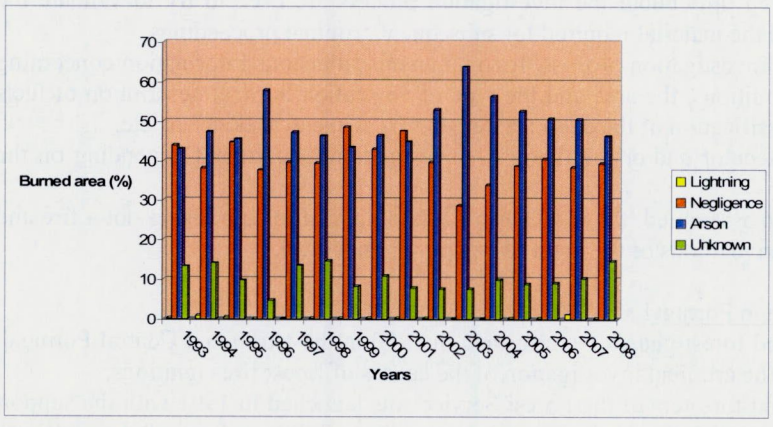


Figure 126: Distribution of the percentage of burned area by causes in Poland from 1993 to 2008 *(Source: National Headquarters of the State Fire Service).*

PORTUGAL

Information on the causes recorded

Determination of causes until 1989

Until 1989, each fire in Portugal was assigned with a probable cause determined by forest rangers, fire fighters or other credible bodies or persons. While the number of forest fires remained small (about 1 500 in the decade from 1959 to 1969), the method was very satisfactory although it contained a wide range of subjectivity.

The number of fires and the burned areas increased strongly in the mid-1970s and it became impossible to reliably attribute a cause to each fire.

Thus, from 1980 to 1988, 73.9% of a total of 24.9% forest fires were of unknown origin.

Given the importance of knowing the causes of fire for the development of appropriate prevention policies, the results were not at all satisfactory at national level and especially at regional level.

Testing the physical evidence method

The physical evidence method was tested for the first time in 1989 by the Forest Services in cooperation with the Judiciary Police, using the model commonly applied in the USA.

The method is applied to each fire and moves from the general to the particular using analysis of the geometry of the boundary of the burnt area and examination of physical evidence on stones, vegetation, tree trunks, posts, fences, etc., to establish the direction of movement of the fire and leading to determination of the cause by use of all the data.

The remains are examined carefully at the place thought to be the site of ignition in order to exhaust all possibilities of finding one or more material clues to identify the heat source that caused the fire.

The results inspired sufficient confidence for application to be broadened. Although the method does not give the cause of all fires, it is nonetheless possible to perform an exhaustive inquiry for each fire in a significant sample of all fires.

It is considered that the method reduces the percentage of unknown causes in the inquiry sample.

The material and personal clues gathered throughout the investigation process are used to try to validate the classification of a cause by collecting all the material required for subsequent criminal proceedings.

A technical sheet is filled in during the investigation process. It contains miscellaneous information concerning the fire location, the meteorological conditions, the area and the type of vegetation burned, description of fuels and all the indicators that enable the classification of the cause: statements by witnesses, sketches, etc.

A report is also sent to the public Prosecutor and/or the Criminal Investigation Department depending on the case.

When a significant set of cases has been assembled, the results can be extrapolated by appraising not a fire and cause relationship but the general indicative trends of the main causes at regional level.

The evolution of forest fire investigation in Portugal

Seven investigation brigades with trained forest guards were formed in 1990 in the North and Central Portugal, using the physical evidence method for the criminal investigation of the causes of forest fires ignitions.

A training program for forest rangers and foresters of the Forest Service was launched in 1991 with the support of the Luso-American Development Foundation and the Criminal Investigation Department of the Judiciary Police.

Later, in 1996, due to an institutional reorganization of the Forest Services, the investigation brigades were over and the forest rangers integrated in regular brigades. This measure resulted in a decay of the fire causes investigation capacity.

Between 1999 and 2003, a special program in the Forest Services to reinforce the National Forest Rangers Corps developed the fire investigation issue, promoting training and organizing the regional services. Also, in 2000 the fire causes classification scheme was revised and operation directives were established.

In 2006, following the Government reform on the forest fire protection national system, the National Forest Rangers Corps was extinct in the Forest Services and the personnel integrated in the National Guard, under the Nature and Environment Protection Service. These change resulted in a increase of the number of investigated fires, but the results quality decreased with a significant increase of the unknown causes (66% in 2006).

In 2007, the Forest Service with the collaboration of the Judiciary Police and the National Guard, trained 120 agents of the National Guard - Nature and Environment Protection Service, on the Forest Fire investigation process.

The aim of investigation of causes

The main objectives are as follows:

- to identify the causes of fires in order to develop appropriate preventive measures;
- to prosecute law-breakers;
- to convert identified causes in national, regional and local fire risk indexes.

Prosecution is the corollary of a good criminal investigation process. Bringing suspected arsonists to the courts with well-formulated charges and sufficient proof for fair sentencing will represent the expected goal for society and will play a preventive role through the example given.

Statistics on fire causes

The year 1973 makes a break with a history of a low number of forest fires. Two years later, in 1975 (after the 1974 revolution), is the start of the rising number of forest fires and burned area. This trend kept in the 1980s and especially during the 1990s. In the first eight years of this century, the trend started to be inverted. Figure 127 expresses the yearly evaluation of the number of fires recorded in Portugal since 1980, the first year with official statistics on forest fires.

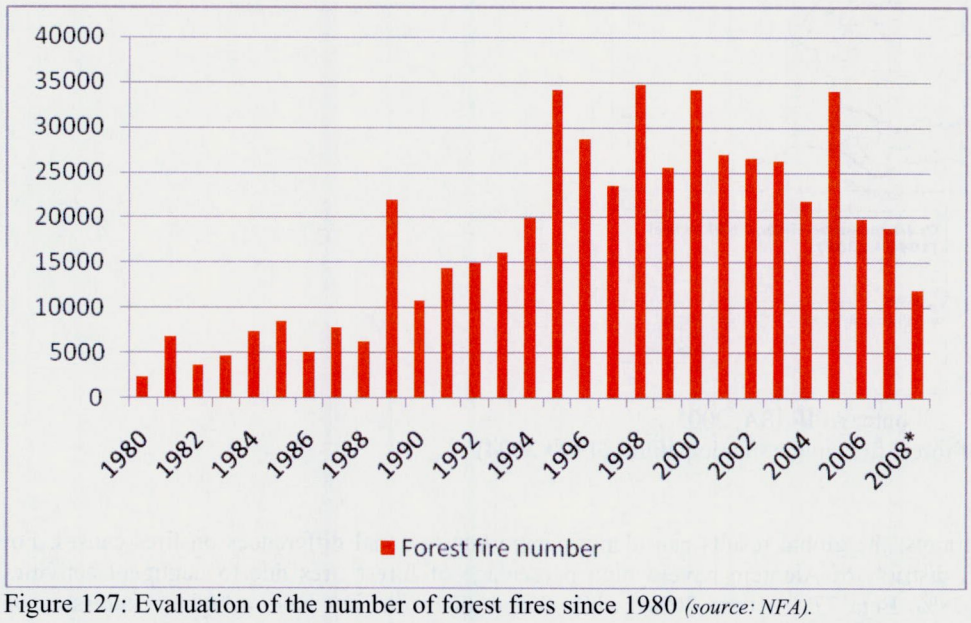
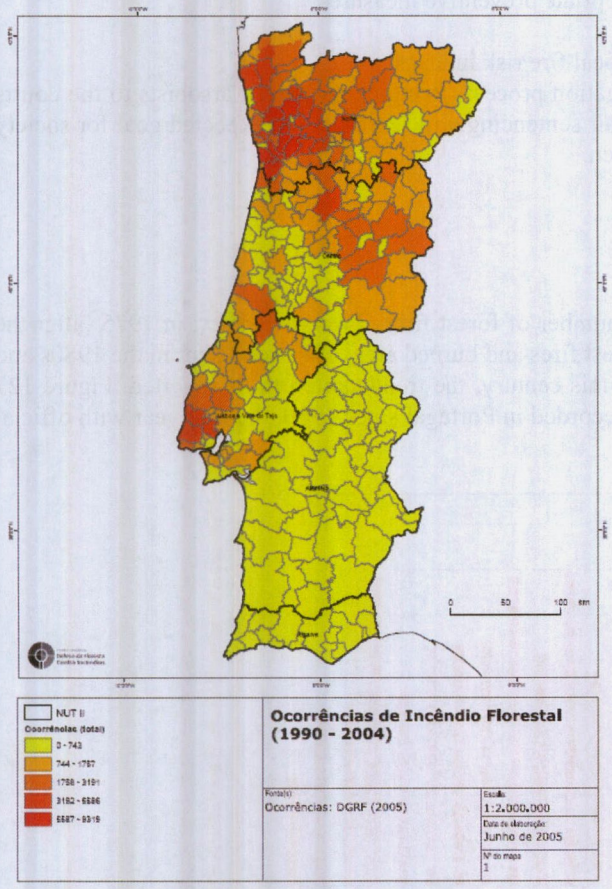


Figure 127: Evaluation of the number of forest fires since 1980 *(source: NFA).*

The spatial distribution of forest fires it is not uniform in the Portuguese territory. The annual average of the number of fires is significantly higher in the urban and peri-urban municipalities, despite the burned area is small. In fact, there is a positive correlation between the number of inhabitants and the number of forest fires (APIF/ISA, 2005).

The analysis of figure 128 expresses very well that the North-western region of Portugal, where there is a high demographic density has also a high number of forest fires. In the opposition, the Alentejo region, in the south, has a low demographic density and a low number of fires occurrences.

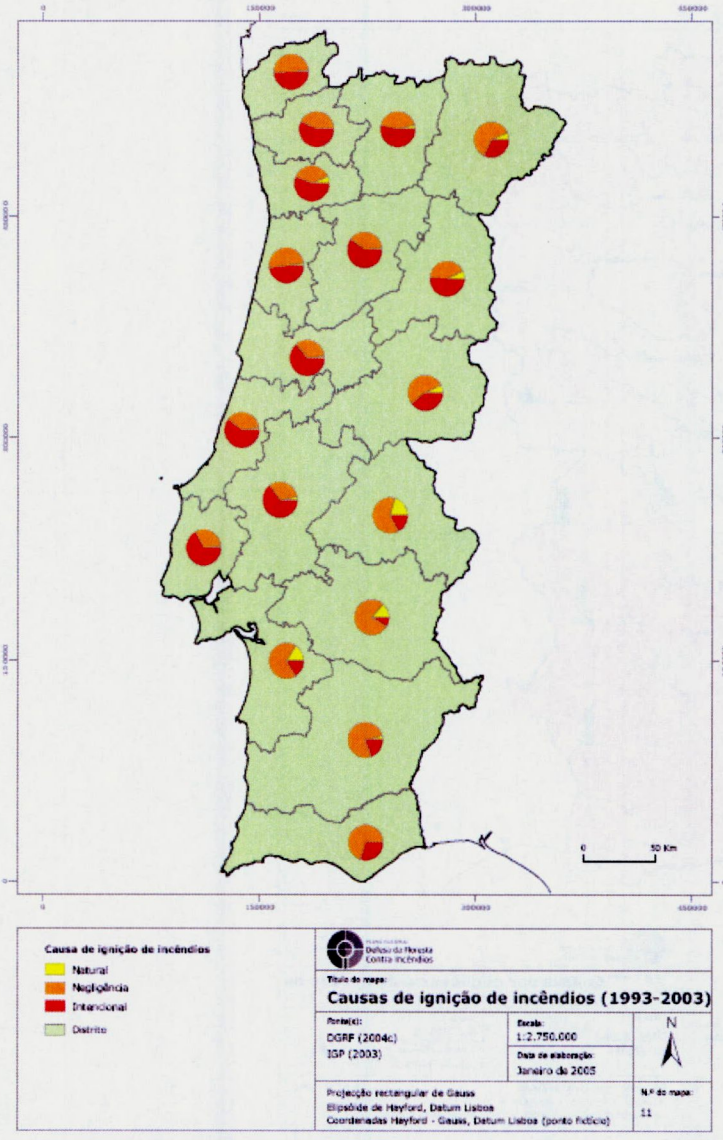


Fonte: APIF/ISA, 2005

Figure 128: Number of forest fires in the municipalities (1990-2004).

Analysis by districts

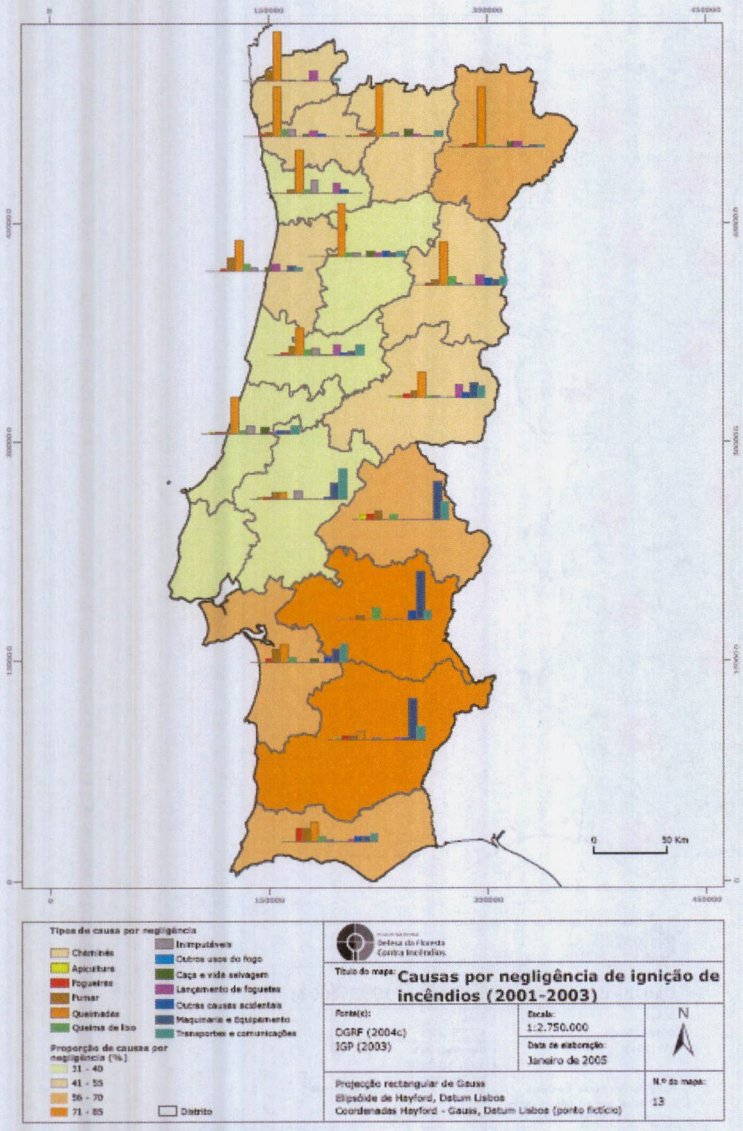
Even with these constraints, the global results can identify important regional differences on fires causes. For instance, the Southern districts of Alentejo have a high percentage of forest fires due to negligent activities (Setúbal 68%, Évora 78%, Beja 77% e Faro 70%), while the northern districts have a higher expression on arson/deliberate causes, especially the littoral (more urban) districts (Fig. 129, APIF/ISA, 2005).



Fonte: APIF/ISA, 2005A

Figure 129: Forest fires causes in Portugal (1993-2003) – district analysis

Looking at the causes derived from negligent usage of fire and accidents, there is a significant variability between North and South. In the North and Central regions of Portugal the usage of fire for pasture renewal (queimadas) is the main concern. There are also some other important causes, such as fire works on summer festivals, especially in the North-western region. In the South (below Tagus river), there is a predominance for forest fires ignitions starting in the crops harvesting activities (Fig. 130, APIF/ISA, 2005).



Fonte: APIF/ISA, 2005A

Figure 130: Negligent usage of fire and accidents (2001-2003) – district analysis.

Among the deliberate causes, the regional distribution is more homogeneous. With the exception of the Alentejo region (hunting conflicts), this type of causes still has an important lack of critical information on the motivation behind the fire ignition. There fore, the ignitions associated to vandalism acts (pleasure in destruction) assume an important role in the fire causes statistics.

Case study: Forest Focus - Project 2004.PO.C1.05
Project objective:
Use the results obtained with the fire cause origin investigation as a source of information for the **definition of prevention strategies**, namely for public awareness campaigns, and therefore contribute to decrease the number of ignitions and the burned area.

Analysis information:
Period: 1st July 2004 – 31st December 2005 (Fig. 131)
Data: 2.150 fire origin investigations (National Forest Guards Corp)

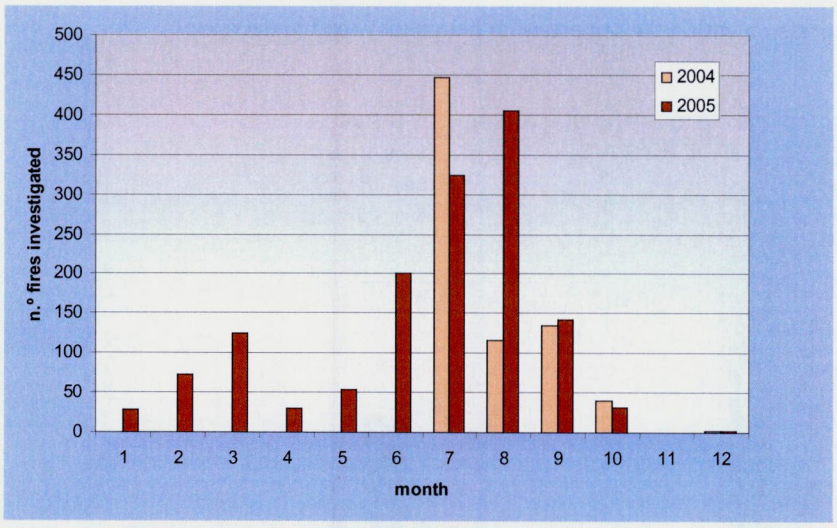


Figure 131: Monthly evolution of the forest fire investigated

Regional expression based in the NUTS II (Fig. 132)
- Significant differences among regions;
- Most of the criminal investigations took place in the Central and Northern regions of Portugal (North of Tagus river);
- Arson with high expression in all the regions, except for Alentejo. The higher expression of this phenomenon occurs in Lisboa Metropolitan region (urban municipalities);
- Negligent usage of fire with more expression in the North, due to traditional agricultural practices (specially for pasture renewal on the mountainous areas);
- Accidental causes in Alentejo, most related to crops harvesting machinery;
- Algarve with specific characteristics in the Southern context.

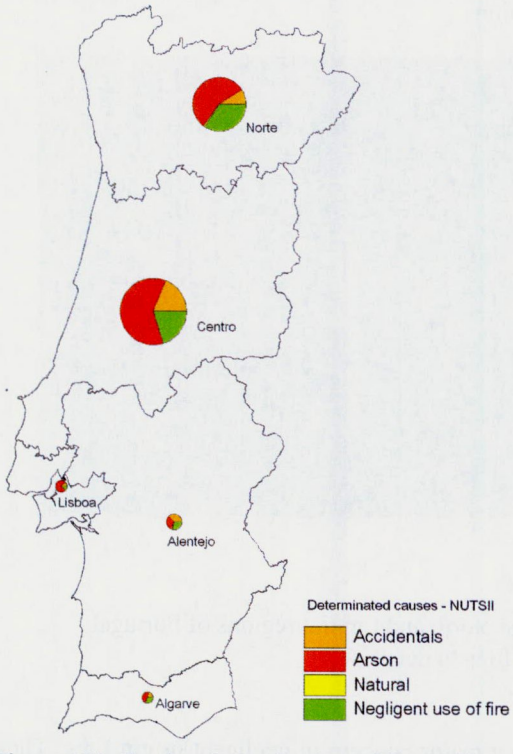


Figure 132: Regional distribution of forest fires causes (NUTSII)

Seasonal expression based in semesters period (Fig. 133)
- **Negligence** has more expression in the 1st Semester
- **Arsons** fires trend to increase during the 2nd Semester, with a peak in August
- **Natural** fires (lightning) usually are limited in Portugal.

- **Unknown** fires have a similar expression within the semesters, although they tend to decrease.

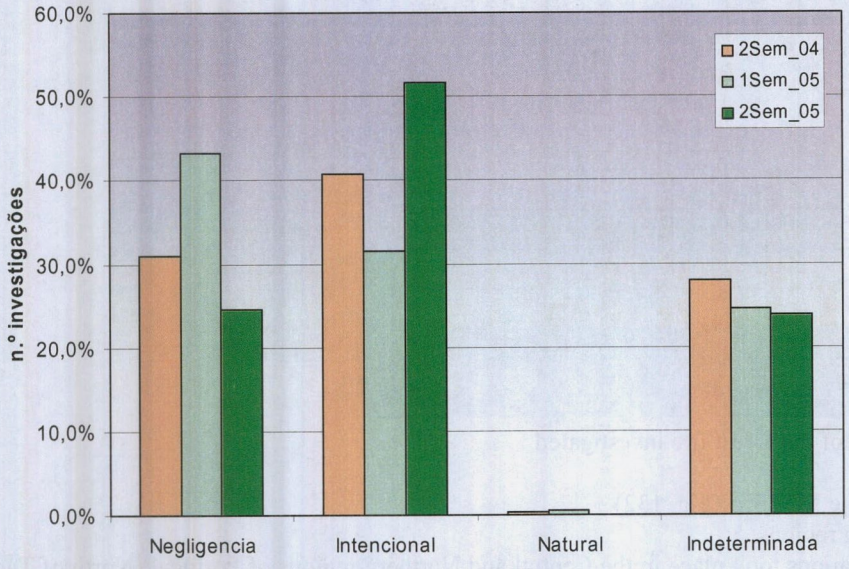


Figure 133: Seasonal expression of the main causes

Cluster analysis to negligent fires (Fig. 134)
- **Pasture renewal** is the most important cause – **27%**
- **Agricultural and forest debris burns** are another important concern – **20%**
- **Machinery and agro-forestry equipment** are the main origin of accidental fires, with a higher expression in the South of the country.
- **Unknow causes**

(Other accidents and other burns) need to gather better information.

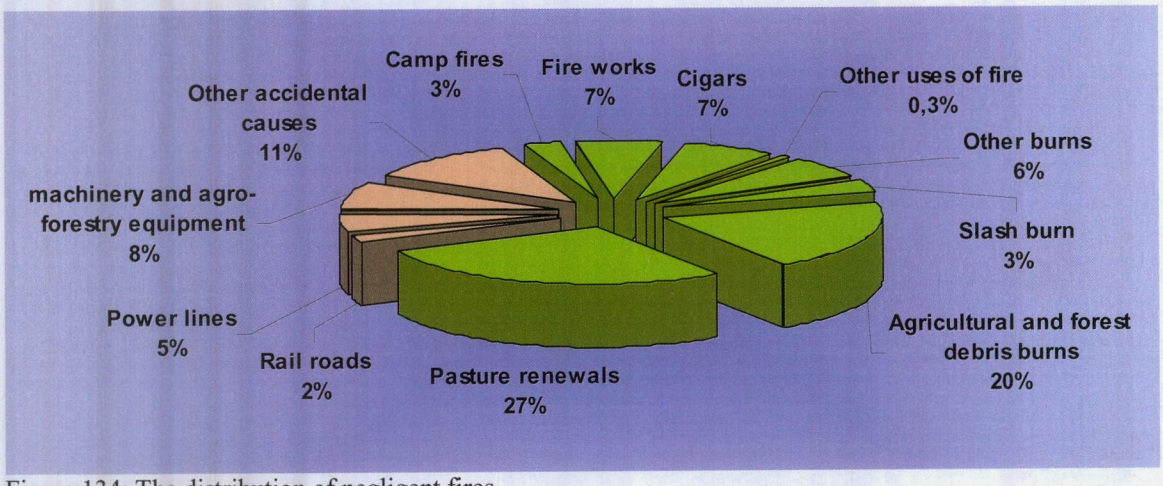


Figure 134: The distribution of negligent fires

Main conclusions:
- 90% of the fire occurrences and investigations took place in the North and Central regions of Portugal;
- Deliberate fires trend to increase and accidental or negligence fires to decrease;
- There are significant differences among regions;
- There are significant differences along the year;
- **Pasture renewal** and **agriculture + forest debris burns** are a major concern in negligent origin fires. These are traditional practices in the rural areas.

Information on the type of database

Since 2005, all the data on natural and other disasters and interventions are gathered in a single place. Since 2005, the Slovenia Forest Service, too, has been entering detailed information on forest fires into this system (the first registration of an event is made by operator in the regional information centre and is subsequently supplemented by the intervention coordinator, the participating units and other participating organisations interested in this information), and does not keep its own forest fire database. Here it adjusts its forest fire classification to ISRIA. In internal reports on forest in Slovenia, however, it still uses its own classification of the causes of forest fires. Prior to 2005, the Slovenia Forest Service had been entering the data on forest fires (as well as on their causes) into its own database, which is available for the 1995-2004 period, while during the 2001-2004 period the Forest Service developed it within the Forest Focus project.

At the moment, both classification schemes are in the phase of reform, in which the Slovenia Forest Service and the Administration of the Republic of Slovenia for Civil Protection and Disaster Relief are participating side by side. Namely, these two institutions have made an agreement to standardise the two classifications, but at the same time consented that these changes should be made in such a way that the possibility of temporal series of data processing would be in no way lost.

Statistics on fire causes

Figure 135 shows that in Slovenia, between 1997 and 2008, the largest burned areas were the consequence of fires due mainly to transport and communication but also to agricultural activities especially in 1999, 2000, 2003 and 2005.

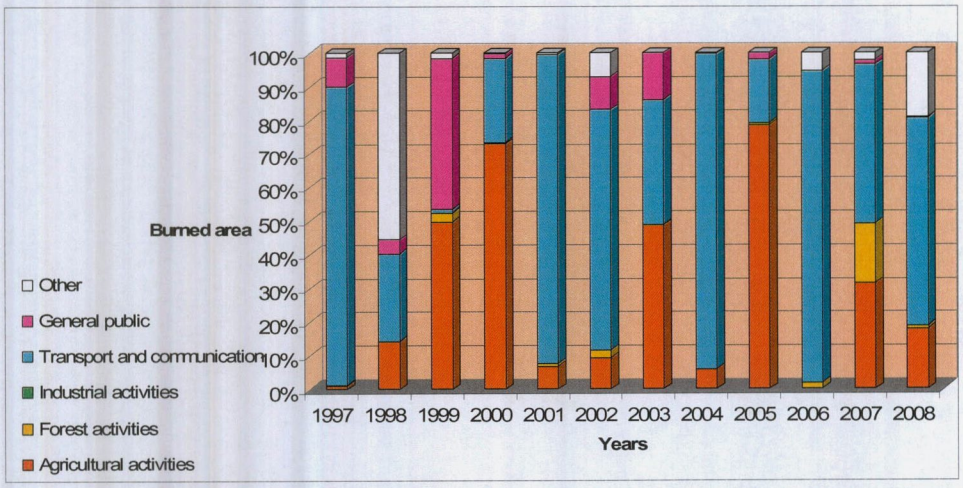


Figure 135: Distribution of the percentage of burned area due to negligence in Slovenia from 1997 to 2008 *(Source: Slovenia Forest Services).*

SPAIN

Information on the type of database

From its beginnings to the present, the data collection questionnaire has experienced several modifications in order to adapt it to the needs arising from the evolution of the forest fire phenomenon, and from the means used in detecting and extinguishing forest fires. Changes have also been made in data storage and processing support so as to adapt it to computer advances. Most relevant dates are showed below:

- **1968** – Creation of the Forest Fire Data Base (BDIF) by the Forests, Hunting and River Fishing General Directorate.
- **1971** – Competences on forest fires were transferred to the National Institute for Nature Conservation, created this very year.
- **1984** - Competences on forest fire were transferred to the Autonomous Communities
- **1989** – BDIF was replaced by EGIF (General Forest Fire Statistics) and introduction of new a record in Wild Fire Reports: Motivation.
- **1998** – New fire causes were introduced into EGIF, Reproduction From a Previous Fire and Type of cause – True/Supposed
- **2004** – Introduction of a new section, Natural Protected Areas,

Information on the types of fires recorded in the database

The data collection and processing system currently works in the following way:

- The Fire Officer of each fire is the person responsible for completing the Wild Fire Report form and submitting it to the office in charge of its coding and recording. It is necessary to complete a form for all fires that affect a forest area, even if the fire covers only a few square meters. The data that the Fire Officer is unable to fill out is completed in the office with his/her own data and that provided by organizations and administrations that have intervened in the incident.
- In the office, there is a program designed for processing Forest Fire Reports.
- Once the Central Administration has received the files, they are subject to a change in format and a review to correct possible logical errors, incorporating new information if necessary and possible. The final databases are returned to the Autonomous Centre so that both administrations have identical data available to them.
- The final data of the annual national total is submitted to the European Commission to incorporate the data into the EU Databases.

The Wild Fire Report questionnaire consists of two file models, one of which collects the General Fire Data and the other collects the Specific Data regarding each area of woodland affected. Both models are related by a single Report Number that corresponds to each individual incidence. Each fire has as a minimum one file of each model, though many Specific Data files may exist for each General Data file.

Information on the causes recorded

Table 10 presents the detail of the fire causes recorded in Spain.

Table 10: Groups and types of causes recorded in Spain

FIRE CAUSE			
Group of causes	Type of cause	Cause	DB Code
Lightning Fires caused by lightning strikes. In this case the number of days since the storm which caused the lightning shall be reported			100
Negligence and accidental causes Fires due negligent causes are ever considered when I) the fire cause is due to careless and II) the fire is not intentionally spreaded into the forest	**Agricultural burning:** Forest fires due to the burning of agricultural wastes as stubbles, pruning rests, etc. which became uncontrolled. As the fire is not due to deliberated cause, the author(s) remain in the burned area	Fires set for agricultural purposes, not specified.	210
		Stubbs burning	211
		Burning of pruning derbies	212
		Fires on the boundaries of farms or plots	213
		Fires in the edges of irrigation ditches	214
		Other fires set for agricultural purposes	215
	Pasture regeneration burning: Fires set for burning grasses and bushes with the intention to facilitate pasture regeneration which became uncontrolled affecting other forested areas. As the fire is not due to deliberated cause, the people who started the fire remain in the burned area	Firis set for pasture regeneration, not specified	220
		Bush Burning	221
		Burning of herbaceous	222
		Other fires set for pasture regeneration	223
	Forestry and forest management works Fires due to forestry works, such us burning of forestry wastes or terrain preparation, where fire escaped from control affecting forested areas		230
	Bonfires Fires due to uncontrolled, unattended or not-extinguished bonfires started by hikers, shepherds or farmers to get hot or cooking		240
	Smokers Fires caused by matches or cigarettes thrown by smokers while driving or hiking across forested areas		250
	Rubbish burning Fires due to urban waste burning out of waste disposal sites		260
	Escape from a dump: Fires due to urban or industrial waste burning started in authorized waste disposal sites and/or waste incinerator sites		270
Negligence and accidental causes Fires due negligent causes are ever considered when I) the fire cause is due to careless and II) the fire is not intentionally	**Bush burning** Fires caused by inadequate control practices during bush burning (i.e. burning of brambles, prickly spices or reedbeds)	Bush burning, not specified	280
		Bush burning near to buildings	281
		Bush burning with the purpose of clearing tracks and paths	282
		Bush burning to eliminate refuges of harmful fauna	283
		Bush burning with other purposes	284
	Other Other fires due to negligence causes not described before. In	Other negligence, not specified	290
		apicultural works	291

FIRE CAUSE			
Group of causes	**Type of cause**	**Cause**	**DB Code**
spreaded into the forest	this case the fire cause shall never be due to deliberate human action	fire works	292
		hot air balloon	293
		kid games	294
		burning of pruning rests from gardens	295
		Fires due other negligence cause	296
	Railway Forest fires due to sparks caused by trains.		310
	Electric lines Forest fires due to electric discharges form electric lines		320
	Engines and machinery Forest fires caused by sparks form engines used in forestry works or vehicles while crossing forested areas	Engines and machinery, not specified	330
		Harvesters	331
		Light or heavy weight vehicles	332
		Vehicle accident	333
		Fixed machinery	334
		Other type of machinery	335
	Army maneuvers Fires due to any of the actions carried out during army manoeuvres, such as shooting training		340
Intended When fires are intended (on purpose) the most probable motivation shall be reported. The identification of the person who started the fire is not needed in this stage.			400
Unknown cause Fires due to unknown or unidentified causes. Unknown cause is ever considered as True type cause instead of Supposed			500
Reproduction of a previous fire: Fires caused by the reproduction a previous fire. Reported since 1998			60

ES

Statistics on fire causes

Figure 136 presents the evolution of the number of fires and of the burned area from 1968 to 2008 in Spain. Since 1990 the number of fires has increased (over 15 000 fires) in contrast of the burned area (less than 200 000ha). A drop in the number of fires began in 2007. The proportions of woodland and non-woodland areas burned during the same period did not seem to vary, the proportion of non-woodland being slightly higher (Fig. 137).

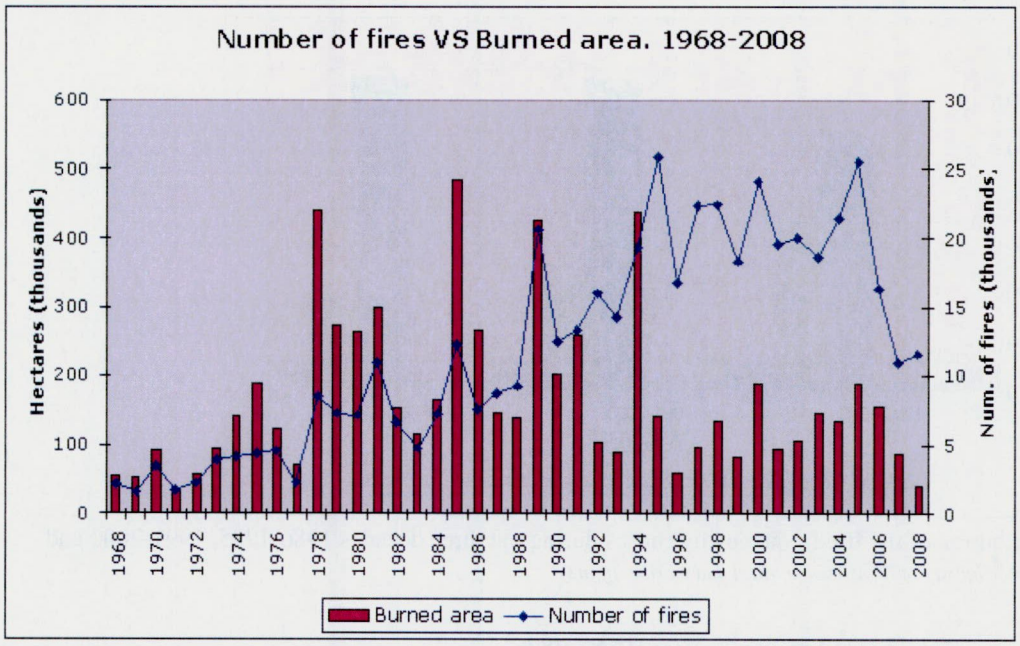


Figure 136: Variation of the number of fires and of the burned area in Spain from 1968 to 2008 *(Source: Ministry of Environment, rural and marine Affairs).*

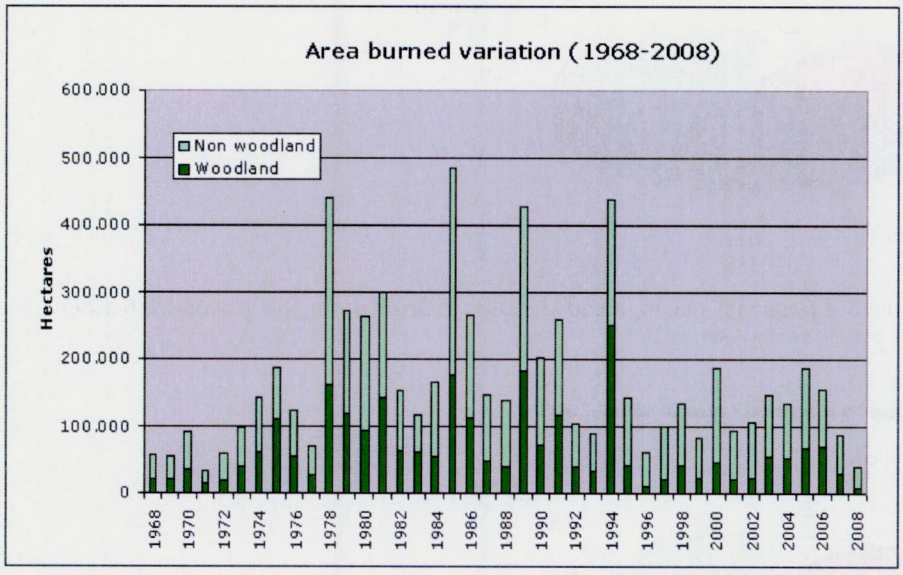


Figure 137: Variation of the proportion of woodland and non-woodland areas burned in Spain from1968 to 2008 *(Source: Ministry of Environment, rural and marine Affairs).*

The comparison of the fire frequencies by causes between three decades ranged from 1986 to 2005 shows an increase in the number of fires due to arson and intended causes and a decrease in the number of fires due to unknown causes. The proportion of fires due to negligence and to natural causes did not vary a lot (Fig. 138).

Figures 139 and 140 present the variation of the fire frequency according to the intended causes recorded in Spain between the periods 1986-1995 and 1996-2005. The variation was mainly due to an increase in the fire frequency due to agricultural burnings (from 31 to 43%) and to a decrease in the fire frequency due to pasture burnings (from 43 to 31%). The proportion of fires due to hunting and arson did not vary a lot.

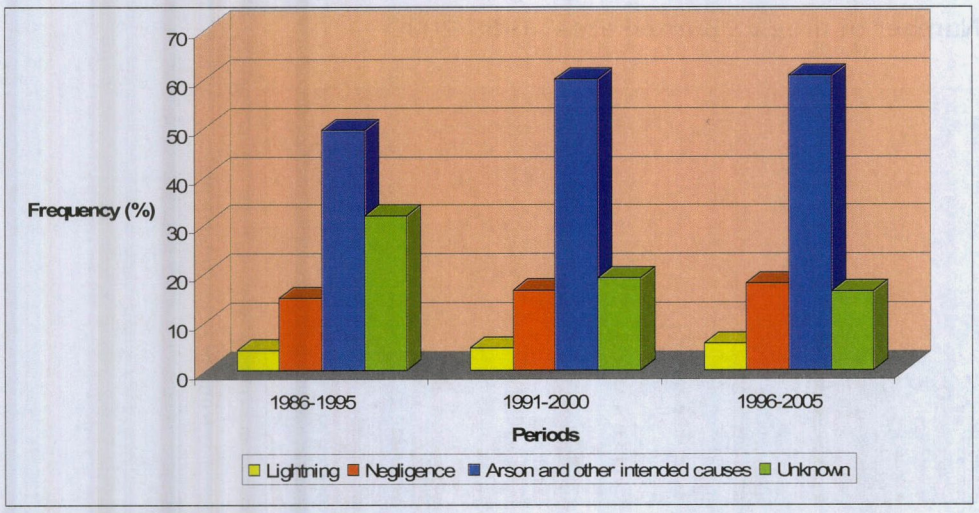


Figure 138: Distribution of the fire frequency by causes during the three decades 1986-1995, 1991-2000 and 1996-2005 *(Source: Ministry of Environment, rural and marine Affairs).*

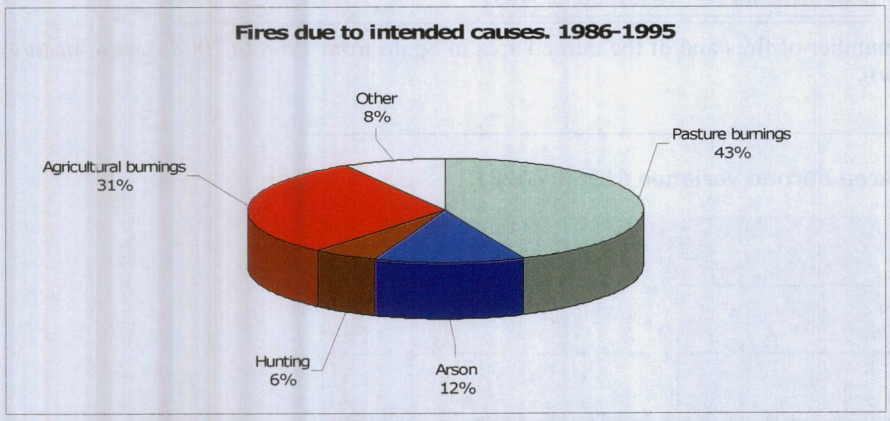


Figure 139: Break-down of the fire frequency due to intended causes in Spain during the period 1986-1995 *(Source: Ministry of Environment, rural and marine Affairs).*

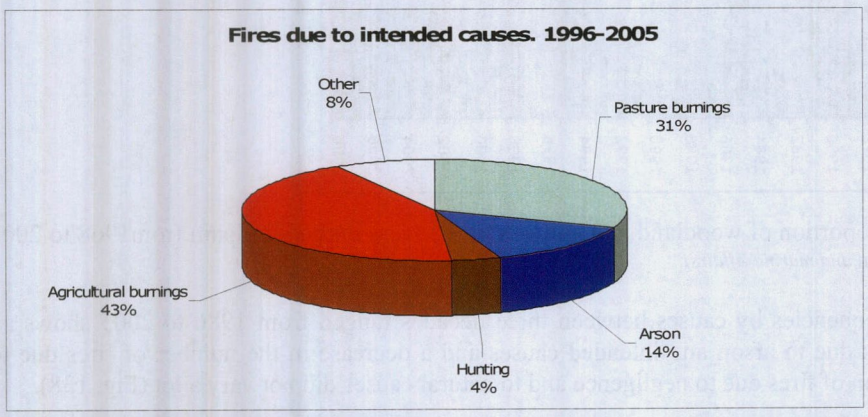


Figure 140: Break-down of the fire frequency due to intended causes in Spain during the period 1996-2005 *(Source: Ministry of Environment, rural and marine Affairs).*

Figure 141 presents the distribution of the fire frequency by causes for four geographical areas of Spain in 2005. The northwestern part of Spain presented the highest frequency of fires due to arson and other intended causes (more than 70%) and it was also the main cause in Canary Islands (40%). In the part of the country located in the Mediterranean area and in the Inner communities, negligence was the main cause of fires (35% and 39% respectively). Fires due to lightnings were the most frequent also in these same regions (around 10%).

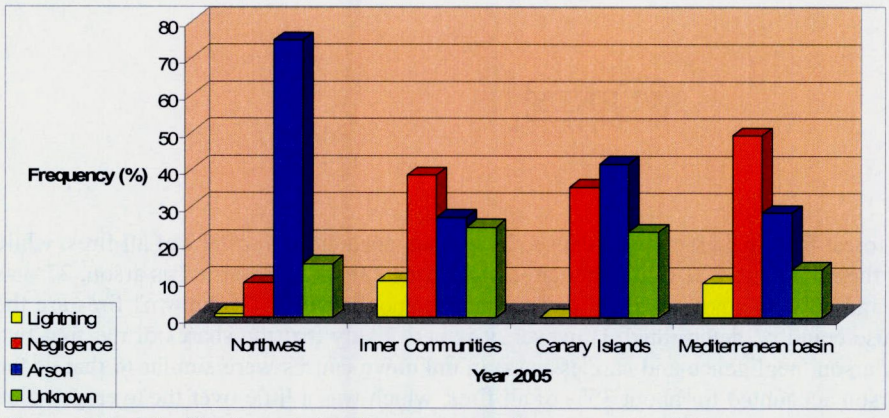


Figure 141: Distribution of the fire frequency by causes in different parts of Spain in 2005 *(Source: Ministry of Environment, rural and marine Affairs).*

TURKEY

Statistics on fire causes

Before 1997, the majority of forest fires in Turkey were caused by people, accounting for 98% of all fires, while lightning was responsible for the remaining 2%. Of the human-caused fires 23% was classified as arson, 27% as negligence and carelessness, and 50% as unknown (Mol and Kuçukosmanoglu 1997). "Unknown" fires are the fires for which no known cause could be determined. However, it is very likely that the shares of the first two categories of fire causes (i.e., arson, negligence and carelessness) in unknown causes were similar to that of the known causes. In this case, arson accounted for about 35% of all fires, which was a little over the average value (32 %) found in temperate forests of the northern hemisphere (Mol and Kuçukosmanoglu 1997).

Figure 142 shows the detail of fire frequency by causes between 1990 and 1997. Since 1995, the proportion of fires due to unknown cause has decreased (down to 28%) in contrast of the proportion of fires due to human causes (up to 66%). Natural causes were not important (less than 5%).

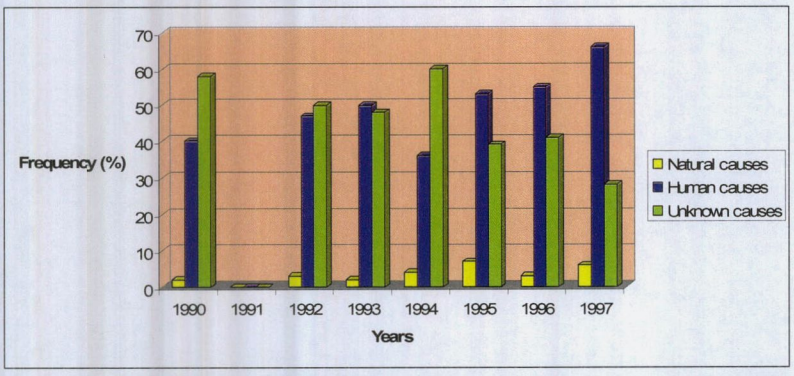


Figure 142: Distribution of the fire frequency by causes in Turkey from 1990 to 1997. No data available for 1991 *(Source: IFFN)*.

Break-downs of causes due to ignorance/negligence, to accident and to arson during the period 1997-2004 are presented in figures 143, 144 and 145. Agricultural burning, shepherds and cigarettes were the main causes of fire due to negligence, power line was by far the main accidental cause (70%) and pyromania was by far the main cause of arson (75%) during this period.

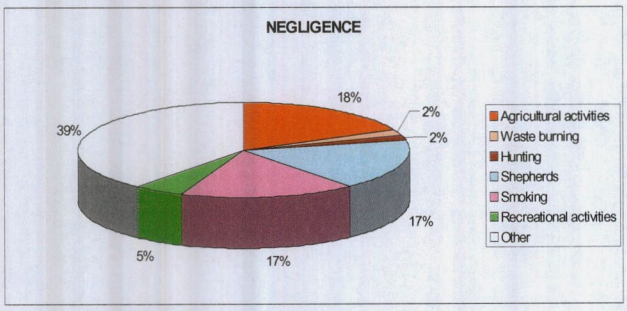


Figure 143: Break-down of fire causes due to negligence/ignorance in Turkey for the period 1997-2004 *(Source: IFFN)*.

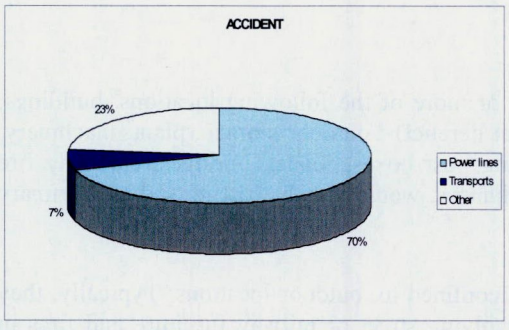


Figure 144: Break-down of fire causes due to accident in Turkey for the period 1997-2004 *(Source: IFFN)*.

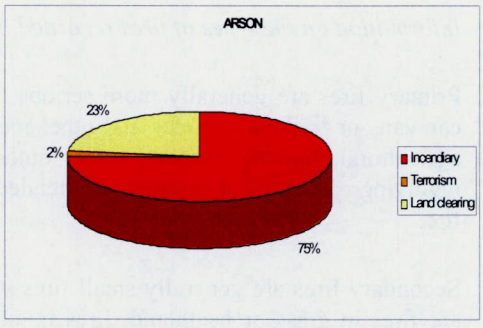


Figure 145: Break-down of fire causes due to arson in Turkey for the period 1997-2004 *(Source: IFFN)*.

The report of Colin and Veillon (1999) showed that there was a geographical variation of the fire causes. For instance, in Istanbul, the main cause of fire was arson (90%) instead of negligence.

UNITED KINGDOM

Information on the types of fires recorded in the database

Primary fires are generally more serious fires occurring in one or more of the following locations, buildings, caravans or trailers, vehicles and other methods of transport (not derelict) : outdoor storage, plant, machinery, agricultural, forestry property, other outdoor structures including post boxes, tunnels, bridges, etc. Any fire involving casualties or rescues, or attended by five or more appliances, would also be categorised as a primary fire.

Secondary fires are generally small fires which start in, and are confined to, outdoor locations. Typically, they are fires in grass or heathland, fires involving rubbish, fires involving street or railway furniture and fires in derelict buildings or vehicles. Aggregated basic information is collected for secondary fires, chimney fires and false fire alarms from the monthly summary provided by brigades. However, fires in secondary locations which involve casualties or rescues or which are attended by five or more appliances are reported in the same way as a primary location.

Information on the causes recorded

Fire cause is an important factor in understanding the different vectors for incidents and addressing the cause of the problem. UKVFS use five types of Data Fields to define Fire Cause being; 'Fire Cause', 'Cause by or action', 'Contributing Factors', 'Place where fire started' and 'Item first ignited'. Table 11 gives the classification of fire causes used in UKVFS.

Statistics on fire causes

Outdoor fires (primary and secondary) totalled 337500 in 2006. Of these 153100 (45%) were refuse fires, 59200 (18%) were road vehicle fires and 92300 (27%) were grassland fires (including heathland and intentional straw and stubble burning). The remaining 32900 were in other outdoor locations. Deliberate fires include those where deliberate ignition was merely suspected and recorded by the fire and rescue service as "doubtful". Accidental fires include those where the cause was "not known" or "unspecified". The number of grassland and heathland fires is very dependent on weather conditions. In 2006, there were 92300 such fires recorded, 27% more than the previous year. Outdoor fires exhibit the strongest seasonal pattern mainly due to the effect of the weather on grassland fires. There was an average of 729 grassland fires per day in July 2006, compared with just 35 fires per day in December 2006 (Tab. 12).

Table 11: UKVFS fire causes classification.

No.	UKVFS – Fire Cause			
	Motive Category	Cause Type	Fire type relevance	
			Wildfire incidents	Prescribed Fire Operations
1	Deliberate	a. Incendiary device	✓	
		b. Prescribed burning operation	✓	✓
		c. Prescribed burning operation out of control	✓	✓
		d. Suppression fire out of control	✓	
		e. Heat sources and combustibles brought together deliberately	✓	
		h. Later found as arson	✓	
		i. Restart from previous fire	✓	
		j. Other	✓	
2	Accidental	a. Faulty leads to equipment or appliance	✓	
		b. Fault in equipment or appliance		
		c. Prescribed burning out of control	✓	✓
		d. Suppression fire out of control	✓	
		f. Burning out of control (i.e. Bonfire)	✓	
		g. Careless handling – due to sleep or unconsciousness	✓	
		h. Careless handling – due to careless disposal	✓	
		i. Careless handling – due to knocking over	✓	
		j. Combustible articles too close to heat source	✓	
		k. Person too close to heat source (or fire)	✓	
		l. Vehicle crash or collision		
		m Playing with fire (or heat source)	✓	
		n. Accumulation of flammable material	✓	
		o. Military training	✓	
		p. Natural Occurrences	✓	
		q. Restart for previous fire	✓	
		r. Overheating, unknown cause		
		s. Other	✓	
3	Not Known	a. Faulty leads to equipment or appliance	✓	
		b. Fault in equipment or appliance	✓	
		c. Prescribed burning out of control	✓	✓
		d. Suppression fire out of control	✓	
		f. Burning out of control (i.e. Bonfire)	✓	
		g. Careless handling – due to sleep or unconsciousness	✓	
		h. Careless handling – due to careless disposal	✓	
		i. Careless handling – due to knocking over	✓	
		j. Combustible articles too close to heat source	✓	
		k. Person too close to heat source (or fire)	✓	
		l. Vehicle crash or collision	✓	
		m Playing with fire (or heat source)	✓	
		n. Accumulation of flammable material	✓	
		o. Military training	✓	
		p. Natural Occurrences	✓	
		q. Restart for previous fire	✓	
		r. Overheating, unknown cause	✓	
		s. Other	✓	

Table 12: Primary and secondary outdoor fires by location 1996-2006[1] *(Source: Fire statistics UK 2006)*

United Kingdom					Fires (thousands)[2]
Year	Total[3]	Road vehicles	Grassland, etc (inc. intentional straw and stubble burning)	Refuse, etc (inc. derelict vehicles)	Other outdoor fires
1996	384.9	73.3	110.3	163.7	37.7
1997	330	71.5	68.7	157.1	32.7
1998	277.8	76	40.9	131.3	29.7
1999	336.6	90.1	62.5	150.2	33.7
2000	348.3	94.9	60.2	159.3	33.8
2001	417.9	102.2	73	203.4	39.4
2002[1]	401.3	101.2	65.7	196.1	38.3
2003[1]	503.8	92.8	152.7	215.2	43.2
2004	335.9	72.8	61.5	167.6	34
2005	327.6	65.2	72.4	159.2	30.7
2006	337.5	59.2	92.3	153.1	32.9

[1] Includes estimates for incidents not recorded in November 2002 and January and February 2003 during industrial action (see explanatory notes 3 and 4).
[2] Figures are rounded and the components do not necessarily sum to the independently rounded totals.
[3] With the exception of 2005 and quarter 1 of 2006, fire figures are based on sample data weighted to individual FRS totals.

➢ **Other European countries**

RUSSIAN FEDERATION

Statistics on fire causes

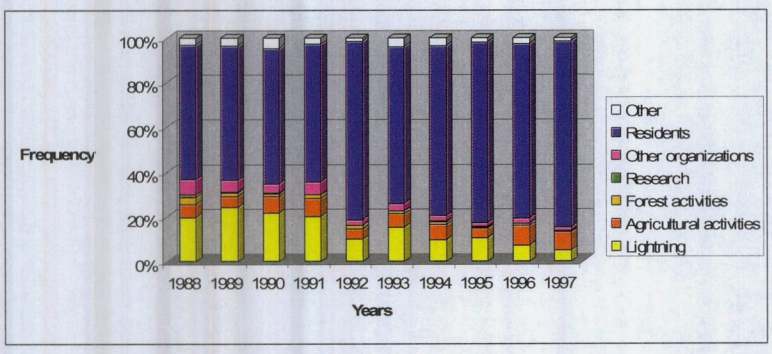


Figure 146: Distribution of fire frequency by causes in Russian federation from 1988 to 1997 *(Source: IFFN).*

Figure 146 shows that local population lighted 71% of the total fires during the period 1988-1997 and this proportion significantly increased after 1991. Natural causes were the second cause of fire during this period even if it decreased after 1991.

These results followed the same trend than Shetinsky's (1994) who found that the major ignition causes (as a percentage of the total number of fires) were local population 64.8%, lightning 16.0%, agricultural prescribed burning 7.3%, forest harvest activity 2.9%, expeditions 0.9%, activities of other enterprises 5.0% and unknown reasons 3.1%. The data did not include prescribed controlled burns on Forest Fund areas (which were negligible) and on "other lands" (for which no statistics exist; some expert estimates are given in Shvidenko *et al.*, 1995).

A geographical variation of the distribution of causes has been highlighted in Russia. Figure 147 shows that, in the Krasnoyarsk region, between 1981 and 1991, most fires were caused by humans. The share of lightning fires, however, was higher than in other regions of the world (>30%). It could be up to 90% in the Northern regions. It must be remembered, however, that these numbers were referring to the land under fire protection only. This means that the fires burning in the unprotected *taiga* and *tundra* regions were statistically not represented.

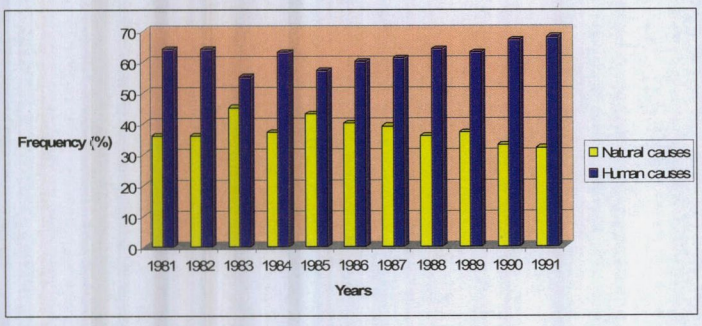


Figure 147: Distribution of the fire frequency by causes in the Krasnoyarsk Region (Central Siberia, Russia) from1981 to 1991 *(Source: IFFN).*

In 1998, in spite the stop of the traditional burning practices, most forest fires were human-caused, only 15% of the fires recorded in the Russian Federation were caused by lightnings (Korovin 1996).

➢ **Other countries in the world**

ALGERIA

Statistics on fire causes

The high percentages of the unknown origin fires and reduction of fires caused by negligence maybe due to:

- insufficient investigations to determine the real causes and to rigorously enforce sanctions;
- less intensive forest management
- lesser frequentation of the forest

However, the largest fires were caused by arson. This category represented 7.8% of all fire causes before the independence versus 0% after, but, actually, this category of causes after the Independance would be more important if investigations had been conducted more rigorously by the concerned services; this fact explaining the elevated percentage of unknown causes. It is noteworthy to mention lighting-caused fires. The share before the independence was 2.6% of the total number of fires whereas they were absent after the Independance would be more important if investigations had been conducted more rigorously by the concerned services, possibly due to a dryer climate.

The statistical data for the 15-year period from 1977 to 1991, in the Abou-Taleb region, also show the importance of the unknown origin of fires at a regional level. Unknown caused fires represented 82% of all cases; they consumed more than 409ha, equivalent to 94% of the burned area. The frequency of fires caused by negligence, mainly by smokers, was low in Bou-Taleb and represent only 6% of all cases.

Another underlying cause of fire was conflicts between residents and forest authorities. Those residents and forest owners who had been penalised by forest rangers due to violation of laws, such as illegal grazing or wood cutting, started fires as an act of revenge. This category of causes was hidden in category unknown and most likely represented a considerable part.

Information on the causes recorded

Table 13 presents the causes recorded on FIRES.

Table 13: Overall of the fire causes used on FIRES ***(Source: Davis 1997).***

Code	Description
1	Lightning
2	Exhaust, chainsaw
3	Exhaust, other
4	Snigging, hauling
5	Burning vehicle, machine
6	Pipe, cigarette, match
7	Campfire, barbecue
8	Burning off (Departmental prescribed)
9	Burning off, railway
10	Burning off, stubble, grass, scrub
11	Burning off, windrow, heap
12	Train
13	Deliberate lighting (malicious)
14	Waste disposal - domestic
15	Waste disposal - industrial, sawmill, tip
16	Power transmission
17	Burning house, stove, flue
18	Burning building
19	Fireworks
20	Relight -wildfire
21	Relight - prescribed fire
22	Relight - burning off
23	Other
24	Unknown
25	Not reported*

*The *Unknown* cause source code differs from the *Not reported* cause source code in that *Unknown* means that the cause of the fire was investigated, but no conclusive evidence indicated the cause of the fire. *Not reported* is for fires at which the cause was not investigated.

Statistics on fire causes

There is a geographical variation within the state of Victoria concerning the type of causes and the proportion of fires. Natural causes were the most frequent in Gippsland (40%) and deliberate lighting is the highest in Port Phillip (39%) (Tab. 14).

Table 14: Fire cause frequency showing significant deviations from the statewide averages for the period 1976-1996 *(Source: Davis 1997).*

Fire region	Total no. of fires	Avg. per season	Cause group	Percentage (%)	Deviation from Statewide avg(%)
North East	2669	133	Lightning strikes	33.3	+7.4
			Deliberate lighting	12.0	-9.4
North West	1954	98	Lightning strikes	13.6	-12.3
			Escapes - burning	11.3	-6.7
			Escapes - campfire, BBQ	19.7	+10.2
			Pipe, cigarette, match	15.6	+7.8
Gippsland	3023	151	Lightning strikes	40.2	+14.3
			Pipe, cigarette, match	3.3	-4.5
Port Phillip	1041	52	Lightning strikes	8.1	-17.8
			Deliberate lighting	39.0	+17.6
South West	2930	147	Lightning strikes	19.0	-6.9
			Escapes - burning	23.7	+5.7
Unreported	59	3	Lightning strikes	20.3	-5.6
			Escapes - burning	5.1	-12.9
			Pipe, cigarette, match	0.0	-7.8
			Unspecified	44.1	+38.2

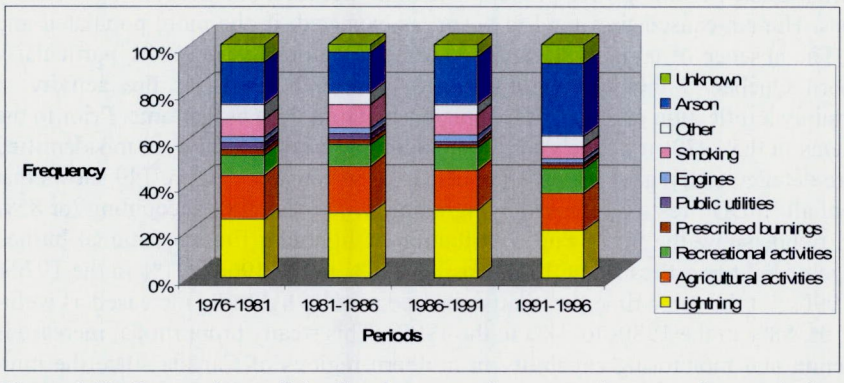


Figure 148: Comparison of the fire frequency by causes between four periods of time *(Source: Davis, 1997).*

When analyzed as four separate five-year periods in figure 148, a decrease in the proportion of fires due to lightning and an increase in the proportion of fires due to arson happened in the period 1991-1996. The proportion of fires due to negligence, especially to agricultural burning and recreational activities (hikers) remained the same over the whole period. There was a slight decrease of the frequency of fires due other negligence (cigarette, public utilities, etc).

Information on the causes recorded

Baxter *et al.* (2002) studied the causes of slash fires in Alberta. They identified four main causal factors of wildfires in the study, in order of significance:
1. *Lightning*. Alberta receives high numbers of lightning strikes each year. Any fire report involving slash with lightning listed as the specific cause was identified, meaning that, lightning ignited a fire that eventually involved slash fuels. Determining the occurrence of lightning actually striking and igniting top piles is from anecdotal evidence. A quick survey of personnel reporting piles ignited by lightning revealed no pattern in terms of pile location, either in the cutblock or on the landscape as a whole. It was initially assumed that piles struck by lightning would be located beside a stand or on a hilltop, but evidence showed the location of these pile fires was random.
2. Land clearing activities are a second causal group, and include activities such as land clearing for range improvement, garbage burning, slash/brush disposal burns and hazard reduction fires from forestry, oil and gas, railroads and public projects.
3. Man – Accident includes accidental fires caused by activities such as smoking, campfires (including cooking), and children playing with matches.
4. *Man – Intent* involves any fires where vandalism, arson, grudge or employment is suspected.

Statistics on fire causes

- In the Large Fire Dtabase:
The geographical distribution of lightning- and human-caused fires across Canada by decades is illustrated in Figure 149 using the Large Fire Data Base. Lightning fires predominate in all decades, and account for virtually all large fires in northern ecozones. Human-caused fires tend to occur, as expected, in the more populated and southerly regions of the country. The absence of large fires in some northern regions in the 1960s, particularly northwestern Ontario and northern Quebec/ Labrador, regions that exhibit high levels of fire activity in subsequent decades, is almost certainly a reflection of a lack of complete fire monitoring at that time. Prior to the advent of lightning detection systems in the 1970s it is likely that some lightning-caused fires were misidentified as fires caused by humans. A more detailed analysis of the baseline data used to construct Figure 149 shows that over the 1959–1997 period, 72% of all LFDB fires were caused by lightning, with these fires accounting for 85% of the total burned area. Decadal trends show the increasing contribution of lightning fires to national burned area over time, with the percentage of lightning fires in the LFDB rising - 53% in the 1960s, 71% in the 1970s, 78% in the 1980s to 86% in the 1990s. At the same time the relative burned area by lightning increased as well - 55% in the 1960s, 87% in the 1970s, 88% in the 1980s to 94% in the 1990s. This steady proportional increase is likely due to expanded fire detection and monitoring capability in northern regions of Canada since the mid-1970s, along with improved management of human-caused fires through prevention and aggressive initial attack (Stocks *et al.*, 2003).

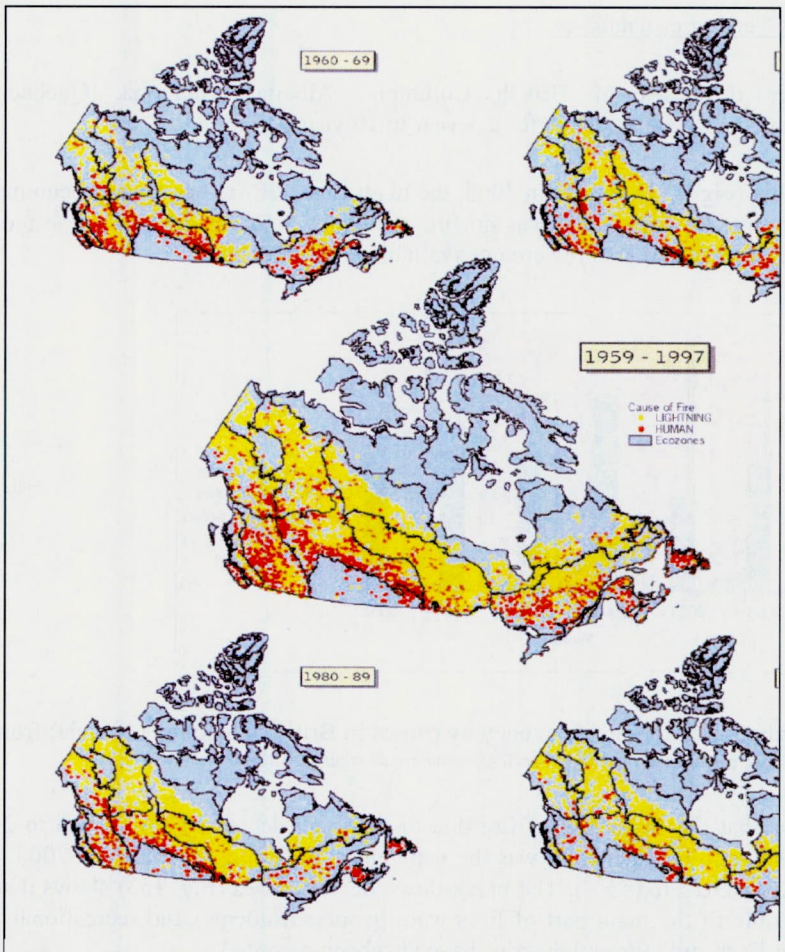


Figure 149 : LFDB lightning and human-caused fire distribution by decades in Canada *(Source: Stock et al., 2003)*.

In the work of Baxter *et al.* (2002), the fires were summarized by decade (Figure 150). The authors found that, while the percentages of negligence (Man accident) and arson (Man intent) fires decreased over the last two decades, the percentage of fires caused by land clearing activities increased. Lightning was the major cause of fires involving slash fuels, igniting an average of 35% of the fires involving slash since 1971. The data suggested that arsonists did not specifically target slash. Fire cause has been expanded to include fires resulting from equipment, including vehicles, heavy equipment, powerlines and flaring gas; piles, which includes re-piles and windrows; and Man (accident) which includes smoking, cooking and garbage fires. These data are from the 1983-89 period (Baxter *et al.*, 2002). If clearing and accident are merged in a same category Negligence/accident, it becomes the main cause of fires just behind the natural causes (lightning).

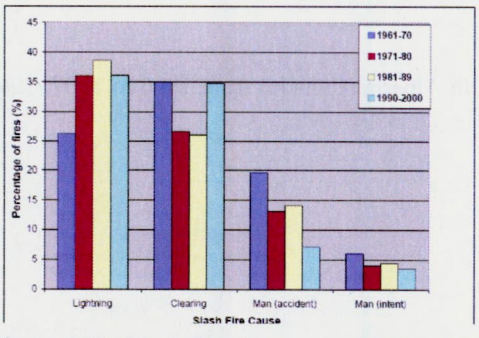


Figure 150 : Slash fires by cause and decade
(Source: Baxter et al., 2002)

- In the Provinces/Territories databases:

The forest fires databases of British Columbia, Alberta, Manitoba, Quebec, Nova Scotia and Labrador/Newfoundland were available for a 5-year to 10-year period.

In British Columbia (Fig. 151), except in 2005, the main cause of fire has always been natural (>50% and up to 70% in 2004). In this Province, there was no fire of unknown causes during this period but the details of the human causes (negligence and arson) were not available in this database.

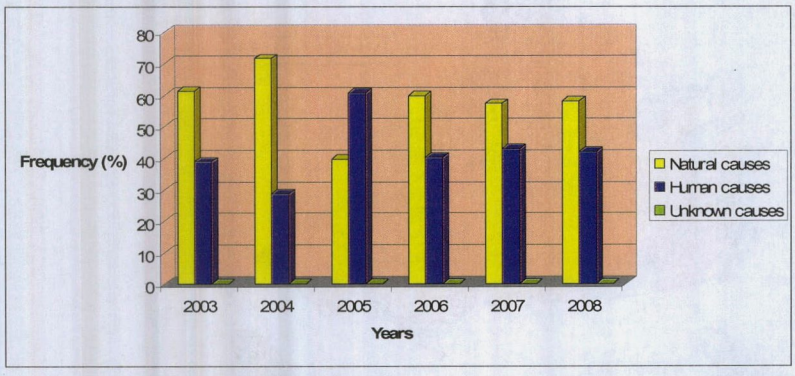


Figure 151: Distribution of the fire frequency by causes in British Columbia (Canada) from 2003 to 2008 *(Source: Ministry of natural Resources, Canadian Forest Services, www.nrcan-mcan.gc.ca).*

Figure 152 shows that the frequency of fire due to lightning decreased from 1996 to 2007 in contrast of the frequency of fires due to negligence. It was the main cause of fire in Alberta since 2003. Fires due to arson and of unknown causes were rare (<5%). The break-down of fire causes (Fig. 153) shows that, in Alberta, the types of causes responsible of the main part of fires were people (residents) and recreational activities. Since 2004, fires due to power lines and oil/gas industries have also been recorded.

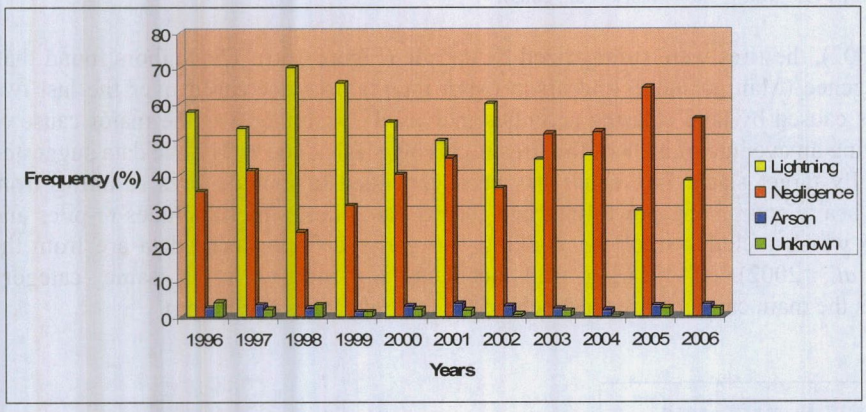


Figure 152: Distribution of the fire frequency by causes in Alberta (Canada) from 1996 to 2007 *(Source: Ministry of natural Resources, Canadian Forest Services, www.nrcan-mcan.gc.ca).*

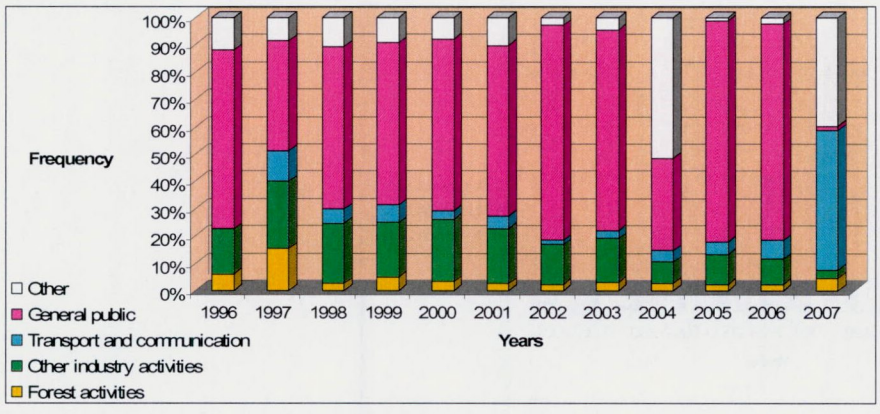


Figure 153: Distribution of the fire frequency by causes due to negligence in Alberta (Canada) from 1996 to 2007 *(Source: Ministry of natural Resources, Canadian Forest Services, www.nrcan-mcan.gc.ca).*

Figures 154 and 155 give the fire statistics recorded in Manitoba. In 2008, the main cause of fire was human (64%), the other fires being lighted by lightning (39%). All the fire causes were known (Fig. 154). During a 10-year period (from 1994 to 2004), the proportions of fires due to human and lightning (always over 30% and up to 60%) were close. Human were the main cause of fire from 1997 to 2000 and from 2002 to 2003 (Fig. 155).

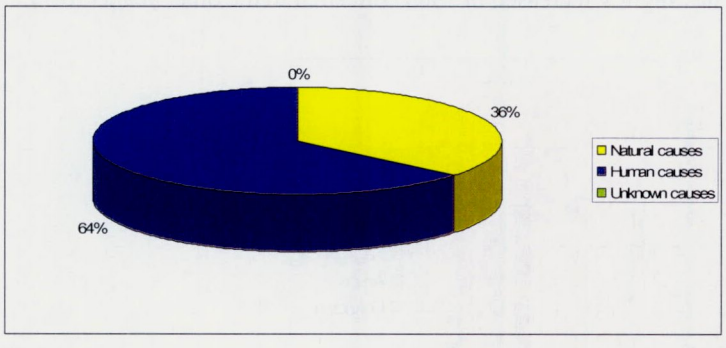


Figure 154: Break-down of fire causes in Manitoba (Canada) in 2008 *(Source: Ministry of natural Resources, Canadian Forest Services, www.nrcan-mcan.gc.ca).*

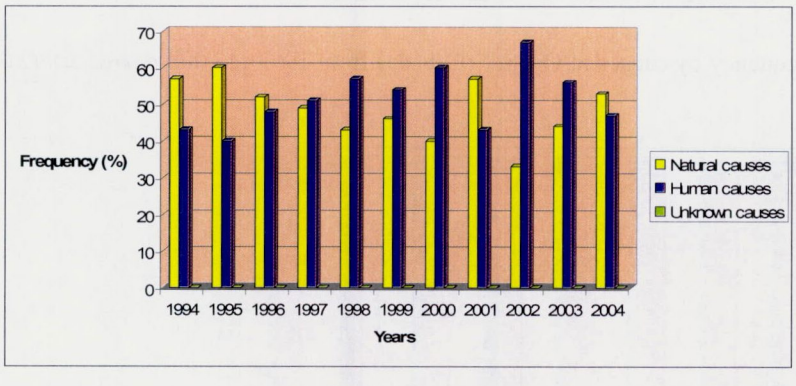


Figure 155: Distribution of the fire frequency by causes in Manitoba (Canada) from 1994 to 2004 *(Source: Ministry of natural Resources, Canadian Forest Services, www.nrcan-mcan.gc.ca).*

Concerning the percentage of burned area (Fig. 156) over this period, lightning was always responsible of the largest burned area (up to 100%), except in 1999 when human causes were as destructive as the natural causes.

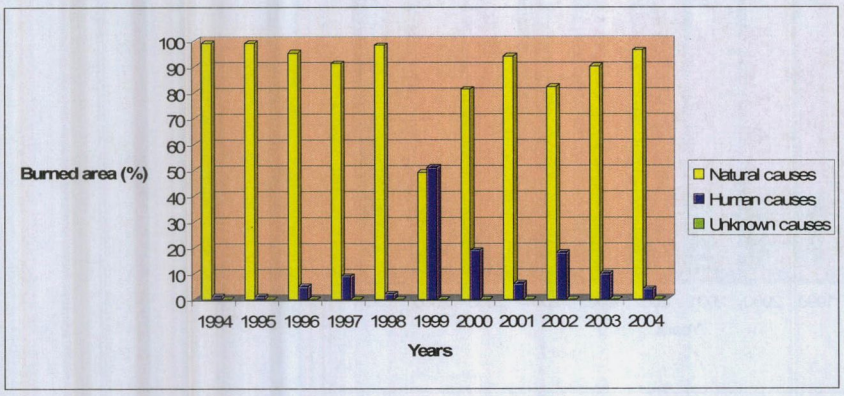


Figure 156: Distribution of the percentage of burned area by causes in Manitoba (Canada) from 1994 to 2004 *(Source: Ministry of natural Resources, Canadian Forest Services, www.nrcan-mcan.gc.ca).*

Figures 157 and 158 give the fire statistics recorded in Quebec. Figure 157 shows that, except in 2005 when lightning was the main cause of fire in Quebec (>50%), fires due to negligence/accident were the most frequent during the last decade, especially in 2004 and 2008 (>80%). There was no fire of unknown information on the causes recorded in this Province. The details of the types of causes due to negligence/accident are given in figure 158. Like in Alberta, fires lighted by the residents and recreational activities were the main causes of fires in Quebec. The proportion of fires due to arson has slightly increased in 2008 compared to the other years (10%).

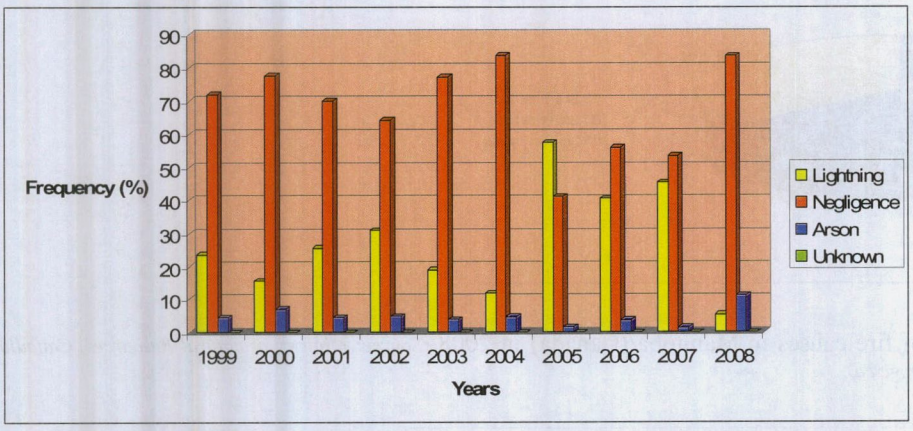


Figure 157: Distribution of the fire frequency by causes in Quebec (Canada) from 1999 to 2008 *(Source: SOPFEU, www.sopfeu.qc.ca).*

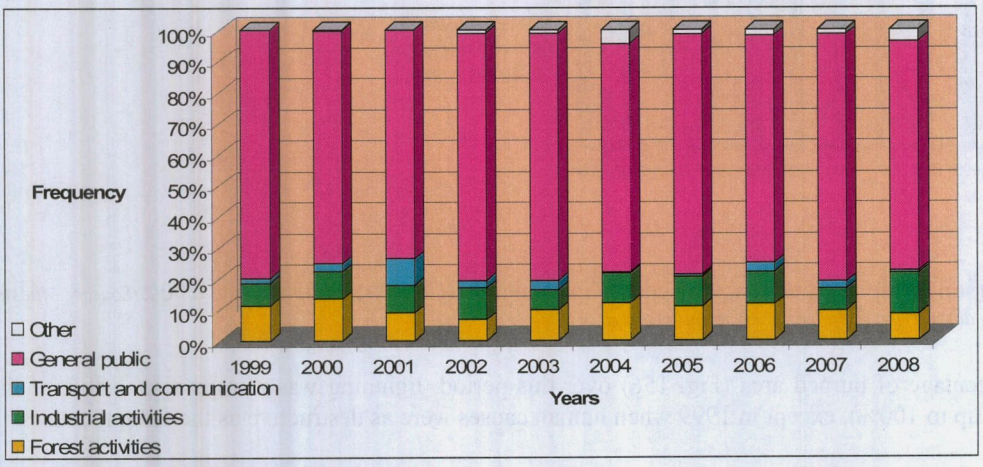


Figure 158: Distribution of the fire frequency by causes due to negligence in Quebec (Canada) from 1999 to 2008 *(Source: SOPFEU, www.sopfeu.qc.ca).*

The only fire statistics available for Nova Scotia concern the years 2006 and 2007. Figure 159 presents the distribution of fire causes in 2006 and 2007 in Nova Scotia, one of the Eastern Maritime Provinces. The proportion of fires due to natural causes was insignificant (0% in 2006). Fires due to arson and to negligence of general public (Fig. 160), mainly due to resident people, were by far the most frequent (>20% and >40% respectively).

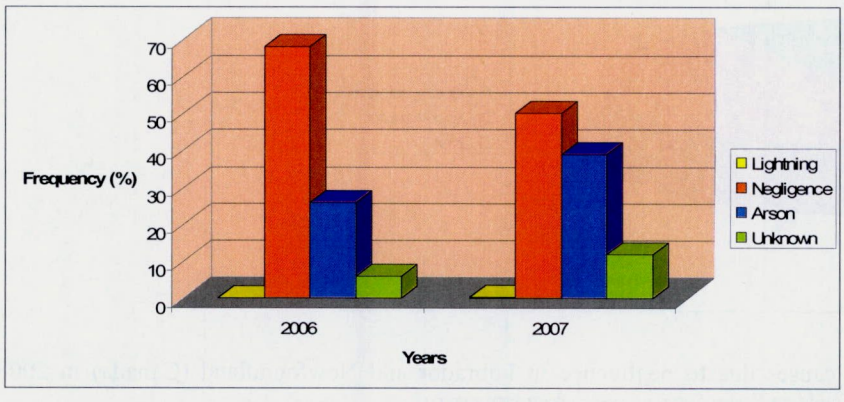


Figure 159: Distribution of the fire frequency by causes in Nova-Scotia (Canada) in 2006 and 2007 *(Source: Ministry of natural Resources, Canadian Forest Services, www.nrcan-mcan.gc.ca).*

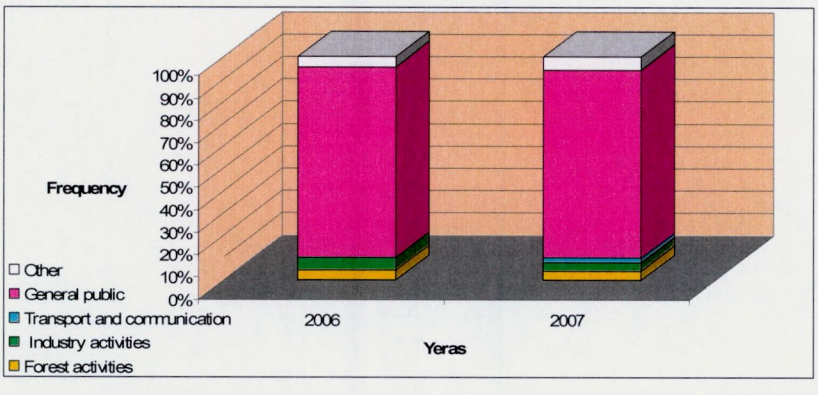


Figure 160: Distribution of the fire frequency by causes due to negligence in Nova Scotia (Canada) in 2006 and 2007 *(Source: Ministry of natural Resources, Canadian Forest Services, www.nrcan-mcan.gc.ca).*

The fire statistics of Labrador and Newfoundland concern only 2008. Compared to 2005 (Fig. 80), the proportion of fires due to lightning has strongly increased in Labrador and Newfoundland in 2008 (35%) as shown in figure 161. The main cause of fires in this Province was also negligence of general public, mainly due to resident people (Fig. 162). Arson was insignificant and there was no fire due to unknown causes.

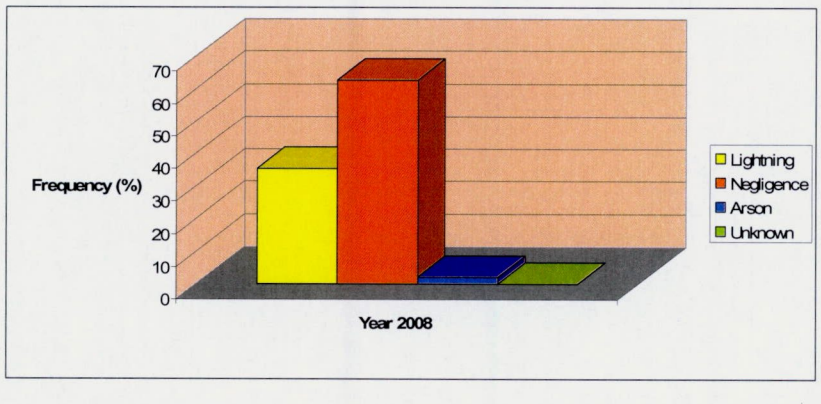


Figure 161: Distribution of the fire frequency by causes in Labrador and Newfoundland (Canada) in 2008 *(Source: Ministry of natural Resources, Canadian Forest Services, www.nrcan-mcan.gc.ca).*

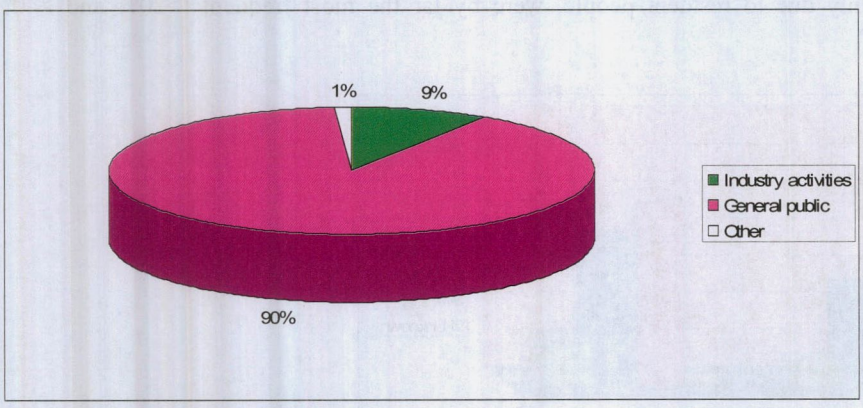


Figure 162: Break-down of fire causes due to negligence in Labrador and Newfoundland (Canada) in 2008 *(Source: Ministry of natural Resources, Canadian Forest Services, www.nrcan-mcan.gc.ca).*

SYRIA

Information on the causes recorded

Existing fire causes classification proposed by the Latakia Forestry Department during the period 1987-1998 shows some incongruity and inappropriateness; a better investigation and reporting system is required and a new fire classification as natural, accidental, culpable and arson is strongly suggested (Tab. 15).

Table 15: Fire causes recorded during the period 1987-1998 in the Latakia region (Syria)

Fire causes (1987-1998)	% of total (number of fires)	Comments
Unknown	40%	Most of "unknown" causes are verisimilarly related to human activity, but not properly investigated to determinate if accidental culpable or fraudulent. Better investigation and reporting are required. A so high percentage of unknown causes can very much change the results.
Agriculture	27%	Specify the activity. To distinguish between Accidental/Fraudulent activities could be useful.
Negligence	11%	The category negligence is worthless, because any fire could be so classified.
Arson	9%	Class as fraudulent causes
Forest Employees	7%	Specify the activity instead of class of people. To distinguish between Accidental/Fraudulent causes could be useful.
Power lines	2%	Class as accidental causes
Lightning	1%	Class as accidental causes
Equipment	1%	?
Tourist	1%	Specify the activity
Smoking	1%	Class as culpable cause

Statistics on fire causes

The reasons that explain the occurrence of fires are both related to weather conditions and to human presence throughout the territory. Natural causes of wildfires like lightning are very rare, occurring on average once per year and causing fire of limited extension (average of 4ha *vs* 30ha as average of fires extension caused by agriculture or negligence). According to data reported in (GCP/SYR/010/ITA) more than 90% of the annual fires are set directly by people and/or indirectly by their related activities. The known culpable causes of fire development are related to human presence throughout the territory. It seems that 27% of total fires are related to agricultural activities. Since the agricultural lands on the hilly areas are very often bordered by natural *maquis* and mixed-pine forests, the widespread of fire over the natural vegetation in the surroundings is immediate. Forestry Department information registers that the income generating activities of the local people are often one of the causes of forest fires, related to cropland maintenance activities which farmers perform according to their traditional agriculture techniques, like pruning, burning of stubbles and wood residues at the edges of the land property.

A further anthropogenic culpable cause of wildfire was the negligence of tourists and local people for who the forest is a recreational area (11%). In Latakia province about 140 picnic areas are potential fire ignition points. An increasingly important cause is the burning of large quantities of solid waste left by tourists and users of forested areas. The disposal of garbage by burning is often carried out in conditions of high fire risk, without taking the necessary precautions. Among the culpable cause, also abusive landfills represent a potential fire ignition point, lacking the control from the Local Administration. According to reports of fire events that occurred in past years, a relatively large number of fires were caused by arsonists and forest employers, (16% of total number of fires recorded in the period 1987-1998). It also seems to be a growing number of fires initiated by the auxiliary workers who are retained by national forest fire services during the critical summer months. These workers are better paid when they actually fight fires than when they are on standby.

It is finally recorded that from 1989 to 1998, more than 40% of fire causes were "unknown". This information should be better investigated, because most of "unknown" causes are very similarly related to human activity.

US

UNITED STATES OF AMERICA

Statistics on fire causes

No recent statistics on fire causes are available.

In 1994, humans caused the vast majority of the 45 to 50 000 wildfires in the 13 southern states each year, with about 40% of the total due to arson. Less than 10% were attributed to lightning although many more were caused by this source but were not included in the database because they were not reported, or went out without human intervention. Lightning generally caused more fires than humans during the summer with most of the acreage burned between late April and early June.

Figure 163 shows the distribution of fire causes according to the number of fires and the burned area on State lands in 1995. The highest proportions of fires and of burned area were due to negligence and arson but 19% of the burned area were also due to lightning despite the low frequency of fires due to natural causes.

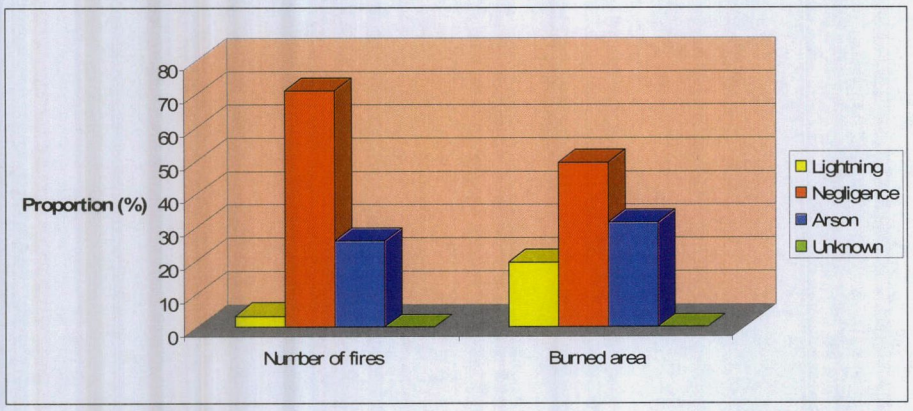


Figure 163: Distribution of fire causes according to the number of fires and to the burned area on American State lands in 1995 *(Source: IFFN).*

Regarding the types of causes due to negligence, agricultural burnings presented the highest values as well as for the fire frequency than for the burned area (Fig. 164).

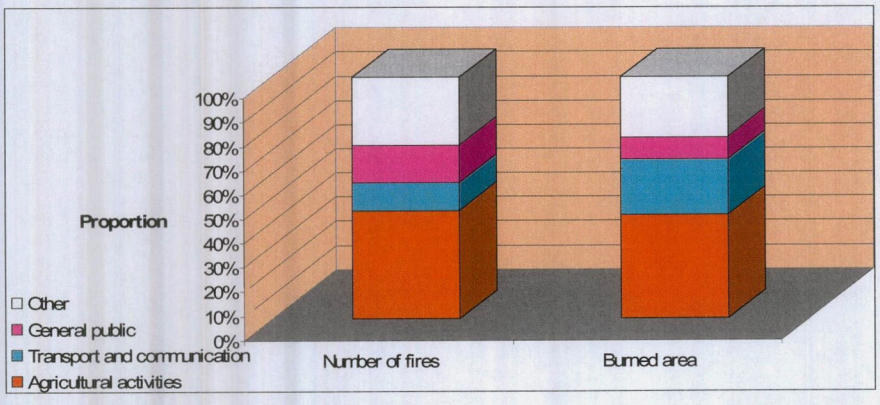


Figure 164: Proportions of fire causes due to negligence according to the number of fires and to the burned area on American State lands in 1995 *(Source: IFFN).*

Figure 165 shows the distribution of fire causes according to the number of fires and the burned area on Federal lands in 1995. One of the main causes of fire was lightning that also gave the largest part of the burned area. Most fires were due to negligence. Regarding the types of causes due to negligence, rail transport (transport and communication) and other types of causes presented the highest values as well as for the fire frequency than for the burned area (Fig. 166).

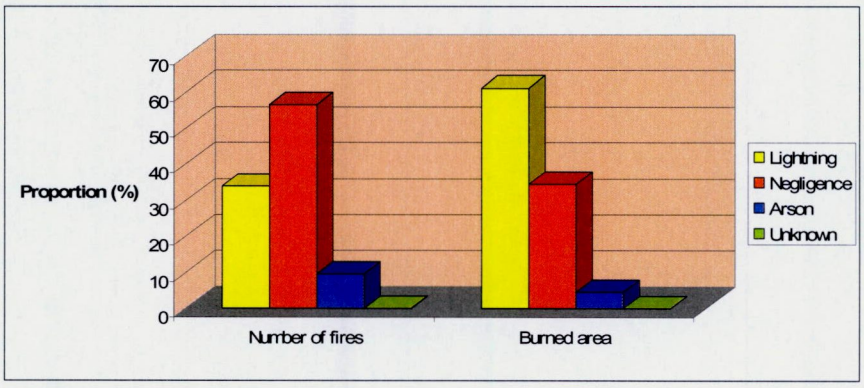


Figure 165: Distribution of fire causes according to the number of fires and to the burned area on American Federal lands in 1995 *(Source: IFFN).*

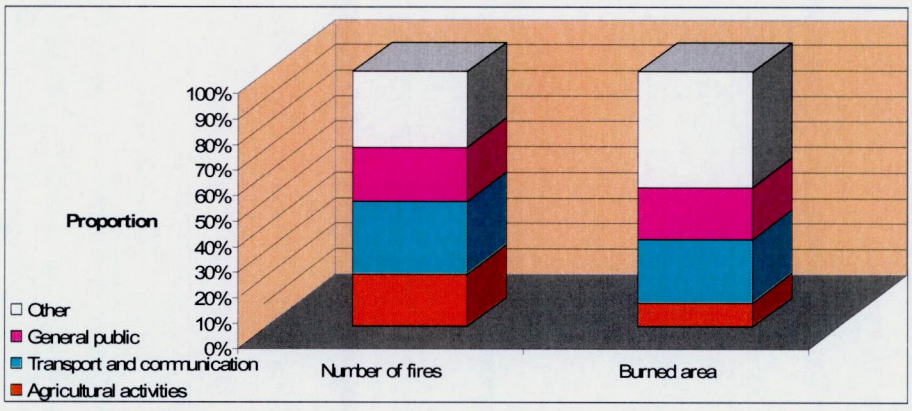


Figure 166: Proportions of fire causes due to negligence according to the number of fires and to the burned area on American Federal lands in 1995 *(Source: IFFN).*

Comparing the data collected in state lands and in federal lands, results showed that, in federal lands, lightning was the main cause of fire whereas arson and burnings were less frequent. Conversely, in state lands, arson and burnings were the main causes of fire.

Šifra projekta	Naslov projekta	Vodja proje	Financerji	SKUPAJ	Soizv.	2008 v EUR	DELITEV	2009 v EUR	DELITEV	2010 v EUR	DELITEV	2011 v EUR	DELITEV	SKUPAJ ARRS/MKGP	SKUPAJ GIS/BFG
V4-0521	Nove poti za razvoj trajnostnega PRL v RS	Mirko Medved	ARRS	40.000,00	GIS	15.000,00	15.000,00	16.000,00	14.400,00	9.000,00	8.100,00	0,00	0,00	37.500,00	90.000,00
					BF		0,00		1.600,00		900,00		0,00	2.500,00	
			MKGP	60.000,00	GIS	0,00	0,00	15.000,00	13.500,00	15.000,00	13.500,00	30.000,00	25.500,00	52.500,00	10.000,00
					BF		0,00		1.500,00		1.500,00		4.500,00	7.500,00	
			SKUPAJ	100.000,00		15.000,00	15.000,00	31.000,00	31.000,00	24.000,00	24.000,00	30.000,00	30.000,00	100.000,00	100.000,00
			SK.GIS	90.000,00			15.000,00		27.900,00		21.600,00		25.500,00		90.000,00
			Dogovor	14.1.2009	ARRS	%GIS	100		90		90		85		
					ARRS	%BFG	0		10		10		15		
					MKGP	%GIS	100		90		90		85		
					MKGP	%BFG	0		10		10		15		

Osnovni razrez GIS		**443**		908		772		747		**2870**
Medved		0				0		0		0
Robek		53		300		272		250		875
Klun				150		100		100		350
Kobler		0		150		100		147		397
Piškur				100		100		100		300
Krajnc				100		100		100		300
TP/MMI										
Sinjur*0,7				108		100		100		308
SKUPAJ		**53**		**908**		**772**		**797**		**2530**

Podpora 2010

	Posvet	Anketa	Ostalo
TP-ŠS		80	
TP	80	80	
Mmi	50	140	
IS*0,7	50	80	
MP	40	40	
NK	40	40	
RR	50	80	406
JK	50	80	
Skupaj	260	460	

Plan GIS s prenosi		**443**		**1269**		**1266**		**747**		
Medved		50		0		0		0		50
Robek		53		475		536		250		1314
Klun				100		130		100		330
Kobler				100		0		0		100
Piškur				50		80		50		180
Krajnc				50		80		50		180
TP/MMI				0		350		50		400
Sinjur*0,7				0		90		50		140
SKUPAJ		**103**		**775**		**1266**		**550**		**2694**

Realizacija GIS										
Medved		20		0		0		0		20
Robek		62		415		536		250		1263
Klun				60		130		100		290
Kobler				0		0		147		147
Piškur				70		80		100		250
Krajnc				70		80		100		250
TP/MMI				3		350		100		453
Sinjur*0,7				30		90		100		220
SKUPAJ		82		648		1266		897		2893
OSTANEK		**361**		**494**		**0**				