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Contents

The Forest Fire Net is a publication
of the European Center for Forest Fires,
focuses on organizations and people
in forest fires.
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Editor's Page

The second volume of FFNet serves as a forum for presenting the activities of the European Center for Forest Fires, as well as for pointing out a number of important items in the forest fires agenda.

In this volume a summary of the activities discussed during the ECFF inaugurating meeting, held in Athens on the 13th of October 2003, are presented.

What are the “lessons learned” from the large scale forest fires in summer 2003 in Europe? That question was addressed to participants of the workshop, which took place in October 2003 in Athens. Speakers presented their views and proposed actions to be taken. You will find most of the works presented in the workshop, in this volume of FFNet.

There is also an article on air quality during forest fires and the health impact of smoke on fire-fighters and the exposed population. This article, attempts to answer questions such as: what are the components of forest fire smoke, which components may have health impacts, what are the short- term and long - term impacts, what are the health impacts in the fire front and what in long distance.

Forest fires, is the main topic of Institutes and Universities in many countries. A brief presentation of the State Key Laboratory of Fire Science of China is the topic of Organizations Profile of this volume.

Milt Statheropoulos

People

ECFF operates within the framework of the EUR-OPA Major Hazards Agreement of Council of Europe, ratified by the Greek Law 2031/92. The Center is Associated to the Network of European Centers of the Agreement with a view to definitive status as European Center of the Agreement within a period of two years commenced on July 2002.

ECFF is accommodated and run at the headquarters of the General Secretariat for Civil Protection in Athens, which provides the Center with secretarial support.

The Center is administrated by an Administration Committee and supported scientifically by a Scientific Committee. Both the Administration and Scientific Committees are appointed by the Government of the Hellenic Republic on the basis of proposals put forward by the Council of Europe. The present Committees were appointed by the Minister of Interior, Public Administration and Decentralization (Ministerial Decision 1324/9-4-2003).

The President of the Administration Committee is Dr M. Statheropoulos, Chemical Engineer, Associate Professor in the National Technical University of Athens.

The members of the Administration Committee are:

- Dr Galanopoulos, D., Physicist-Geophysicist, National Permanent Correspondent of Greece to the EUR-OPA Major Hazards Agreement, General Secretariat for Civil Protection / Ministry of Interior, Public Administration and Decentralization
- Brigadier Honianakis, A., Direction of Forest Fires, Fire Brigade, Greece
- Mr Kuvshinov, V., First Deputy Director, EMERCOM of Russia, Russian Federation
- Dr Massue, J.P., Nuclear Physicist, Executive Secretary of the EUR-OPA Major Hazards Agreement, Council of Europe
- M. Michaut, P., Charge de mission a la Direction de la Dιfense et de la Sιcuritι Civiles, Ministθre de l'Intιrieure, de la Sιcuritι Intιrieure et des Libertιs Locales, France
- Mr Vardakis, G. Forester, Ministry of Agriculture, Greece

The members of the Scientific Committee are:

- Dr Arianoutsou-Faragitaki, M., Biologist, Associate Professor, National and Kapodistrian University of Athens, Greece
- Dr Alexandris, D., Physicist-Meteorologist, Deputy National Permanent Correspondent of Greece to the EUR-OPA Major Hazards Agreement, General Secretariat for Civil Protection / Ministry of Interior, Public Administration and Decentralization
- Dr Balatsos, P., Forester, Ministry of Agriculture, Greece
- Colonel Bodino, P., Etat-major de zone sud, CIRCOSC de Valabre, France
- Mr Chrysiliou, C., Forest Fires Specialist, Civil Defense, Cyprus
- Dr Dimitrakopoulos, A., Forester, Assistant Professor, Aristotelian University of Thessaloniki, Greece
- Fire Lieutenant Labris, C., Forester, Direction of Forest Fires Fighting, Fire Brigade, Greece
- Dr Gitas, I., Forester, Remote Sensing and Space Applications, Mediterranean Agronomic Institute of Chania, Greece*****
- Dr Kalabokidis, C., Forester, Assistant Professor, University of the Aegean, Greece
- Mr Lahore, J.P., Director of International Relations, Permanent Correspondent of Spain to the EUR-OPA Major Hazards Agreement, Civil protection, Spain
- Dr Lourenco, L.F., Natural hazards and forest fires expert, Associate Professor, University of Coimbra, Portugal
- Dr San Miguel-Ayanz, J., Forester, Remote Sensing and Space Applications, Institute for Environment and Sustainability, DG JRC, European Commission
- Dr Statheropoulos, M., Chemical Engineer, Associate Professor, National Technical University of Athens
- Mr Stoimenov, A., Head of Department Training of Management Bodies, Forces and Public, State Agency for Civil Protection, Bulgaria
- Mr Theodorou, F., Forester, General Secretariat for Civil Protection / Ministry of Interior, Public Administration and Decentralization
- Mr Veselov, I., Deputy Head of the Department for Emergencies Prevention and Liquidation, EMERCOM of Russia, Russian Federation
- Dr Xanthopoulos, G., Forester, Researcher, National Agricultural Research Foundation, Greece.

Activities of the ECFF

What are the activities, which ECFF needs to focus? That question was addressed to the administration committee during the inaugurating meeting which took place in Athens on the 13th of October 2003. The members of the administration committee outlined their views and prepared a report that put the framework of the possible actions. A summary of this report is presented in the follow:

Legal Status of coping with forest fires in Europe

A Study is needed on the legal framework of the European countries regarding forest fire management in all phases (prevention, suppression and reforestation), in order to define similarities and differences, with the potential of compatible methods, practices and policies. The main aim is to facilitate the cooperation between the member states, as well as to reinforce assistance exchange.

Compatibility of equipment and tools

A study on the technical procedures, equipment and tools so as to examine compatibility and communication issues, has to be done. Also, a study on the existing training methods and operational techniques to select the most effective and best practices has to be carried out.

Data base of means and human resources

The recording and documenting of the number and types of ground and aerial means, as well as of the human resources, provided types and quantities of retardants is needed, in order to develop a complete data-base, which will be frequently updated in the future.

Master Diplomas in Forest Fires

More discussion is needed on how the AECFF could provide official Master Diplomas in specialized forest fire issues.

Specialized medical units for severely burned

A study on medical treatment of severely burned people in case of a large –scale forest fires should be done. Registry of the specialized medical units in Europe and possible net-working of hospitals is needed for that reason.

Web-page of the center

Further work on the AECFF web-page construction and its target audience is needed.

Proposals

Support of an Interreg project on forest fire management in Islands e.g Sicily, Malta, Cyprus, Corsica, Greek islands is proposed. The difficulties in dispatching means and men, due to the topography of the islands, as well as difficulties in reforestation activities, are the basis for such a project.

Health impact of forest fire smoke

A study on the health impact of smoke, due to a large scale forest fire, on the exposed population (firemen and civilians), needs to be carried out. More research is needed to be done on the hazardous emissions (Permanent gases, Volatile Organic Compounds, Particulate Matter). Field analysis of the evolved products could create first response safety measures for firemen, according to permissible exposure limits given by OSHA. Epidemiological issues should also be examined.

News

- The EurOPA representative J.M. Goerens will visit Athens between 8 and 12 of December 2004, in order to discuss on the activities carried out by the Center.
- The second annual meeting of the administration and scientific committee of the European Center of Forest Fires is planned to take place during spring of 2005.

Lessons learned from forest fires of 2003

Lessons learned from forest fires of summer 2003 in Europe

ECFF organized a workshop on “European Planning and Policies for Forest Fires”, on the 14th of October 2003, in Athens. The workshop aimed at identifying the causes of the devastating large-scale forest fires of summer 2003 in Europe. It also aimed at extracting important lessons for coping with forest fires. Speakers presented their views and attendees worked to determine future actions which will reduce devastating consequences of forest fires. The discussions attempted to address the following questions:

- What are the causes of having such large scale forest fires
- How we can reinforce assistance exchange?
- How we can use state of the art technologies during crisis management?
- How we cope with severely burned people?
- Is European co-ordination of assistance possible?

Meeting of the Scientific Committee of ECFF

Meeting of the Administrative Committee of ECFF

Meeting of the Administrative Committee of ECFF

Forest Fires in France in 2003

Philippe Michaut, Ministere de l' Interieur, Direction de la defense et de la securite civiles email: philippe.michaut@interieur.gouv.fr

Brief Summary

More than 60.000 ha have been affected by fires in Mediterranean areas during 2003 (10 years average was 10.000 ha). It's the highest number since the data base Promethee has been set up in 1973. 14 fires reached more than 1.000 ha burned. The intensity of the 2003 fire season is reflected by the number of buildings destroyed (more than 100) and by the death of 10 people.

These important fires, occurred under extreme meteorological conditions including extremely dry period and very high summer temperatures.

An unmatched situation in terms mobilization of national means took place both for preventive reasons and for attacking the fires, and international aid was made available through the contribution of Greek, Italian, Spanish, German, Russian means.

Besides Mediterranean areas, other regions were affected by fires during spring and summer (Aquitaine, Massif Central, Alpes...). 12.500 ha burned in these regions (average: 7.000ha).
A vast part of France has suffered in usual high risk of fire due to the precipitation deficit together with the high summer temperatures.

In total, 74.000 ha were burned in France in 2003, (10 years average: 19.000 ha).

Les premiers elements sur la campagne feux de forets 2003

Des surfaces touchées par le feu exceptionnellement élevées:

Les très importants incendies de forêts qui se sont développés durant les mois durant l'été entraînant d'importantes mesures de protection des populations, se sont produits dans un contexte météorologique particulièrement difficile du fait d'une sécheresse sans précédent qui a sévit sur l'ensemble des départements méditerranéens aggravée par des températures caniculaires. Des seuils de sécheresse extrêmes, atteints précédemment en seconde partie d'été particulièrement sec, ont été franchis dès la mi-juillet.

Le cumul des secteurs météorologiques classés en risques très sévères ou exceptionnels s'établit à plus de 1500. Il est en moyenne de 380 à l'issue d'une campagne feux de forêts. En 1989, année considérée comme étant la plus difficile sur le plan des risques (55.000 ha touchés), ce nombre s'établissait à 800 à l'issue de l'été.

Plus de 61.000 ha ont été touchés par le feu dans les départements méditerranéens sur l'année (la moyenne décennale : 10.000 ha), dont 58.000 ha durant l'été (moyenne décennale : 8.000 ha). Depuis l'instauration de la base de données statistiques Prométhée en 1973, de tels chiffres n'avaient jamais été atteints.

Les départements les plus touchés sont ceux de Haute-Corse (21.000 ha touchés), du Var (19.000 ha), de Corse-du-Sud (6.500 ha). Mais la quasi totalité des autres départements méditerranéens ont également connu des feux importants.

Au total, durant l'été, 14 incendies ont touché plus de 1000 ha (6 en Haute-Corse, 4 dans le Var, 1 en Corse-du-Sud, 1 en Lozère, 1 en Ardèche), la moyenne décennale s'établissant à 1 par été. 50 incendies ont parcouru plus de 100 hectares (contre une quinzaine en moyenne estivale). Mais, 90% des feux ont parcouru moins de 5 ha.

Plusieurs dizaines de constructions ont été touchées par ces incendies et les décès de 10 victimes, dont 4 sapeurs-pompiers témoignent de l'intensité des feux qui se sont développés. Une centaine de sauveteurs ont également été blessés dont 2 très grièvement.

Une mobilisation sans précédent des moyens nationaux:

Le contexte opérationnel a nécessité de mobiliser des moyens importants, soit à titre préventif, soit pour contenir les incendies lorsque l'attaque initiale s'était avérée inopérante:

- les 25 avions bombardiers d'eau de la sécurité civile (11 Canadair, 12 Tracker, 2 Fokker 27) ont effectué 9.000 heures de vol opérationnel (moyenne des heures de vol opérationnelles effectuées annuellement sur la période 1998-2002 : 4.300). Le tiers des appareils risquant de se trouver à court de potentiel dès la mi-août, des mesures d'urgence ont été engagées comprenant le renforcement du suivi de la maintenance, la mobilisation de 2 hélicoptères lourds bombardiers d'eau russes dans le cadre d'un accord de coopération internationale, la location d'1 appareil au Canada.

Il a également été fait appel ponctuellement à l'aide internationale: des Canadair italiens, espagnols et grecs, 1 hélicoptère lourd italien, 3 Super-Puma allemands ont été engagés.

La situation opérationnelle a mis à nouveau en évidence la nécessité de procéder sans délai au remplacement des 2 FOKKER 27 dont la vétusté pénalise la disponibilité.

- à l'occasion de ces vols ont été consommées 5.000 tonnes de produits retardants qui valorisent l'apport des bombardiers d'eau en prolongeant l'effet des largages.
- les UIISC sont intervenus sur 450 départs de feu.
- au titre de la solidarité nationale, des colonnes de renfort feux de forêts de sapeurs-pompiers ont été mobilisées, mesure complétée par le renforcements des centres urbains des départements les plus sollicités par les incendies de forêts pour permettre d'engager un maximum de moyens locaux sur les feux. Au total, 1.500 sapeurs-pompiers venus de toute la France ont, en situation extrême, été engagés simultanément en zone Sud.
- la participation des moyens militaires prévus par le protocole intérieur/défense a été très importante. 730 heures de vol d'hélicoptères de manœuvre ont été assurées pour assurer le transport de commandos héliportés lors des feux très difficile d'accès, 770 heures de vol de surveillance ont été effectuées par des hélicoptères légers, 1.300 missions de quadrillage du terrain ont été assurées par les modules adaptés de surveillance (MAS). Pour tenir compte du niveau des risques, le ministère de la Défense a accru l'apport de son concours prévu par le protocole Intérieur/Défense le portant de 300 à 500 hommes, et de 3 à 8 hélicoptères.

820 des 2.000 feux enregistrés durant l'été ont bénéficié du concours de moyens nationaux.

Le point hors zone Sud:

Hors zone Sud, la surface touchée par le feu durant l'été a également été importante, en particulier en zone Sud-Est (2800 ha) et dans les départements du Sud-Ouest (3.000 ha) portant les surfaces parcourues par les incendies depuis le début de l'année hors régions méditerranéennes à 12.500 ha (moyenne: 7.000 ha).

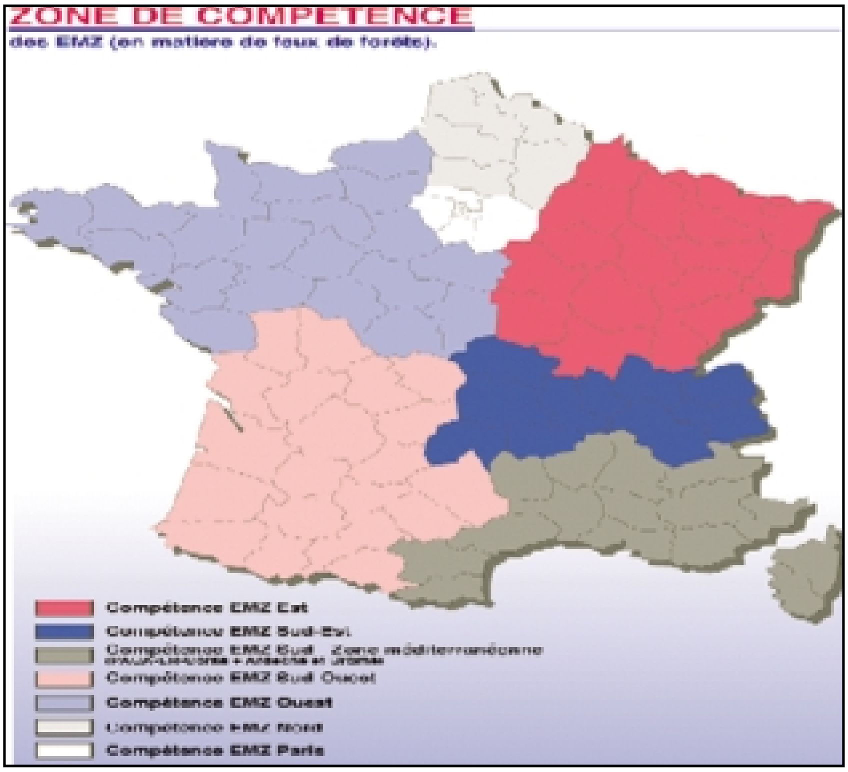
Les moyens aériens ont été engagés à 75 reprises hors de la zone Sud.

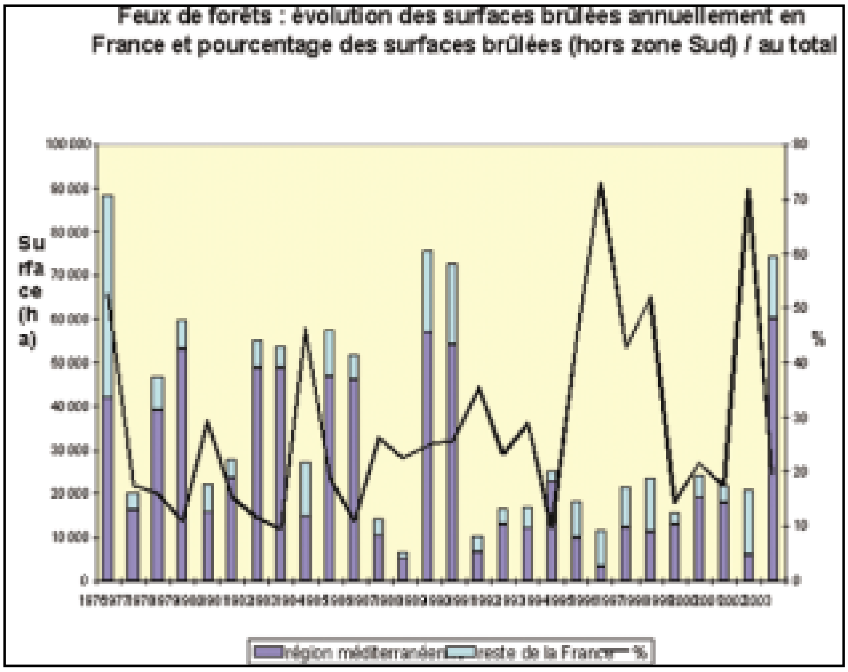
Une grande partie du territoire a connu des risques très élevés d'incendie en raison du très important déficit pluviométrique du printemps et des températures caniculaires estivales. 13 incendies ont dépassé la limite de100 ha : 6 dans le Sud-Ouest, 6 dans le Sud-Est, 1 dans l'Est. L'étendue de la zone des risques est un des éléments aggravants du contexte opérationnel estival.

Au total, depuis le début de l'année, la superficie touchée par le feu en France peut ainsi être évaluée à 74.000 (dont 67.000 ha durant l'été), la moyenne décennale s'établissant à 19 .000 ha. Les bilans atteints en 2002 sont comparables à ceux des années 1989 et 1990 à l'occasion desquelles 75.000 ha avaient été parcourus.

Les feux de forets en France pendant l'ete 2003

UN RISQUE HABITUELLEMENT LOCALISE



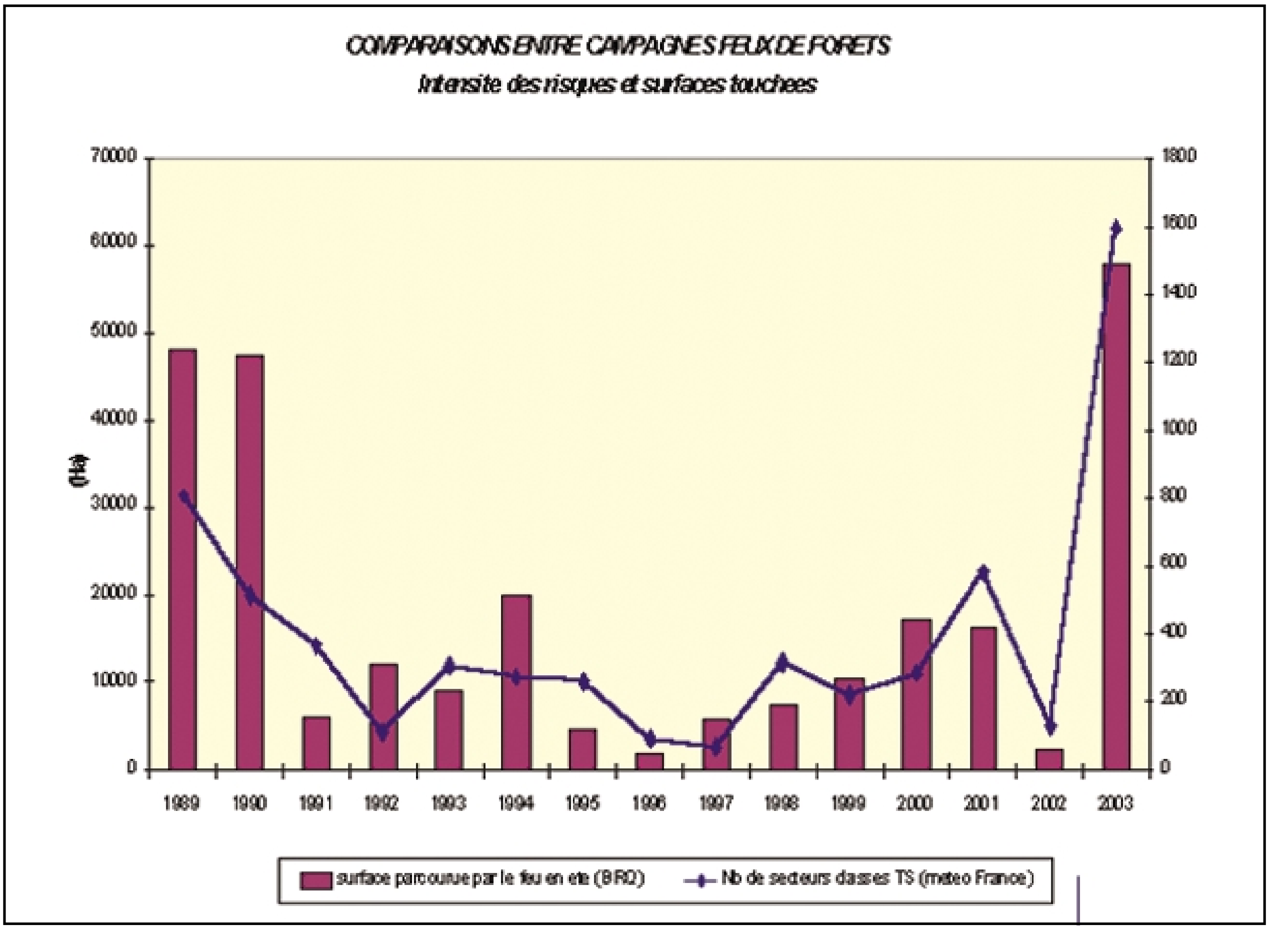


- 75 % des feux en région méditerranéenne
- des paramètres aggravants dans ces départements:
  - climatiques
  - taux de couverture végétale
  - relief accidenté
  - extension de friches
  - absence de retombées économiques de la forêt

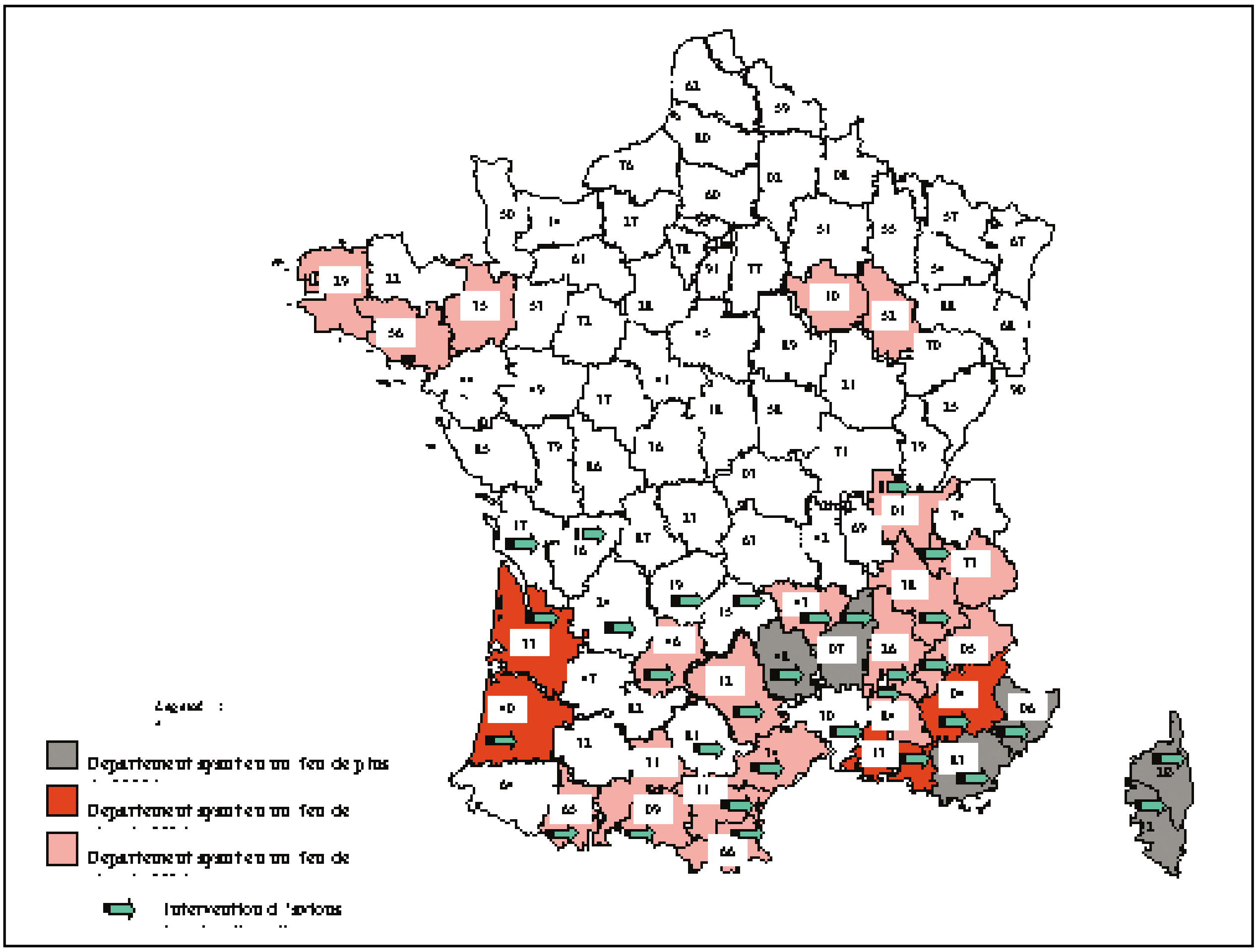
Moyenne 83-2002: Sud 21.500 ha, autres 7.700 ha
2003: Sud 61.500 ha, autres 13.000 ha

2003 une année atypique

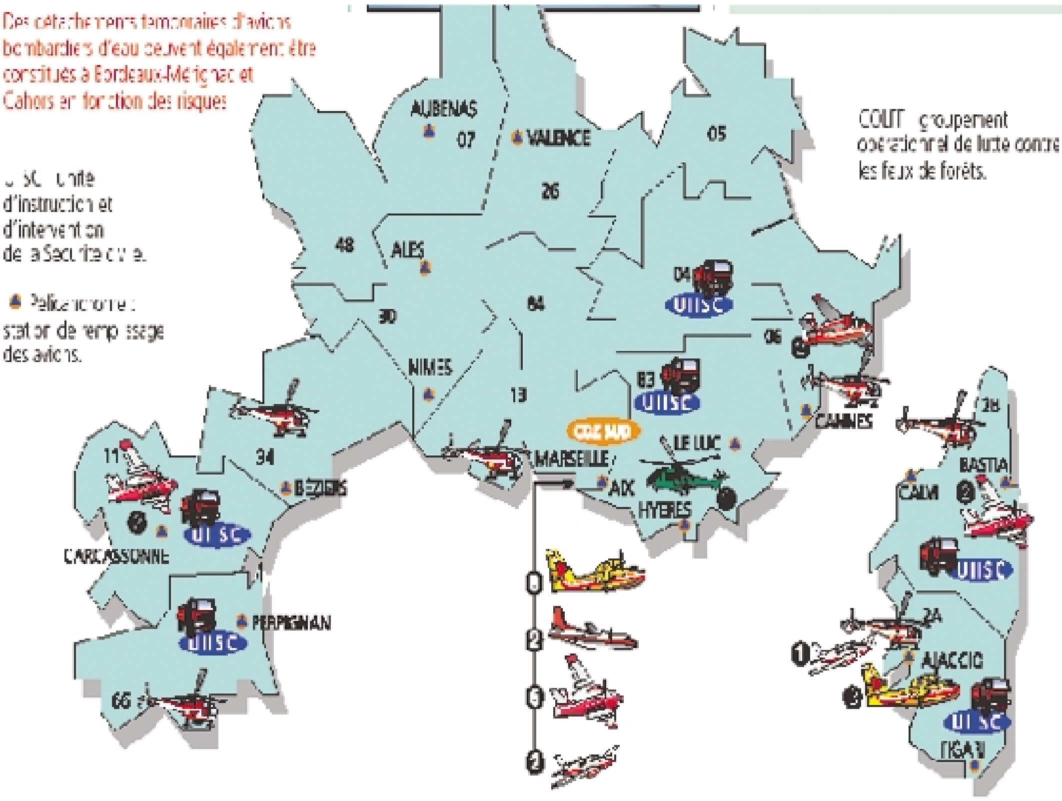
- Un bilan sans précédent dans les régions méditerranéenne - 61.500 ha: des feux importants dans les départements de l'arrière pays souvent épargnés l'été (Alpes-de-Haute-Provence, Hautes-Alpes, Lozère) où le bilan est multiplié par 10 ;
- Des feux importants dans des départements souvent moins concernés: Ain, Isère, Savoie, Haute-Loire, Aube ainsi que dans le Sud-Ouest (Landes, Lot, Haute-Garonne, Ariège ...). Au total 13 feux >100 ha contre 1 à 2 en moyenne: des zones habitées menacées et touchées.



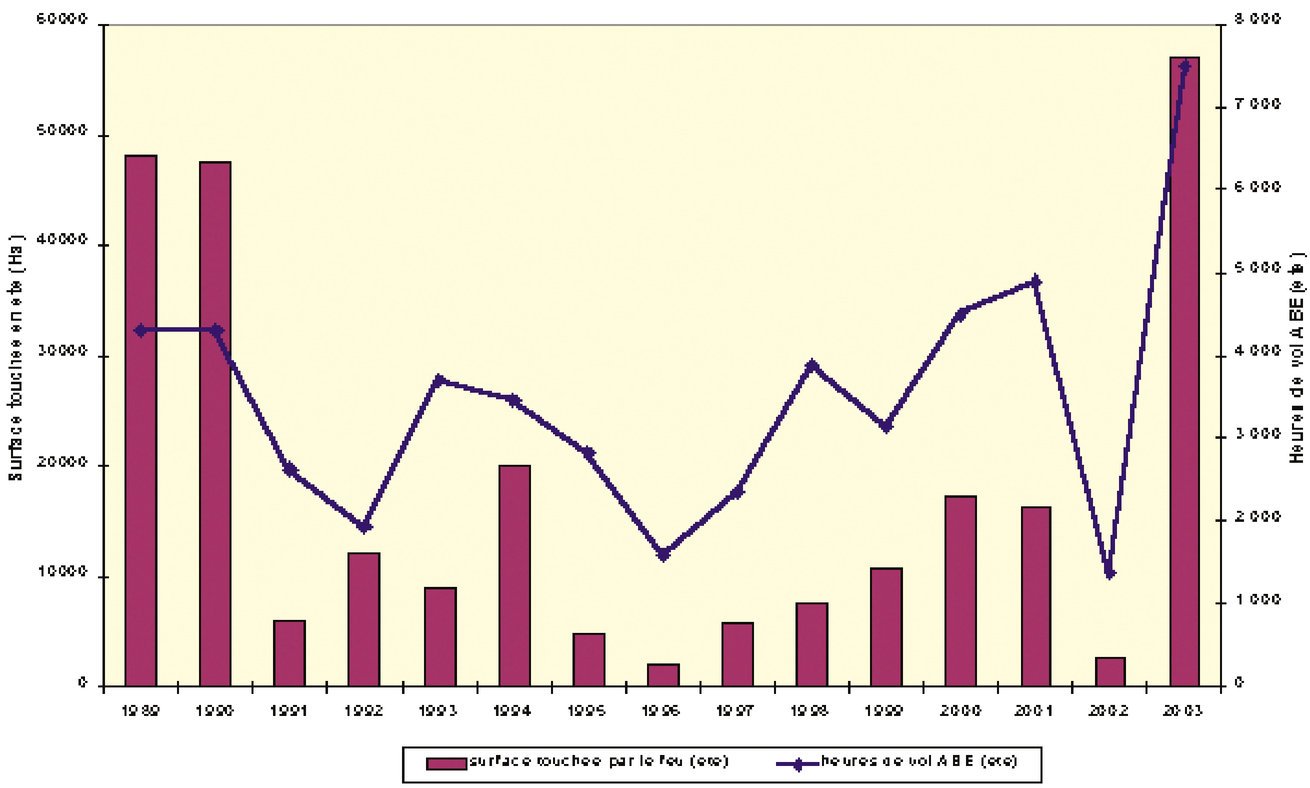
COMPARAISONS ENTRE CAMPAGNES FEUX DE FORETS
Intensite des risques et surfaces touchees
(Ha)
70000
60000
50000
40000
30000
20000
10000
0
1800
1600
1400
1200
1000
800
600
400
200
0
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
surface parcourue par le feu en ete
Nb de secteurs classes TS (meteo France)

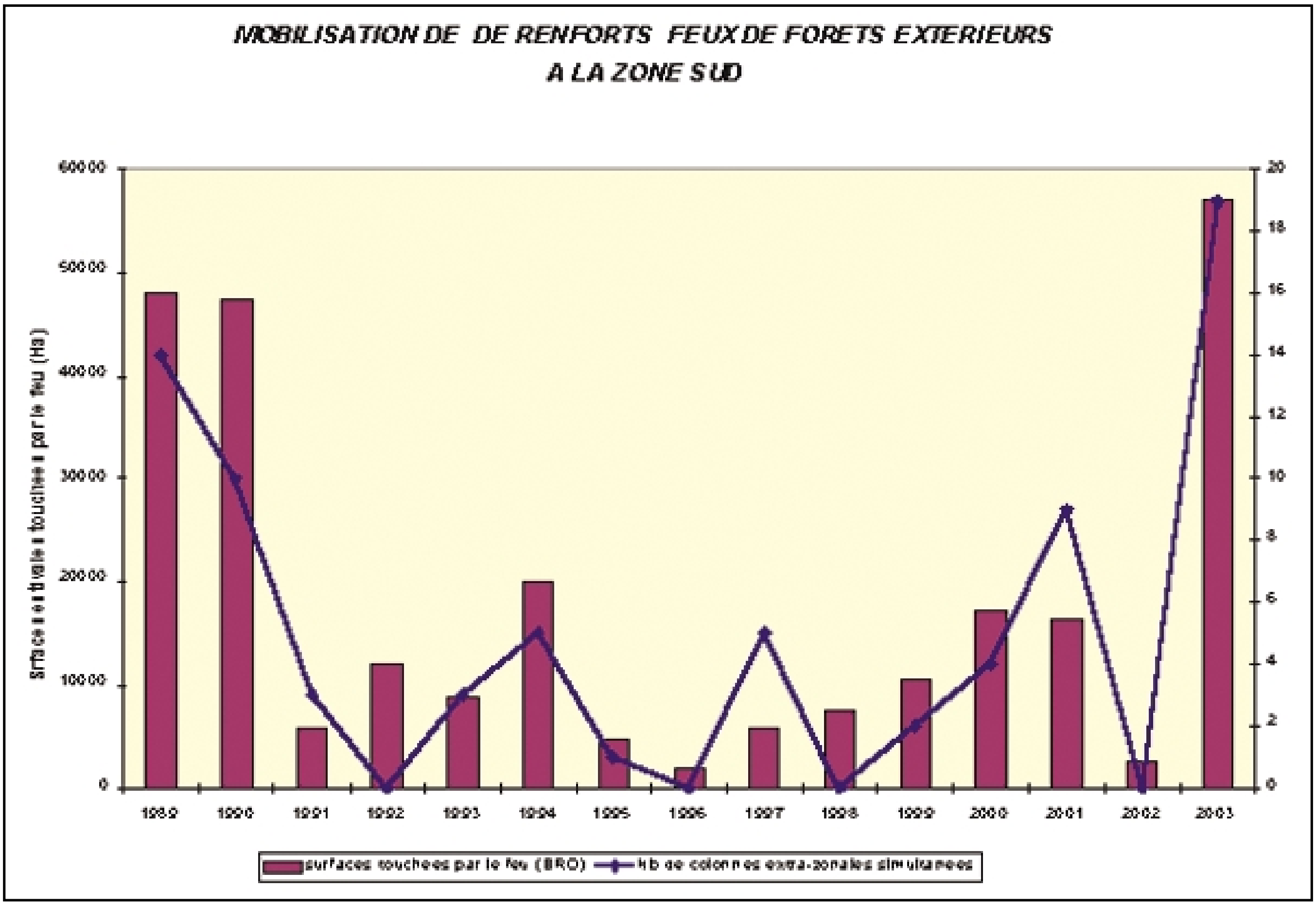


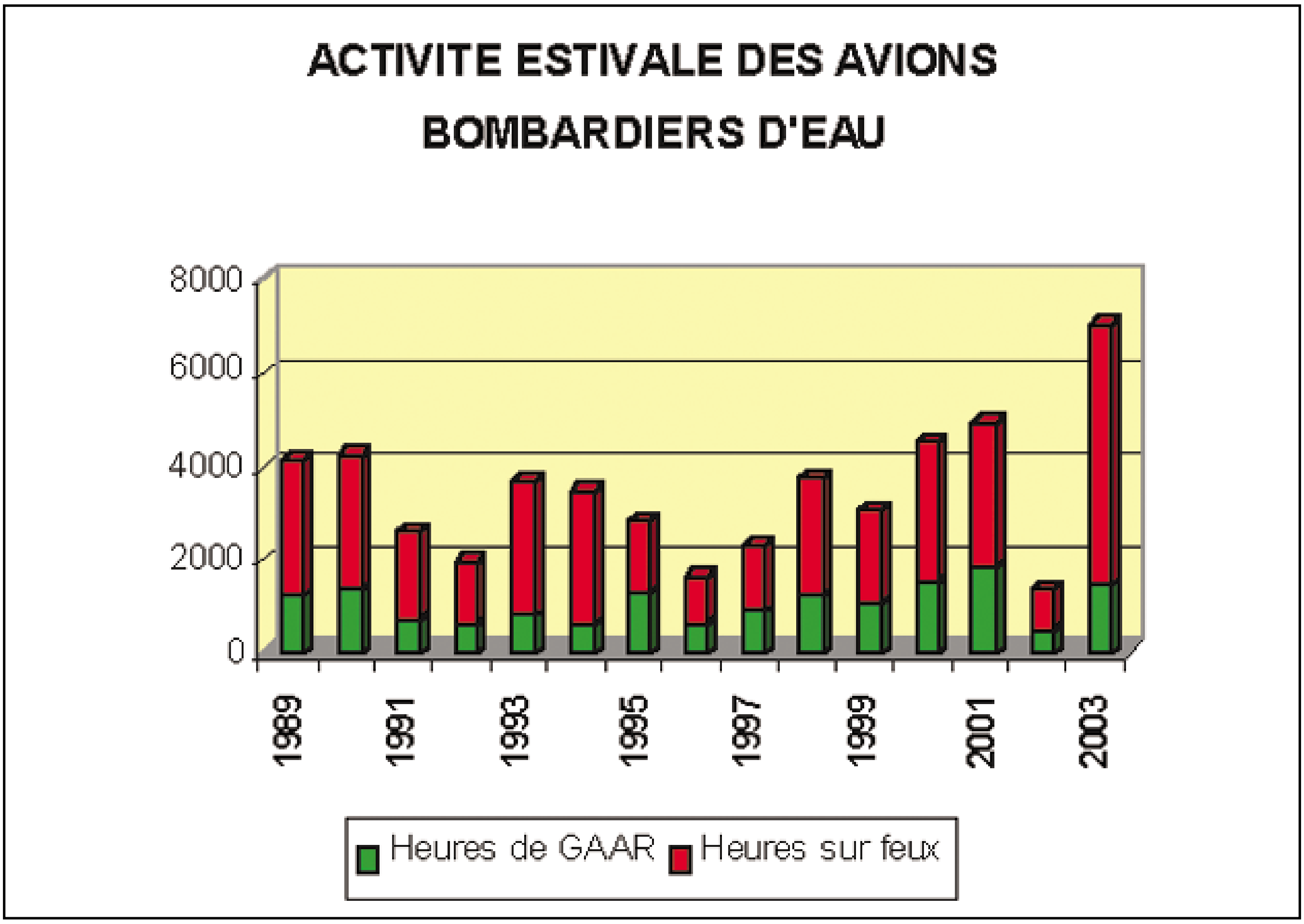
MOYENS NATIONAUX MIS EN ŒUVRE EN 2003



EVOLUTION DE L'ACTIVITE DES AVIONS BOMBARDIERS D'EAU




MOBILISATION DE DE RENFORTS FEUX DE FORETS EXTERIEURS
A LA ZONE SUD
60000
50000
40000
30000
20000
10000
0
20
18
16
14
12
10
8
6
4
2
0
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
surfaces touchees par le feu (BRO)
Nb de colonnes extra-zonales simultanees


ACTIVITE ESTIVALE DES AVIONS
BOMBARDIERS D'EAU
8000
6000
4000
2000
0
1989
1991
1993
1995
1997
1999
2001
2003
Heures de GAAR
Heures sur feux

Portuguese National Service for Fire and Civil Protection

University of Coimbra Portugal
Rui Almeida, ralmeida@snbpc.pt, Luciano Lourenco, lucianol@ci.uc.pt

Topics of presentation:

- Portuguese National System of Civil Protection.
- What happens in the hot Summer of 2003.
- The causes of Forest Fires
- The critical period day by day

Portuguese National System of Civil Protection

The Portuguese Civil Protection System integrates:

- National Service for Fire and Civil Protection (SNBPC), with 18 Coordination Centres that are based on each of the 18 Portuguese districts .
- Regional Services for Civil Protection (SRPCB) (Azores, Madeira)
- Municipal Services for Civil Protection (SMPC).
- Agents: Firemen Services, the security forces (Police and National Guards), the Armed Forces, the Maritime and Aeronautics Authorities, and the National Institute for Medical Emergency (INEM).
- Other entities like Meteorological institute, Forest Service,etc.

Meteorological Conditions

- Very high maximum temperatures (over 40ºC) during 18 days in some inland areas (mainly in Centre)
- Very high minimum temperatures (over 23ºC) during the evening
- Very low values of humidity (less than 30%)
- Very dry east winds
- Dry storms

Causes for the Ignition of forest fires

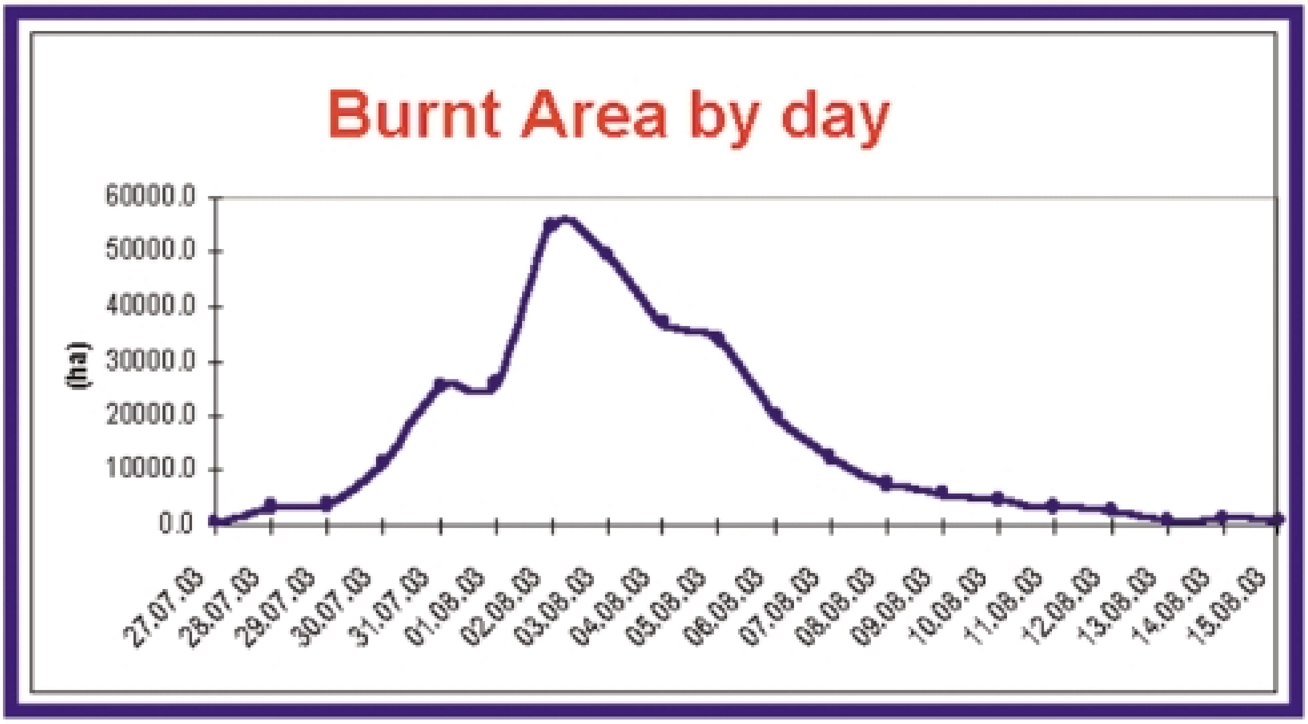
- Negligent behaviour
- Soil renewal for shepherds
- Agricultural machinery
- Pyrotechnical devises
- Smokers
- Intentional causes
- Natural causes - lightning
- Unknown causes

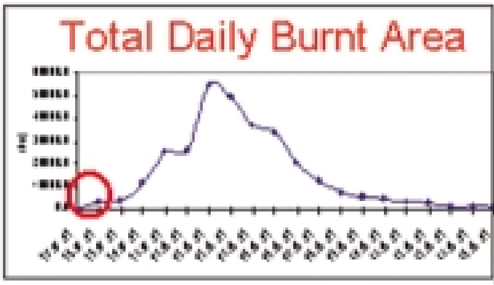
Social causes for happens big forest fires

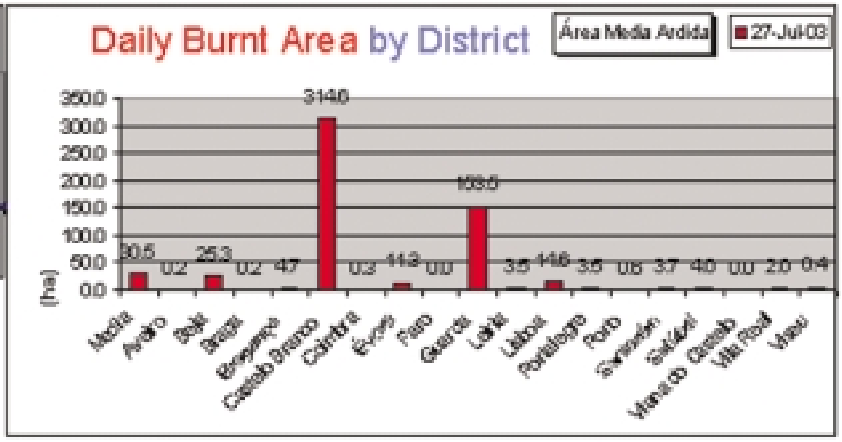
- Rural exodus
- Change in traditional agricultural practices
- Absenteeism of the forest owners
- Wrong landuse of forest areas

Forest Degradation

What happens in the hot Summer of 2003





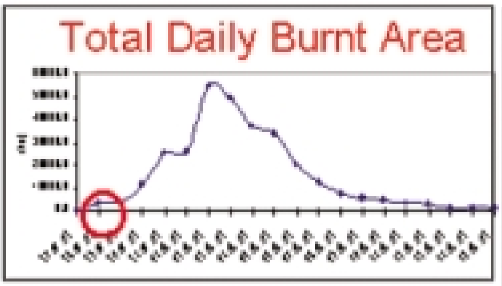


Day 27 July

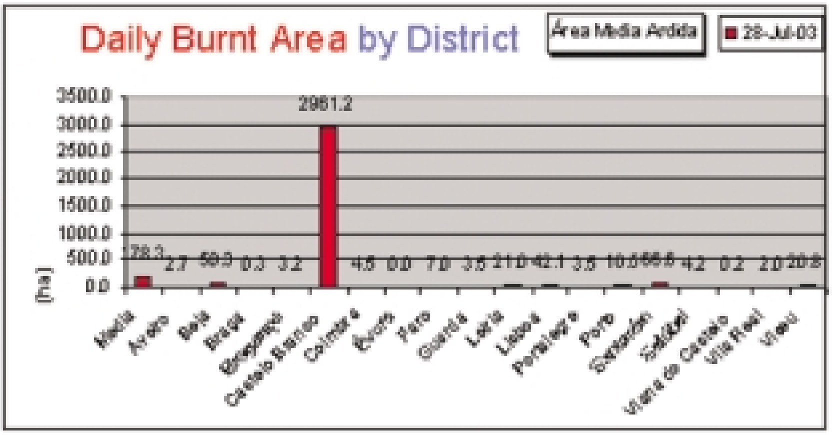
Nº of Fires with more then 1000 ha of Burnt Area: 1

Meteorological data:

Data	Estacão	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
27.07.03	Castelo Branco	30	-	89	-	21	-
27.07.03	Portalegre	28	16	100	27	18	10
27.07.03	Coimbra	24	15	100	53	18	3
27.07.03	Coruche	25	17	96	52	10	-
27.07.03	Guarda	23	13	99	38	39	14



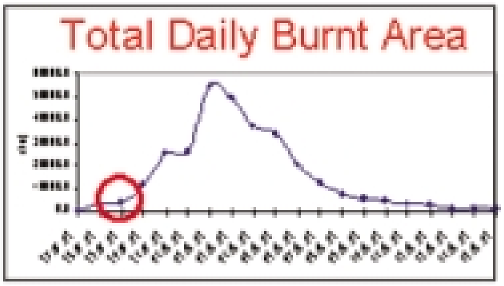
Day 28 July



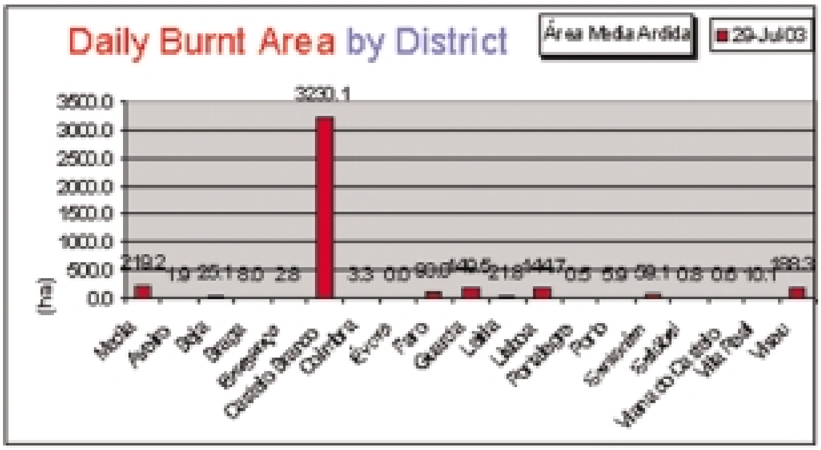
Nº of Fires with more then 1000 ha of Burnt Area: 2

Meteorological data:

Data	Estação	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
28.07.03	Castelo Branco	35	-	70	-	21	-
28.07.03	Portalegre	33	-	73	-	25	-
28.07.03	Coimbra	29	-	100	-	18	-
28.07.03	Coruche	27	15	90	41	10	-
28.07.03	Guarda	27	12	89	20	21	3



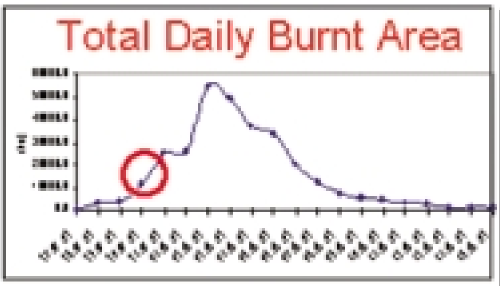
Day 29 July

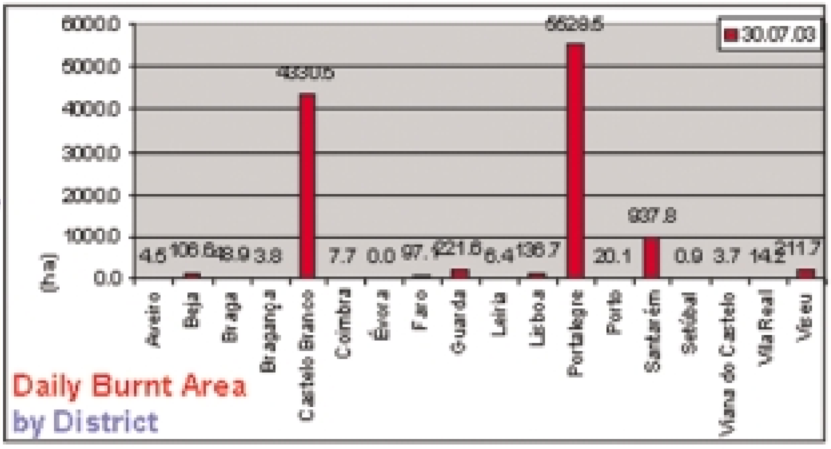


Nº of Fires with more then 1000 ha of Burnt Area: 3

Meteorological data:

Data	Estação	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
29.07.03	Castelo Branco	37	22	48	17	18	3
29.07.03	Portalegre	37	24	34	12	28	-
29.07.03	Coimbra	36	15	97	30	18	-
29.07.03	Coruche	33	15	93	37	3	-
29.07.03	Guarda	30	17	63	26	18	7



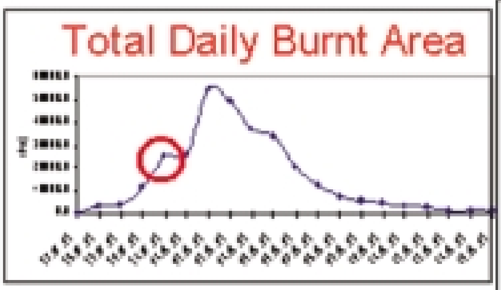


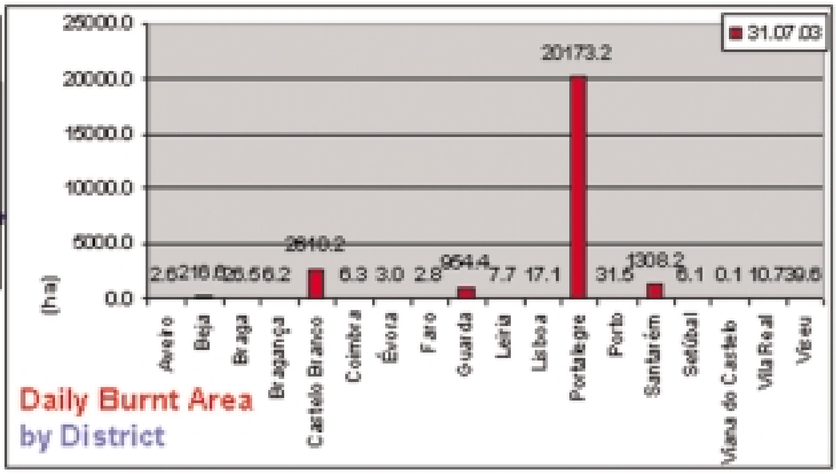
Day 30 July

Nº of Fires with more then 1000 ha of Burnt Area: *6*

Meteorological data:

Data	Estacão	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
30.07.03	Castelo Branco	38	-	37	-	14	-
30.07.03	Portalegre	36	-	31	-	28	-
30.07.03	Coimbra	37	16	99	28	18	-
30.07.03	Coruche	35	18	89	33	7	-
30.07.03	Guarda	32	20	47	17	18	3



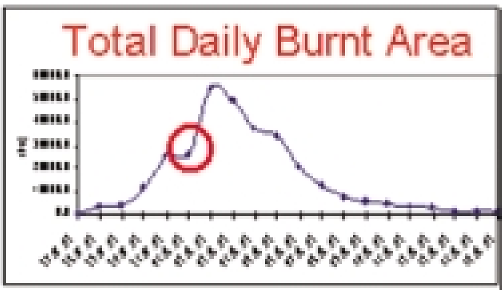


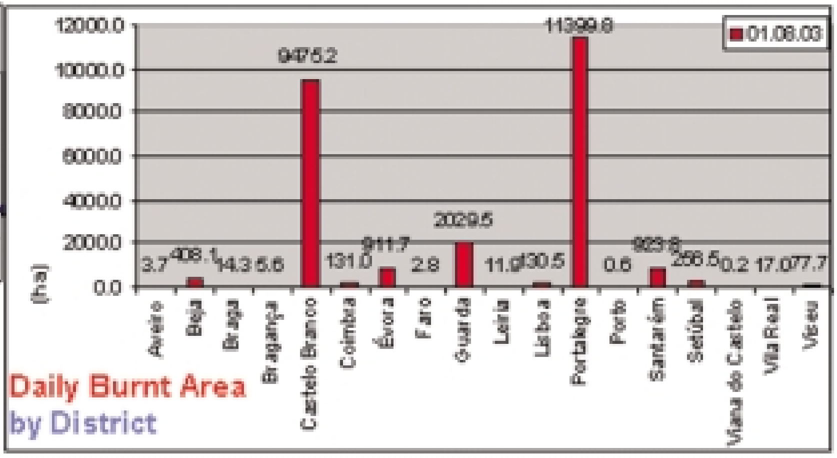
Day 31 July

Nº of Fires with more then 1000 ha of Burnt Area: *8*

Meteorological data:

Data	Estacão	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
31.07.03	Castelo Branco	38	-	48	-	14	-
31.07.03	Portalegre	39	30	26	12	25	-
31.07.03	Coimbra	35	-	100	-	14	-
31.07.03	Coruche	35	18	87	41	3	-
31.07.03	Guarda	33	21	50	16	21	-





Day 1 August

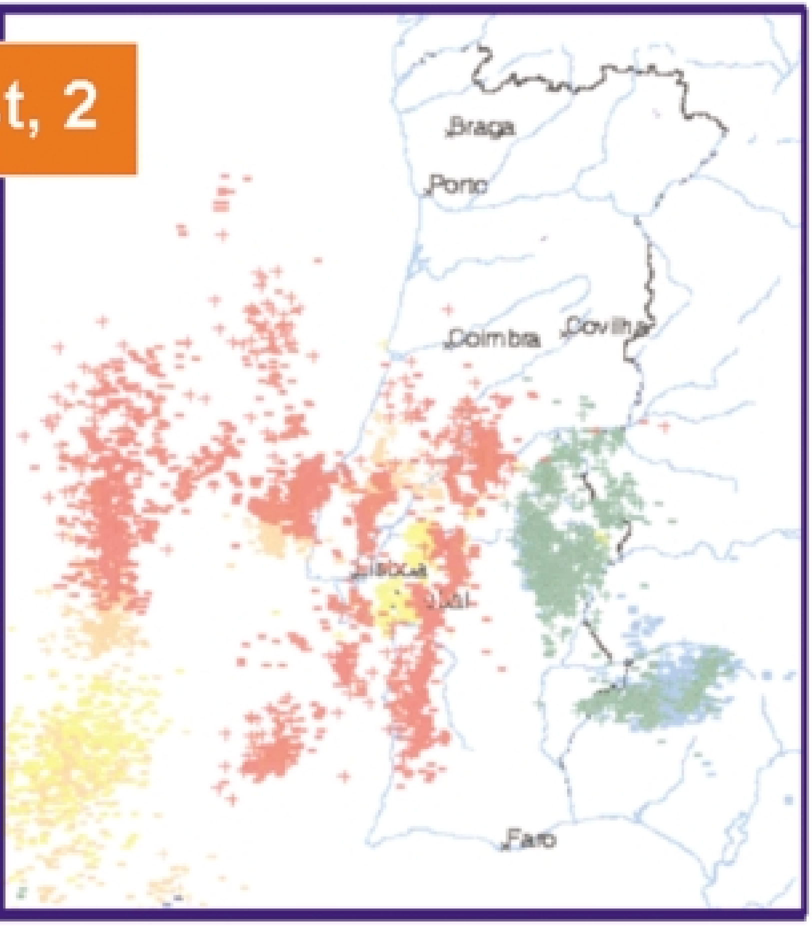
Nº of Fires with more then 1000 ha of Burnt Area: *18*

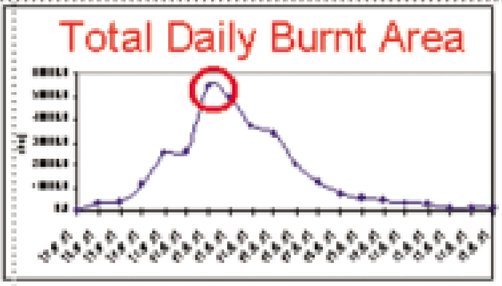
Meteorological data:

Data	Estação	Max. Temp. (°C)	Min. Temp. (°C)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
01.08.03	Castelo Branco	40	24	40	13	25	3
01.08.03	Portalegre	40	-	28	-	28	-
01.08.03	Coimbra	40	-	88	-	18	-
01.08.03	Coruche	43	15	91	13	-	-
01.08.03	Guarda	35	24	41	15	21	3

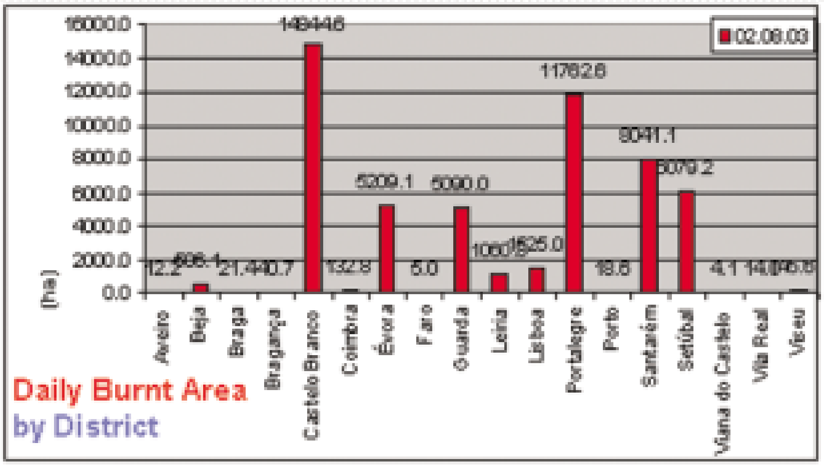
Meteorology - Dry Storms

August, 2





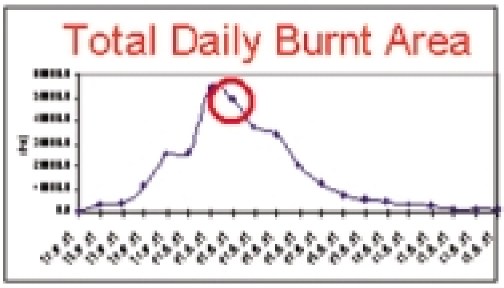
Day 2 August



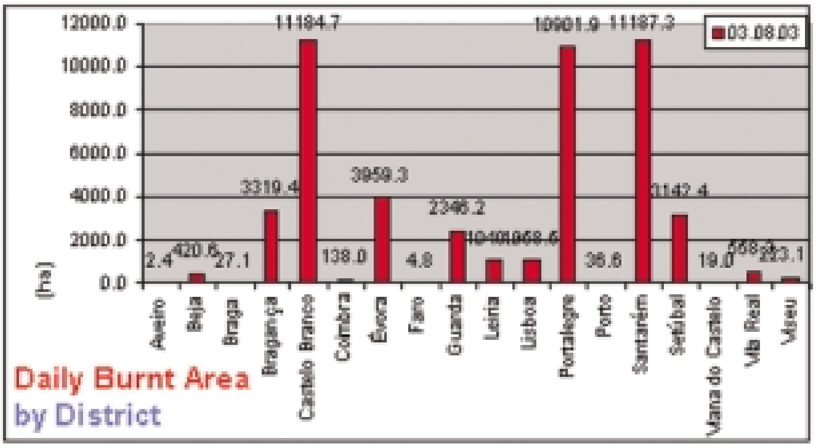
Nº of Fires with more then 1000 ha of Burnt Area: *40*

Meteorological data:

Data	Estação	Max. Temp. (°C)	Min. Temp. (°C)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
02.08.03	Castelo Branco	38	-	30	-	21	-
02.08.03	Portalegre	39	27	46	14	25	7
02.08.03	Coimbra	35	-	77	-	25	-
02.08.03	Coruche	40	22	79	19	10	-
02.08.03	Guarda	31	26	34	24	21	3



Day 3 August

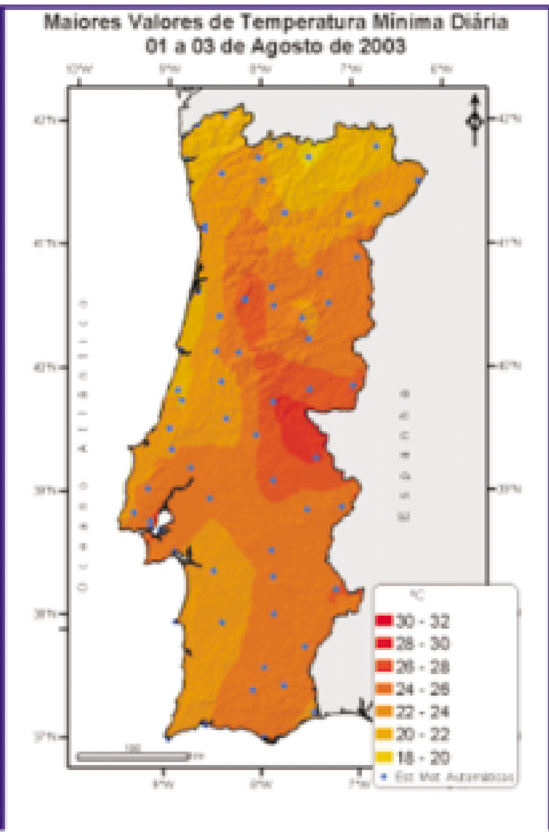


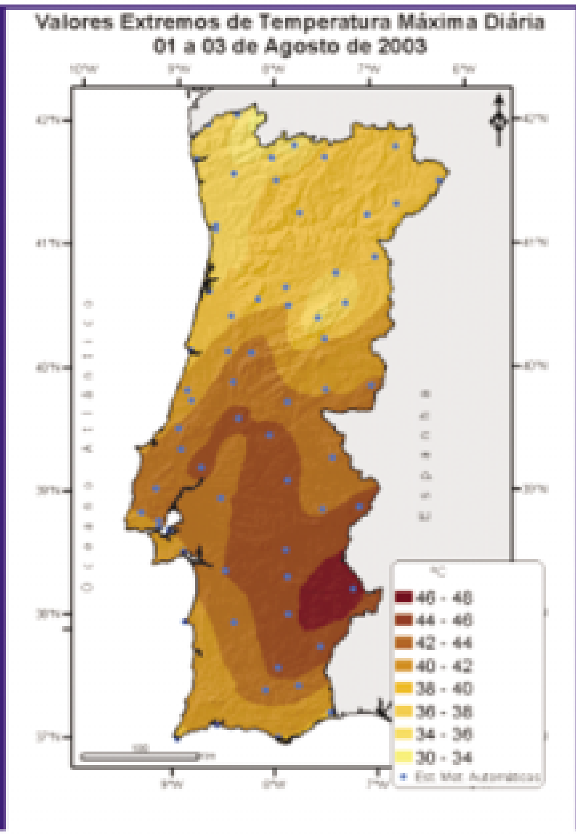
Nº of Fires with more then 1000 ha of Burnt Area: *41*

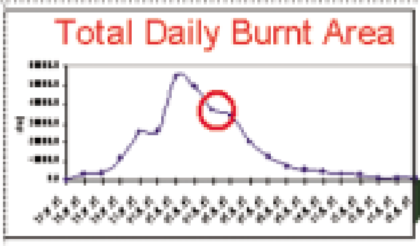
Meteorological data:

Data	Estação	Max. Temp. (°C)	Min. Temp. (°C)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
03.08.03	Castelo Branco	37	-	66	-	21	-
03.08.03	Portalegre	38	-	67	-	21	-
03.08.03	Coimbra	34	-	87	-	18	-
03.08.03	Coruche	34	18	95	35	3	-
03.08.03	Guarda	27	27	27	27	14	14

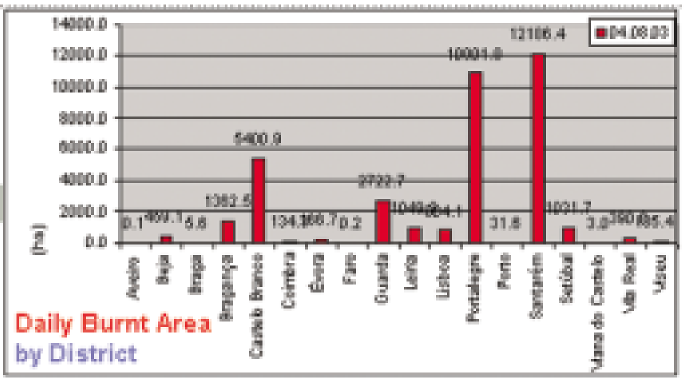
Meteorology - Temperature





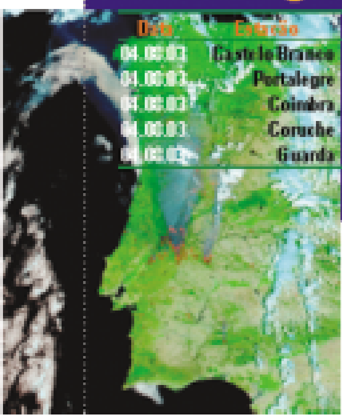


Day 4 August

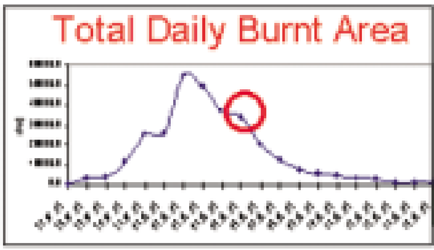


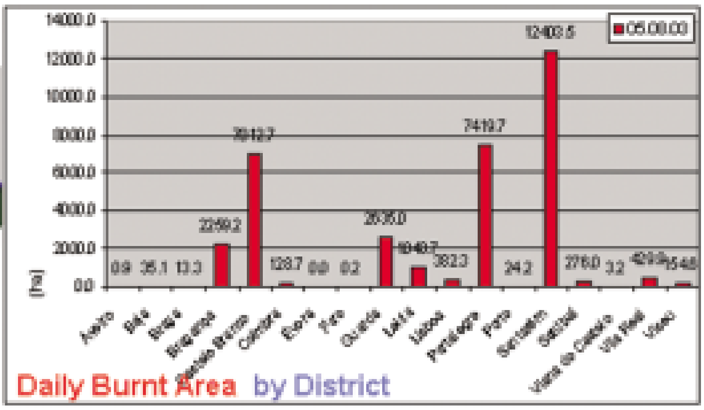
Nº of Fires with more then 1000 ha of Burnt Area: *31*

Meteorological data:



Data	Estação	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
04.08.03	Castelo Branco	36	-	80	-	14	-
04.08.03	Portalegre	37	-	57	-	18	-
04.08.03	Coimbra	31	-	93	-	18	-
04.08.03	Coruche	34	14	90	30	3	-
04.08.03	Guarda	32	21	72	23	25	7

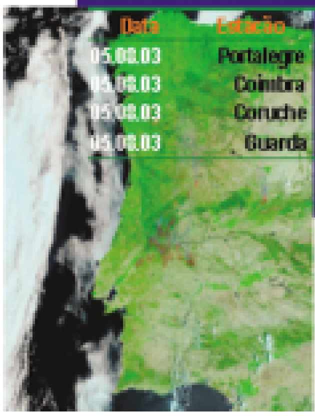




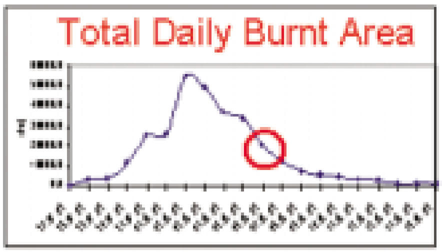
Day 5 August

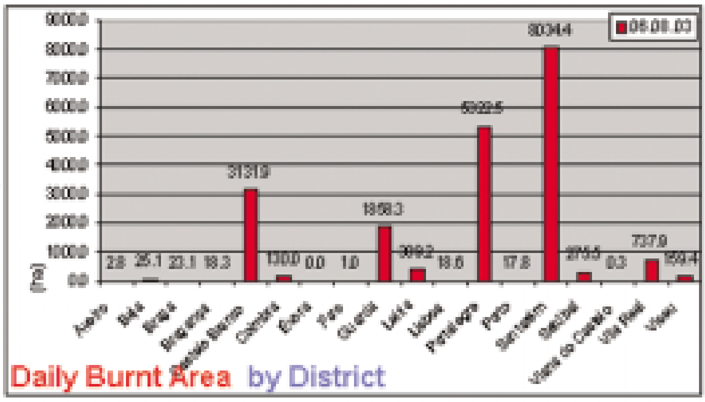
Nº of Fires with more then 1000 ha of Burnt Area: *30*

Meteorological data:



Data	Estação	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
05.08.03	Portalegre	36	-	53	-	18	-
05.08.03	Coimbra	33	-	100	-	14	-
05.08.03	Coruche	34	17	95	35	14	-
05.08.03	Guarda	34	22	64	18	25	3

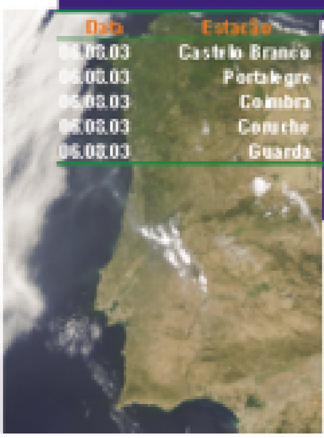




Day 6 August

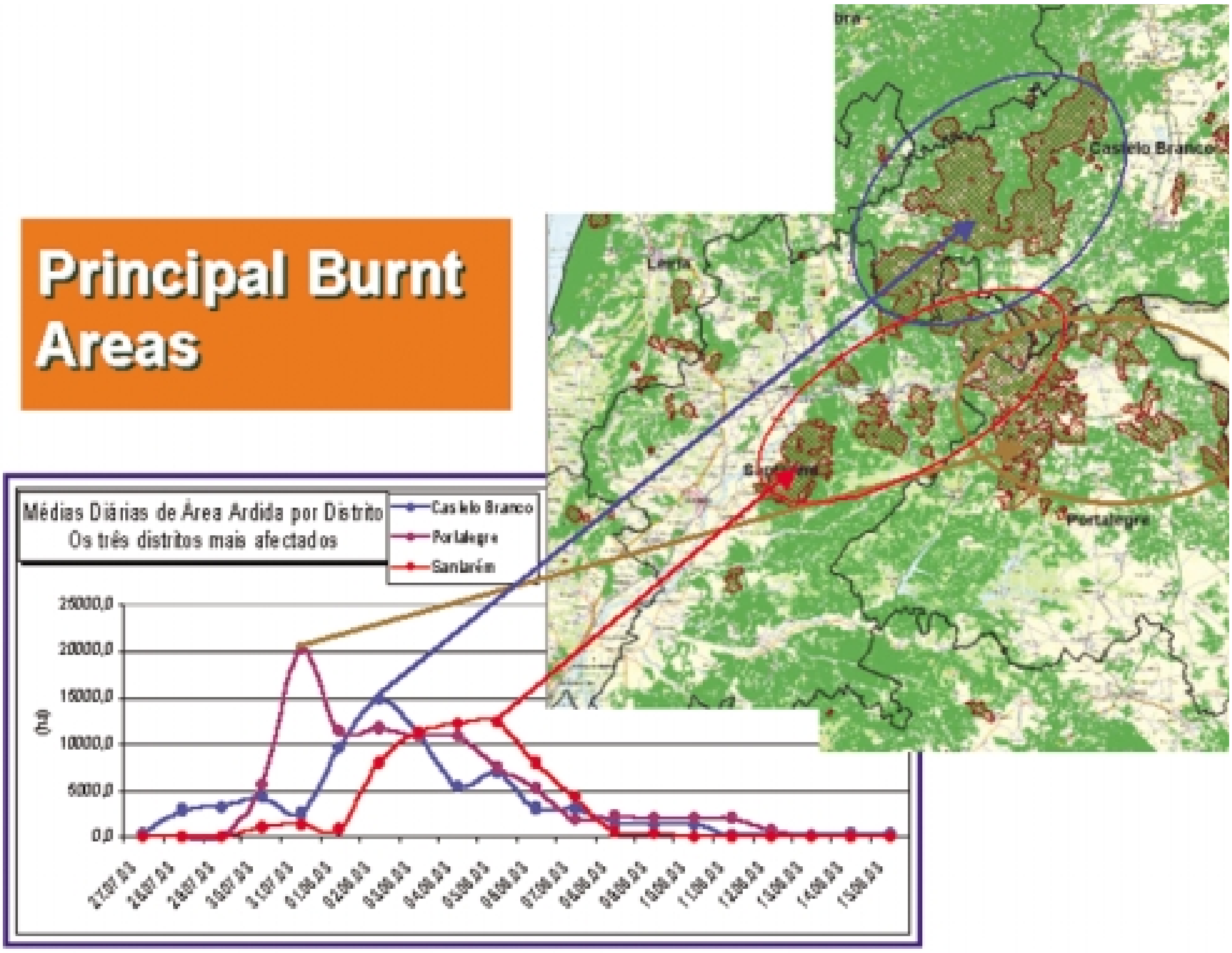
Nº of Fires with more then 1000 ha of Burnt Area: *17*

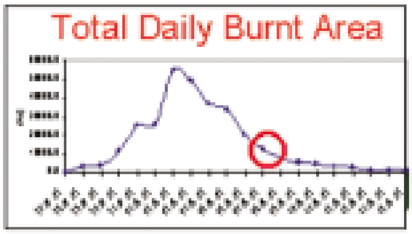
Meteorological data:

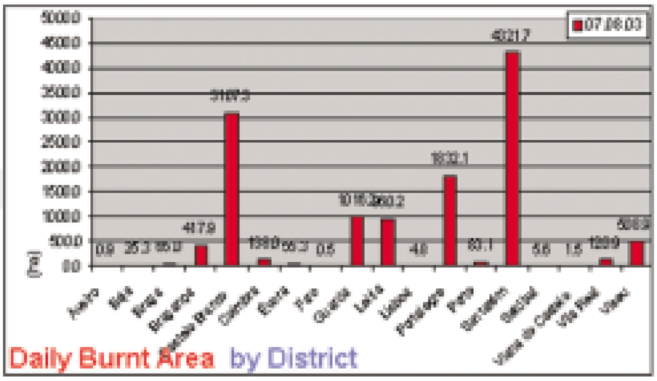


Data	Estação	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
06.08.03	Castelo Branco	38	24	44	19	14	3
06.08.03	Portalegre	38	20	34	17	20	3
06.08.03	Coimbra	39	-	92	-	18	-
06.08.03	Coruche	38	17	92	23	14	-
06.08.03	Guarda	33	21	92	21	18	3

Principal Burnt Areas



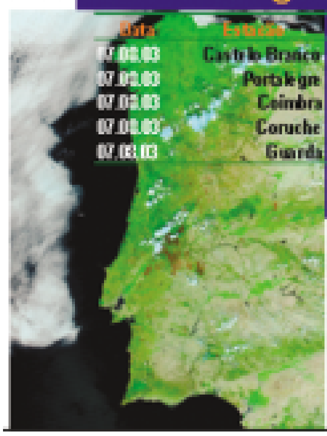




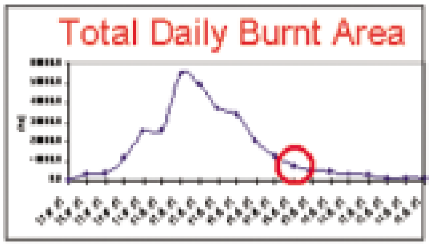
Day 7 August

Nº of Fires with more then 1000 ha of Burnt Area: *14*

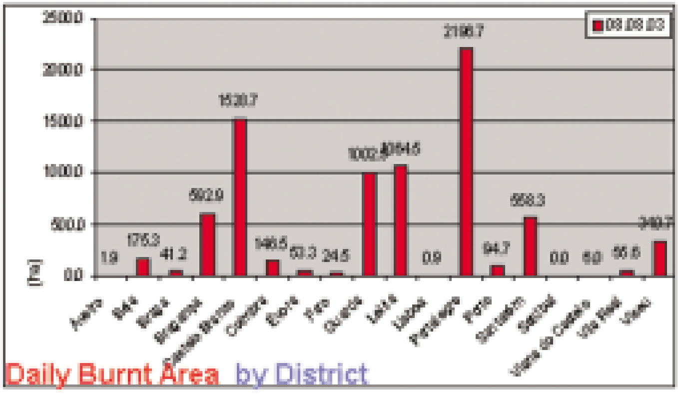
Meteorological data:



Data	Estação	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
07.08.03	Castelo Branco	39	25	39	16	14	7
07.08.03	Portalegre	38	-	38	-	21	-
07.08.03	Coimbra	39	-	75	-	10	-
07.08.03	Coruche	39	18	89	26	10	-
07.08.03	Guarda	34	24	40	13	14	3



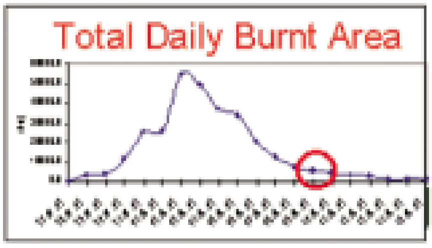
Day 8 August



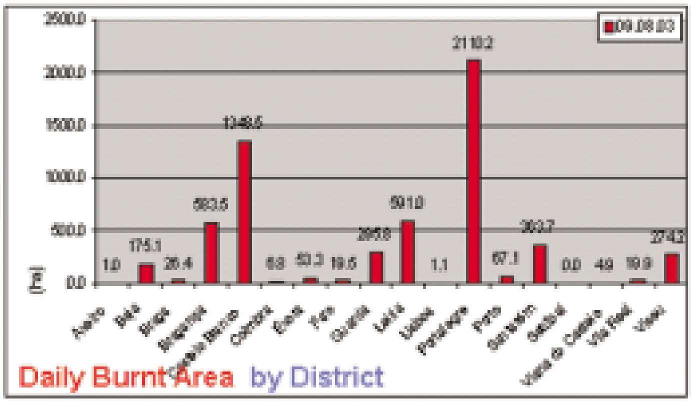
Nº of Fires with more then 1000 ha of Burnt Area: *10*

Meteorological data:

Data	Estação	Max.Temp. (ºC)	Min.Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
08.08.03	Castelo Branco	38	-	39	-	18	-
08.08.03	Portalegre	38	-	36	-	18	-
08.08.03	Coimbra	39	-	99	-	21	-
08.08.03	Coruche	38	18	97	28	10	-
08.08.03	Guarda	33	23	42	17	14	3

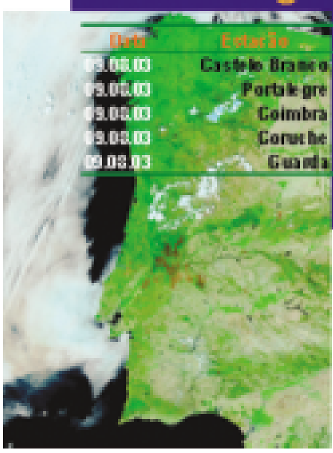


Day 9 August

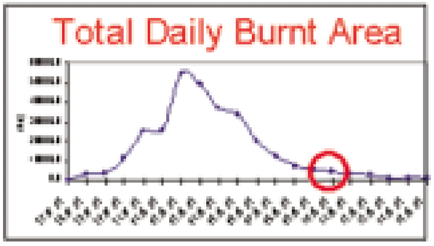


Nº of Fires with more then 1000 ha of Burnt Area: *6*

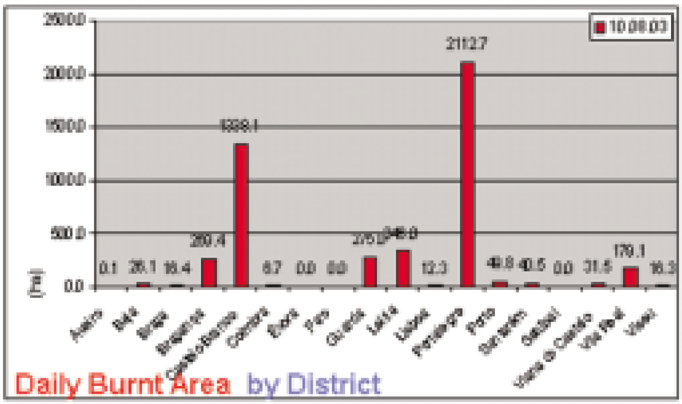
Meteorological data:



Data	Estação	Max.Temp. (ºC)	Min.Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
09.08.03	Castelo Branco	38	-	37	-	14	-
09.08.03	Portalegre	38	-	42	-	18	-
09.08.03	Coimbra	30	17	100	97	10	-
09.08.03	Coruche	31	18	96	93	14	-
09.08.03	Guarda	34	24	39	19	28	-

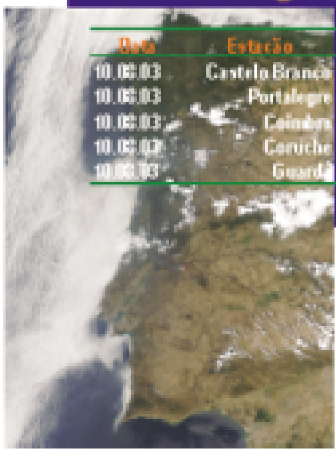


Day 10 August

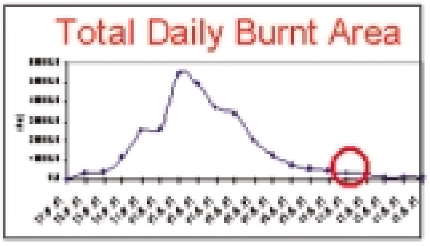


Nº of Fires with more then 1000 ha of Burnt Area: 6

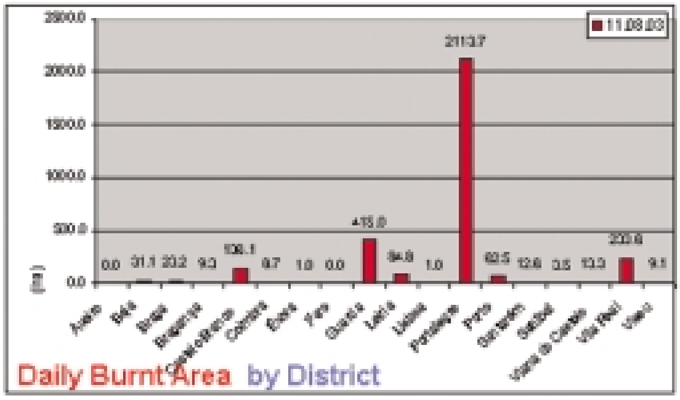
Meteorological data:



Data	Estação	Max. Temp. (°C)	Min. Temp. (°C)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
10.08.03	Castelo Branco	38	-	50	-	21	-
10.08.03	Portalegre	38	-	42	-	14	-
10.08.03	Coimbra	31	-	100	-	10	-
10.08.03	Coruche	31	18	97	56	10	3
10.08.03	Guarda	34	24	56	20	18	3

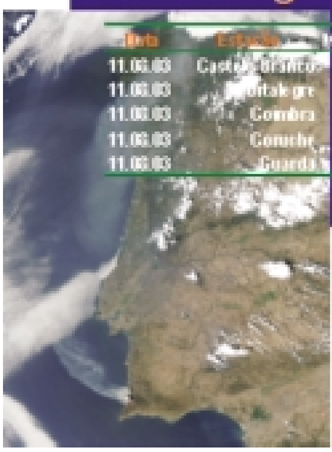


Day 11 August

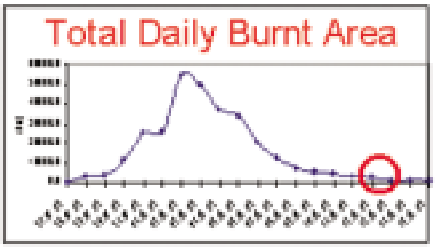


Nº of Fires with more then 1000 ha of Burnt Area: 4

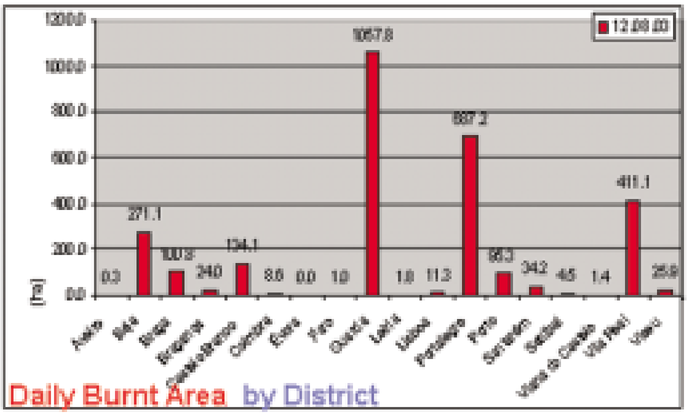
Meteorological data:



Data	Estação	Max. Temp. (°C)	Min. Temp. (°C)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
11.08.03	Castelo Branco	36	26	47	22	10	3
11.08.03	Portalegre	39	-	40	-	14	-
11.08.03	Coimbra	37	17	100	36	14	-
11.08.03	Coruche	40	16	96	28	14	-
11.08.03	Guarda	34	25	40	21	18	3

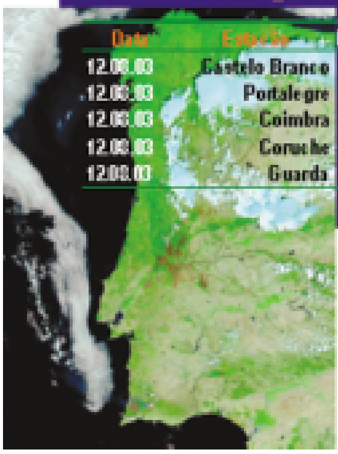


Day 12 August

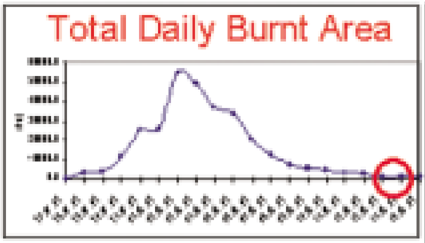


Nº of Fires with more then 1000 ha of Burnt Area: *1*

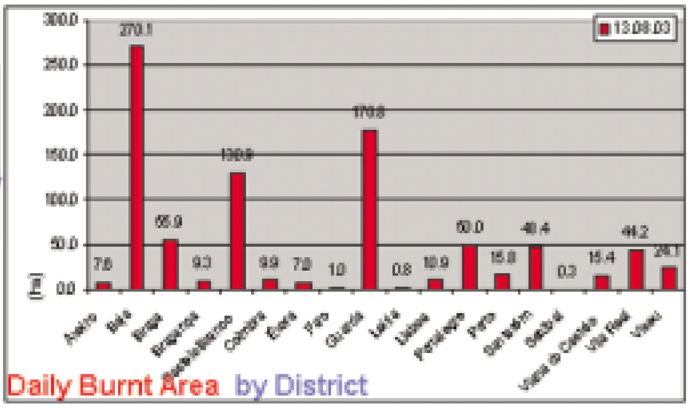
Meteorological data:



Data	Estação	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
12.08.03	Castelo Branco	39	-	46	-	18	-
12.08.03	Portalegre	39	-	38	-	21	-
12.08.03	Coimbra	34	21	95	33	18	3
12.08.03	Coruche	24	19	93	72	7	-
12.08.03	Guarda	35	24	44	17	25	7

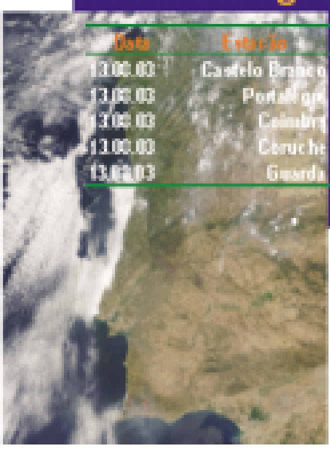


Day 13 August

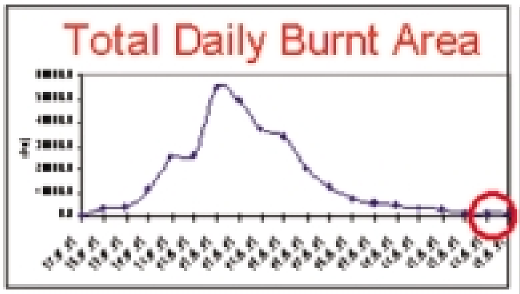


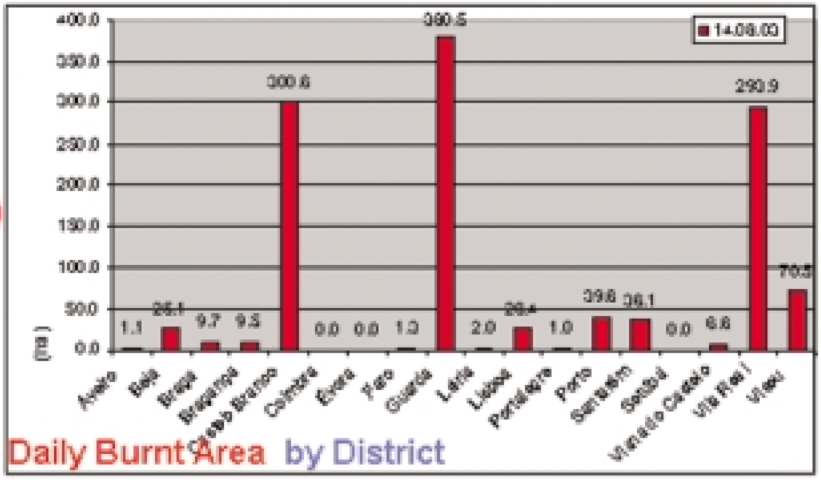
Nº of Fires with more then 1000 ha of Burnt Area: *0*

Meteorological data:



Data	Estação	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
13.08.03	Castelo Branco	38	-	49	-	21	-
13.08.03	Portalegre	38	27	45	18	25	-
13.08.03	Coimbra	30	-	100	-	14	-
13.08.03	Coruche	29	19	96	53	18	3
13.08.03	Guarda	33	23	54	22	32	3



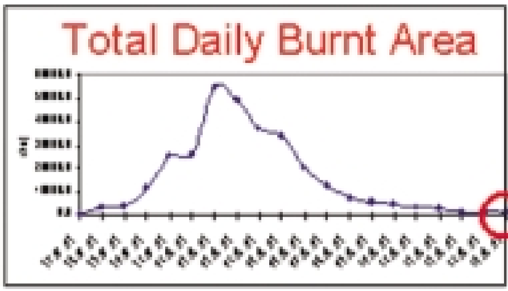


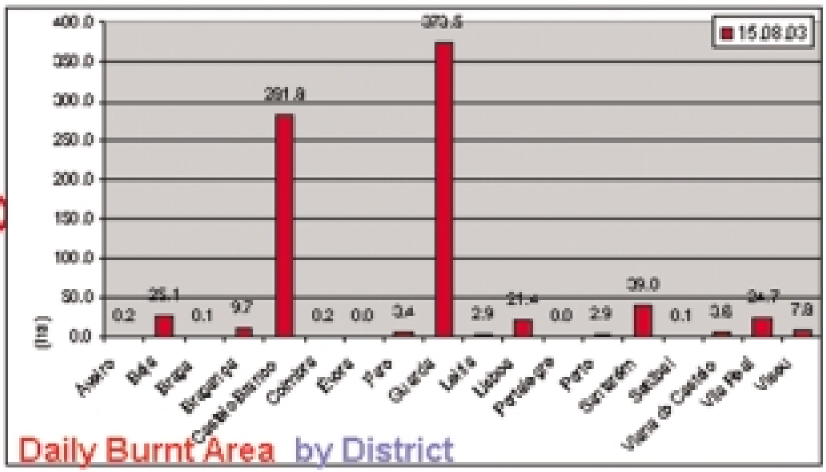
Day 14 August

Nº of Fires with more then 1000 ha of Burnt Area: *1*

Meteorological data:

Data	Estacão	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
14.08.03	Castelo Branco	37	-	46	-	32	-
14.08.03	Portalegre	36	-	61	-	25	-
14.08.03	Coimbra	27	-	99	-	18	-
14.08.03	Coruche	27	18	92	58	21	10
14.08.03	Guarda	30	18	69	19	32	14





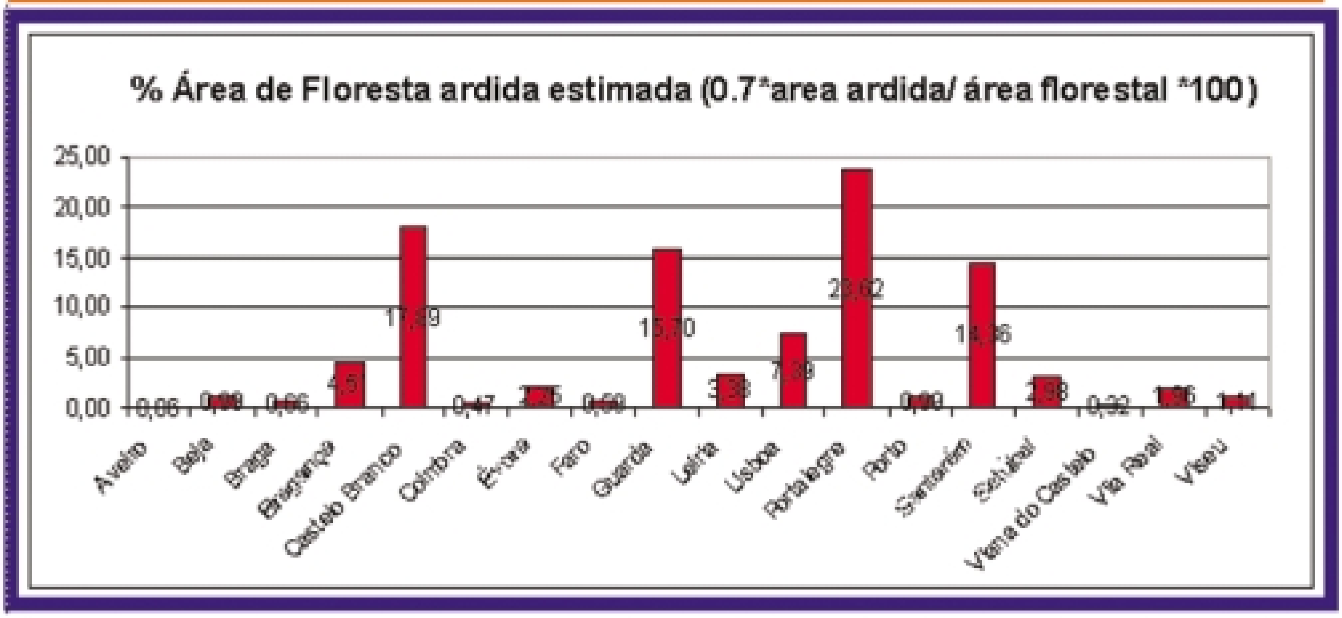
Day 15 August

Nº of Fires with more then 1000 ha of Burnt Area: *1*

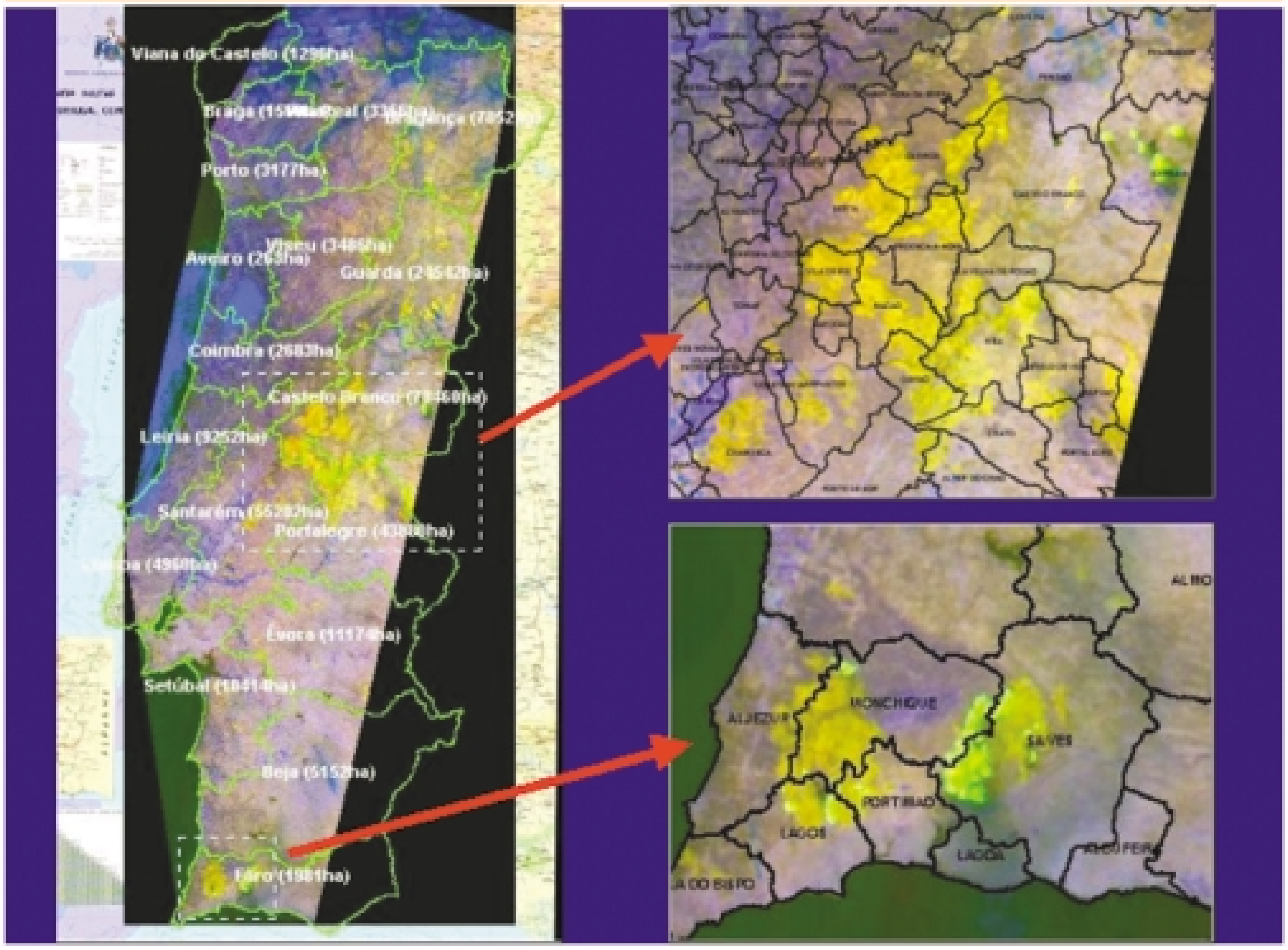
Meteorological data:

Data	Estacão	Max. Temp. (ºC)	Min. Temp. (ºC)	Max.HR. (%)	Min.HR. (%)	Max.IntVento(Km/h)	Min.IntVento(Km/h)
15.08.03	Castelo Branco	27	17	82	39	32	3
15.08.03	Portalegre	27	-	96	-	21	-
15.08.03	Coimbra	24	-	100	-	18	-
15.08.03	Coruche	25	19	91	62	18	7
15.08.03	Guarda	22	13	100	57	39	14

% of Forest area affected by district



Most affected areas



Consequences:

More than 15.500 forest fires, since the beginning of the year (average value 22.000).

- More than 400.000 hectares of burned area, since the beginning of the year (average value 98.500 ha).
- More than 242.000 hectares of burned area only between 28th July and 3rd August.
- 135 "big" forest fires (burned area > 100 ha), which represent about 300.000 hectares (82% of total burned area).

Organize Greece policy in fire management

The role of General Secretariat for Civil Protection

Athens 14-10-2003

General Secretariat for Civil Protection is the legally appointed service for studying, planning and organizing Greece's policy in matters of preventing, informing the public, facing and restoration of natural, technological and other disasters. Additionally, General Secretariat for Civil Protection coordinates private and public sector's resources in order to reassure our country's preparedness in facing disasters.

Forest fires are subsumed in the natural disasters category and are therefore of great concern for the General Secretariat of Civil Protection which being the head service has worked out the national fire plan and the coordination of all involved agents for the last few years.

Forest fires in Greece, occurring in a natural environment exceptionally prone to fires in matters of climate and vegetation, revealed for the last 30 years extreme frequency and intensity.

It is a matter of fact that this year, as well as the last two years the damages caused by fires in the forests were significantly smaller than the ones caused in the past.

This is mainly due to the fact that weather conditions during summer disfavored fires but to some extent it is also due to the measures taken from the responsible for preventing and suppressing forest fires authorities.

Dealing with forest fires, undoubtedly presupposes the involvement and coordinated action of many services and authorities, forest service, fire brigade, local authorities etc.

General Secretariat for Civil Protection has undertaken the coordination of the above services in a common effort against forest fires. Special attention was paid to local authorities since a recent law allowed them a more active role in protecting civilians from natural disasters.

We could say that General Secretariat for Civil Protection has acted on as a catalyst among the involved agents, moderating their differences and creating the conditions for mutual cooperation forming a unified frontier against forest fires.

It is well known that forest fires are caused by natural (e.g. lightning) or human (e.g. garbage burning) activities. Especially in Greece, it has been found that human caused fire risk is extremely high (more than 90%).

Therefore, since human activities are the main cause of forest fires, General Secretariat for Civil Protection has chosen to give priority to prevention activities, aiming at stopping their cause, as well as in the event of fire, to avoid damaging of buildings and settlements bordering with forests.

The Ministry of Interior funded actions for clearing vegetation around settlements and buildings in order to protect them. Specific instructions were given to organizations having networks and structures inside forests to take up measures to reduce fire risk caused by their operation. For example, Greek Public Power Corporation's power network was responsible for many forest fires in the past.

Planning within this framework can only be realized if there is good coordination among the involved authorities so that they act complementary.

That is the reason we have chosen to form small workgroups staffed with managers from all involved services and authorities (forest service, fire brigade, local authorities etc). These workgroups created local firefighting plans on a prefecture level, following specific instructions that we gave them. This way, we achieved a uniform preventative planning that was adapted to local diversities.

In addition to that, a workgroup of fire experts (foresters and meteorologists) has been established in General Secretariat for Civil Protection that was issuing a fire danger map on a daily basis. This thematic map represented 5 risk levels estimated for each geographic area in Greece.

This measure was deemed necessary, because the area that fires take place in Greece covers nearly 80% of its total area. The knowledge of fire risk as it varies over time and space is a great advantage for suppression forces, since they can take up additional pre-suppression measures, raising their preparedness levels, so that they can immediately respond in the event of fire.

Map preparation was completed until 12:30 of the previous day for which it was standing for. It was then sent to all operational centers and was published in General Secretariat for Civil Protection's web page. All agents, voluntary teams and anyone else interested could get information about fire risk.

In the event of extremely high risk in an area, there was a newsletter in the press and on the radio, warning civilians living in these areas, to avoid any action that could start a fire.

Our main goal was to make people responsible in our common effort for reducing the number of fires.

Today, reviewing the past period, we believe that warning the public through the press and the radio was a successful action.

The scientific group has used National Meteorological Service's special weather forecast for forest fires, forecasts resulting from models from the department of Physics of University of Athens, National Observatory's weather forecasts, National Center for Marine Research etc, as well as on-line data from meteorological stations of National Meteorological Service, University of Aegean etc.

Apart from meteorological data, the scientific group used operationally for the first time in Greece, NDVI maps especially produced for this purpose, showing the condition of vegetation and its changes.

Mediterranean Agronomic Institute of Chania created these maps every 10 days based on NOAA and MODIS satellite images. The scientific group was validating those maps with ground truth data.

Especially for Attica region, Forest Research Institute of Athens was taking measurements about vegetation stress of index plants.

Reviewing these forecasts we see that they were quite successful. The suppression forces were alert during summer and they managed to prevent and suppress all fires in their initial stage.

It is quite evident that when planning and facing a disaster is based on science and the use of new technologies the results are significant.

Summing up, I would like to remind you that General Secretariat for Civil Protection through the National Center for Forest Fires supports any effort that gives the opportunity to all involved agents in a scientific or operational level, to come in contact and exchange opinions in order to face forest fires more successfully.

Phivos Theodorou
Forester

Preventive measures against Forest Fires in Greece

Dr. Panagiotis Balatsos, e-mail: pbalatso@yahoo.com

The programs of prevention are related with all the activities that aim in the minimisation of impacts of forest fires. The various techniques that can be used for reduction of the human caused fires fall into two general categories: 1.to reduce the danger and 2.to manage it.

The danger is related to the breaking of fire, and the reduction of this includes elevation of the level of awareness of public and various teams of persons responsible for the beginning and the impacts of fires. The communication avenues for this can be the use of talented and specialised advertisers via national and local mass media (radio, TV, newspapers, magazines), additionally educational programs in schools, social or professional clubs, use of plates and personal contacts. The application of laws on fires is potentially a useful preventive technique. The education and the application of legislation are useful preventive measures when the fires it is result of ignorance, carelessness, or malice. These causes can be minimised by measures on the points of ignition or on fuels that accept the breaking of the fire. These causes can decrease themselves with differentiations of sources of beginning or fuels that accept the beginning the fire. The differentiations (you will moderate) the fuels have various forms. Round and at length of regions of high danger (e.g. installations-residence, dumps, camps, road and railway network) they can be created fire breaks or fuel breaks or replacement of flammable fuels (e.g. conifers) by not flammable fuels (e.g. broadleaves). Despite of the very high cost of manufacturing and maintaining of fire breaks or fuel breaks, a lot of countries continue to use it for reduction of fire danger. The differentiations of fuels (you will moderate) are considered very important measures to prevent very big fires.

After the application of the law N. 2612/98 in Greece in the spectrum of preventive activities, apart from the Forest Service that carries the bigger volume, are involved the Civil Protection and the Fire Brigade and many of the activities are programmed jointly and are executed autonomously or jointly (e.g. fire campaigns, daily fire danger forecast, etc). Because of the above all these activities of preventive confrontation require a very good collaboration among the involved agencies.

Our Forest Service in the frames above has contributes and contributes as following:

1) In the improvement of education of Fire Brigade executives with disposal of experts for programs of education and participation to scientific congresses and conferences on forest fires.
2) Collaborations with Fire Brigade and General Secretariat of Civil Protection for informative campaigns to prevent forest fires
3) It develops special network of meteorological stations to assist forest fire danger forecast and contributes in a daily fire risk mapping with its special scientists.
4) Disposal of experts to support scientifically the General Secretariat of Civil Protection Operational Centre.

Greek Ministry of Rural Development and Foods
General Directorate for Development and Protection of Forests and Natural Environment
Forest and Natural Environment Protection Directorate
Forest Fire Prevention and Suppression Department
tel:+ 30 210 5242349, fax: +30 210 5244135

The preventive activities that are main responsibility of Forest Service are programmed and execute by the Regional Forest Services according to directives of Central Service and depend on the allocated funds and the time of disposal. It is pointed out that the work of moderation of fuels is very costly and yearly repeated and because of this is not possible to be applied in a big scale but only on selected regions of very high danger. Also the forest road network dedicated to forest fire protection it is mainly manufactured to facilitate to the ground means movement to approach fires and not to be used as fire break.

The following table contains preventive measures and work executed from the year 1980 until nowadays specifically by the Forest Service to prevent forest fires.

YEARS	Roads and Fire-breaks construction and maintance km		Watching towers number	Water tanks number	Cleanings hectares
	Opening up	Maintainance			
1980-2001	17803 Annual mean 809	146408 Annual mean 6654	408 Annual mean 18	1400 Annual mean 63	164459 Annual mean 7475

The evolution of forest fires since 1980 until now is presented below in **tables 1 & 2**. While we compare the average fingers per decade we see significant increase in number of fires (from 1264 of the decade 80-89 to 1793 the last 14 years). The respective fingers of burnt areas despite the increase of forest fires decrease during the last 14 years and indicate a more effective control of forest fires during the last years. This is contributed to improvements in preventive and suppression mechanisms with more characteristic the significant increase in the use of aerial means (**table 3**).

Table 1. Wildfire database 1980-1989

Year	Total No. of Fires on Forest, Other Wooded Land & Other Land No	Total Area Burnt on Forest, Other Wooded Land & Other Land Ha	Area of Forest Burnt ha	Area of Other Wooded Land and Other Land Burnt ha
1980	1207	32965	4355	28610
1981	1159	81417	38653	42764
1982	1045	27372	10843	16529
1983	968	19613	10907	8706
1984	1284	33656	12018	21638
1985	1442	105450	48631	56819
1986	1082	24514	10109	14404
1987	1266	46315	13605	32710
1988	1898	110501	27370	83131
1989	1284	42364	23600	18763
Average	1264	52417	20009	32408

Record data for all wildfires, or any fire occurring on wildland except a fire under prescription.

Table 2. Wildfire database 1990-2003

Year	Total No. of Fires on Forest, Other Wooded Land & Other Land No	Total Area Burnt on Forest, Other Wooded Land & Other Land Ha	Area of Forest Burnt ha	Area of Other Wooded Land and Other Land Burnt ha
1990	1322	38593	21088	17505
1991	941	23574	8000	15574
1992	2042	66346	23194	43153
1993	2406	54049	24200	29849
1994	1763	52603	23392	29211
1995	1438	19177	9035	10142
1996	1508	22990	8111	14879
1997	2273	34781	16119	18662
1998	1842	92901	46077	46824
1999	1486	8289	4773	3516
2000	2581	145033	69579	75455
2001	2658	18342	8423	9929
2002	1400	4337	887	3450
2003	1441	3277	956	2321
Average	1793	41735	18845	22890

Record data for all wildfires, or any fire occurring on wildland except a fire under prescription.

Table 3. FIRE CAMPAIGN 2003

STATE OWNED MEANS

AIRCRAFTS	LARGE	CL-215	15
		CL-415	9
	SMALL	PEZETEL	18
		GRUMMAN	6
HELICOPTERS	H/P PK 117	2	
	TOTAL	*50*	

HIRED MEANS

AIRCRAFT	CL-215	0
HELICOPTERS	H/P MI-26	4
	H/P SIKORSKY 64	3
	H/P MI-14	1
	H/P KA-32	4
	AC355	0
	TOTAL	*12*

Despite the increasing expenses with regard to the suppression mechanisms the last years so much in the countries of E.U. but also internationally, becomes more perceptible the calamitous nature of forest fires in such environments and is mainly created needs of turn in a more efficient organization of confrontation with focus in prevention. In Greece where an effort to focus more in prevention and better collaboration among the responsible agencies was made, after the disastrous year 2000, it seems that has good results when we look at results of the last 3 years but we did not faced during this time very severe weather conditions.

In a lot of countries, including Greece, are observed abandoned of rural regions, concentration in urban spaces and ageing of the farmers with very important repercussions in the accumulation of fuel matter that creates big difficulties and this requires important changes in the configuration of forest policy with regard to the preventive confrontation of fires.

Points in which, except the other, it will be supposed is focused the forest policy

a) Use of technological innovations

b) Pilot programs and studies

c) Database improvements, fire causes investigation, cost-benefit analysis.

The new EEC regulation Forest Focus and the European Forest Fire Information System (EFFIS)

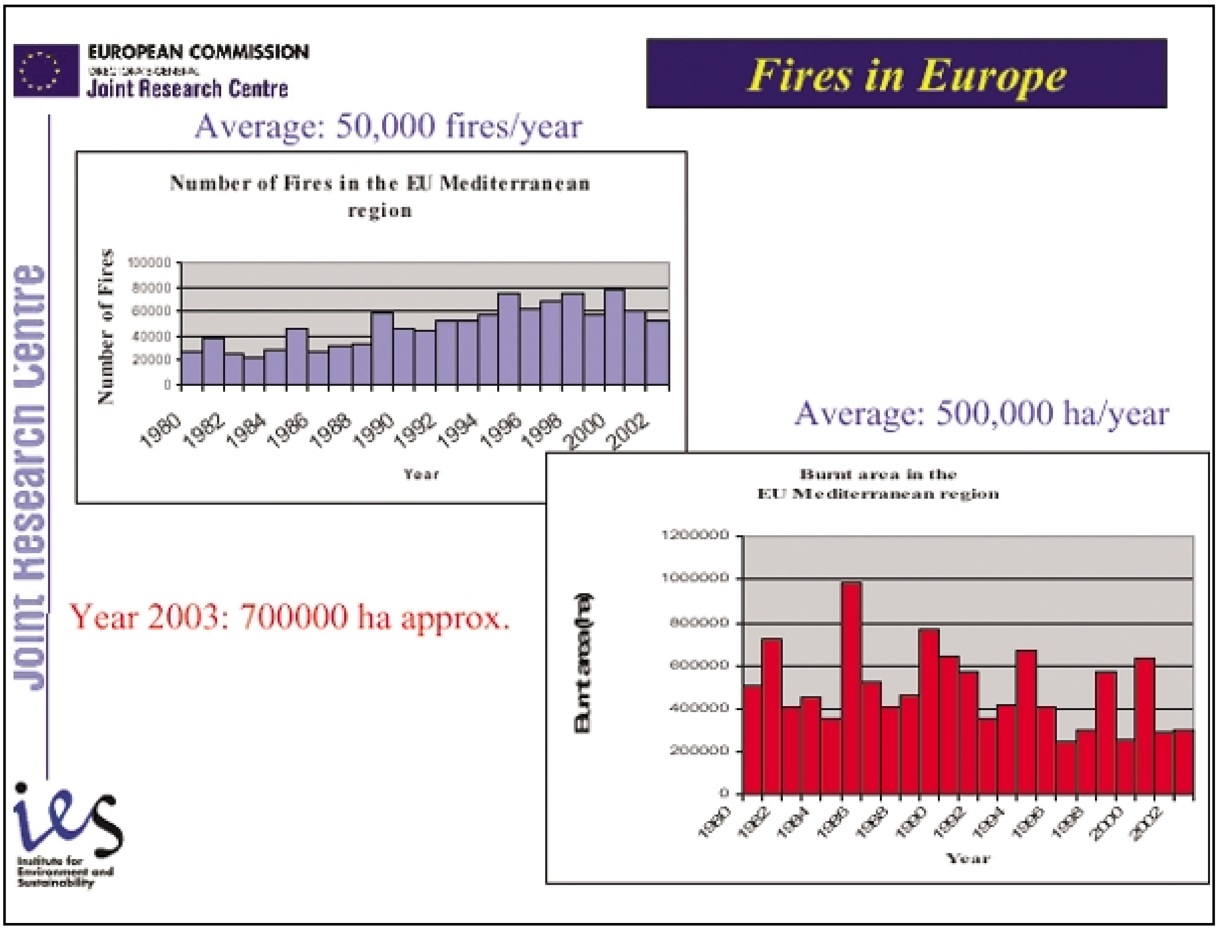
Jesus San - Miguel - Ayanz

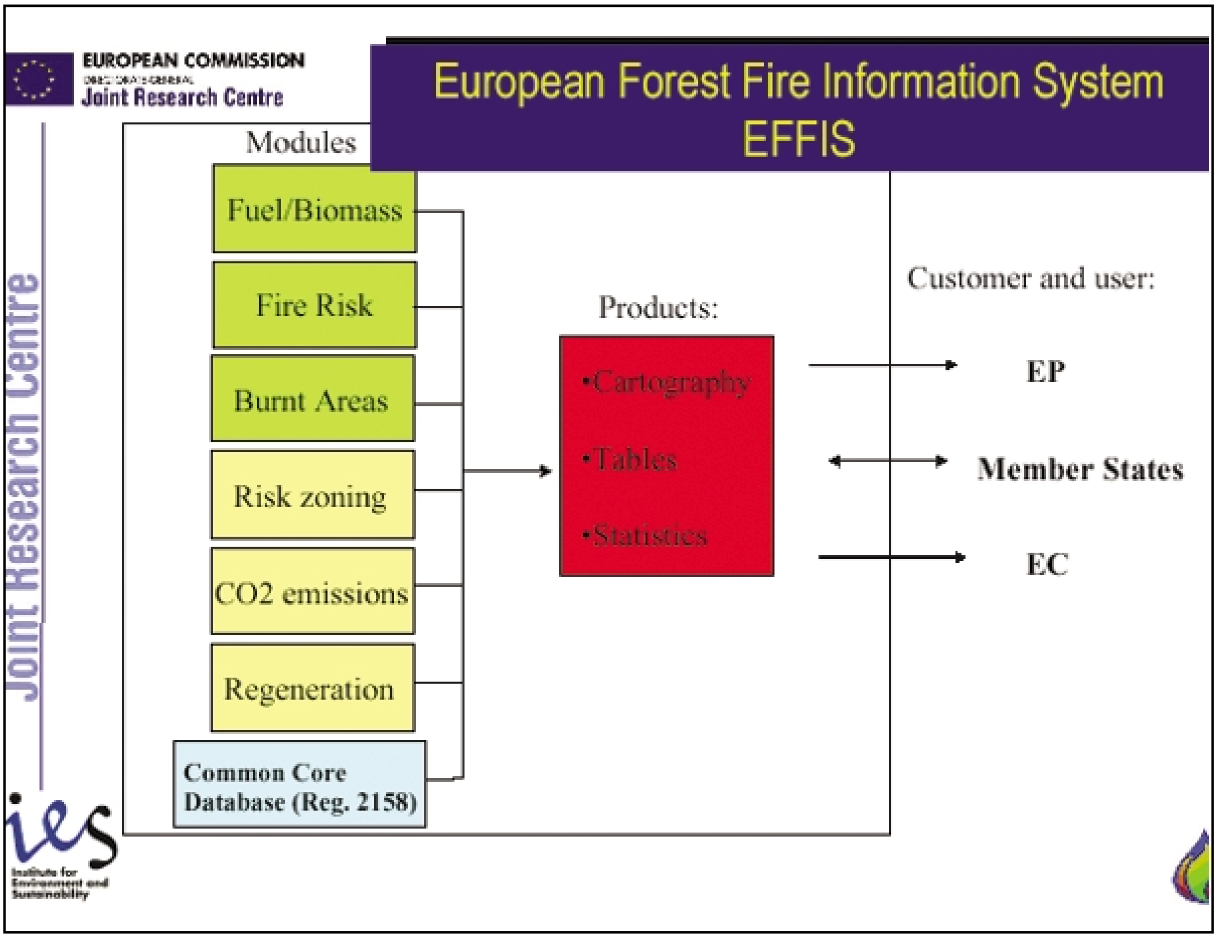
Forest Fires - Policy Framework in the EU

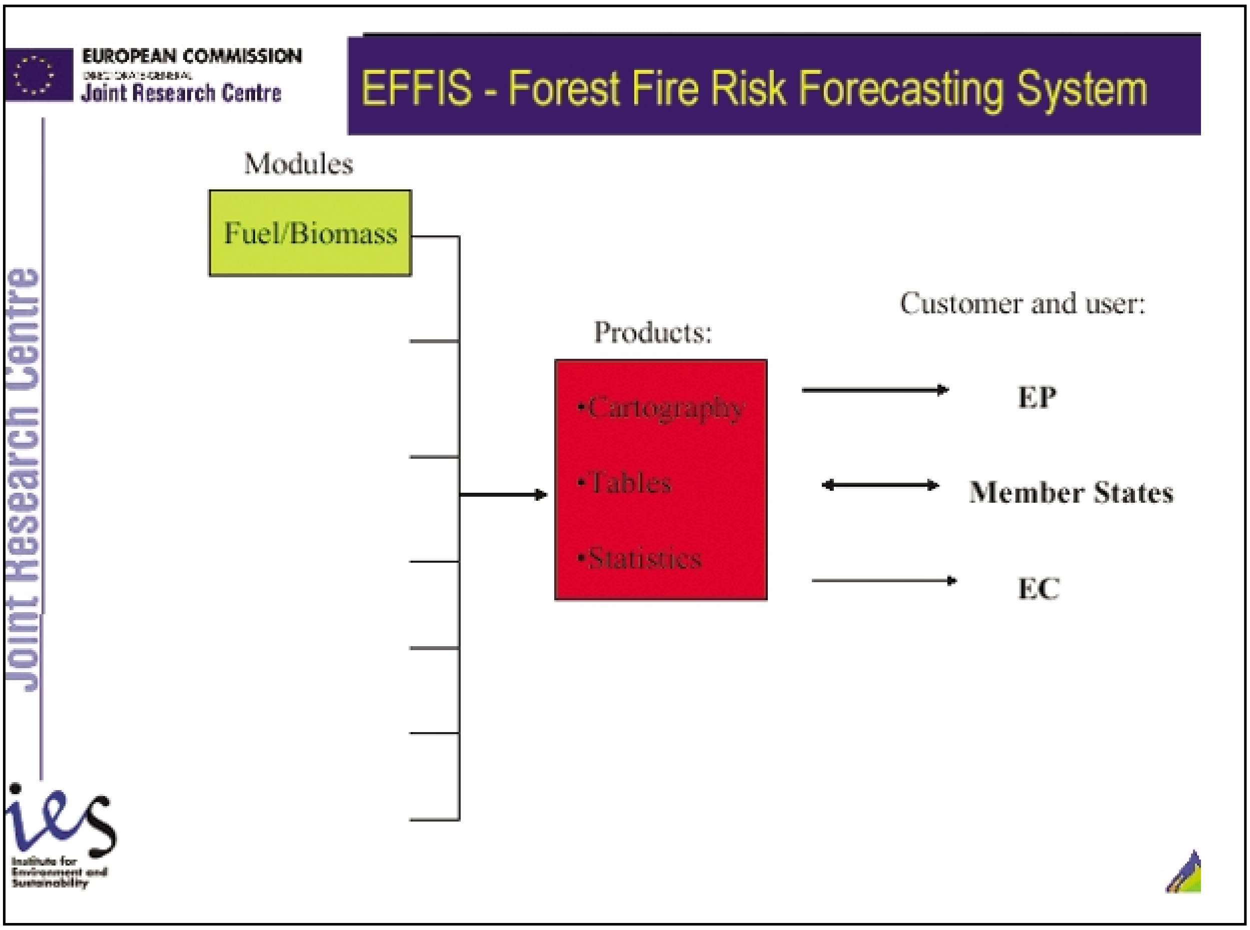
- Lack of harmonized information on forest fires and their impact in Europe
- Forest Fires (EEC 2158/92)
- Need to monitor the effect of atmospheric pollution on forests
- Atmospheric Pollution on forests (EEC Reg.3528/86)
- Need for improved cooperation in forest fire fighting
- Community Action Plan on Civil Protection
- Need to enhance regional development on areas affected by hazards
- European Spatial Development Perspective (ESDP)/ESPON
- Other policies related to fires
- Rural Development, follow up of EFICS

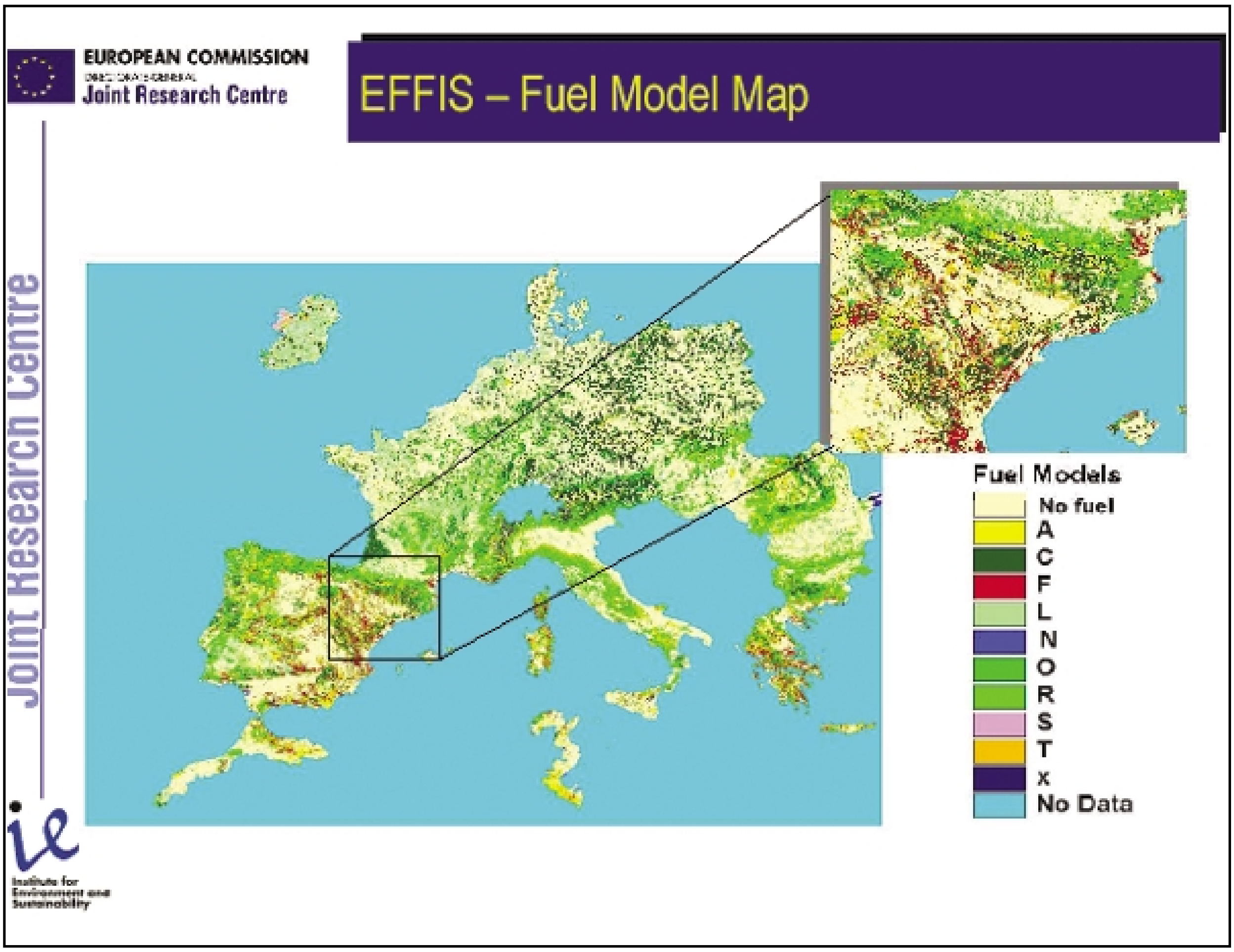
Forest Focus (EEC 2152/ 2003)

- Forest Fires (EEC 2158/ 92)] 2006
- Atmospheric Pollution on forests (EEC 3528/86)] 2006
- Soils
- Biodiversity
- Climate Change & Carbon sequestration
- Protective function of the forests


EUROPEAN COMMISSION
Joint Research Centre
Fires in Europe
Average: 50,000 fires/year
Number of Fires in the EU Mediterranean region
Number of Fires
Year
Average: 500,000 ha/year
Burnt area in the EU Mediterranean region
Burnt area (ha)
Year
Year 2003: 700000 ha approx.
Joint Research Centre
Institute for Environment and Sustainability


EUROPEAN COMMISSION
Joint Research Centre
European Forest Fire Information System
EFFIS
Modules
Fuel/Biomass
Fire Risk
Burnt Areas
Risk zoning
CO2 emissions
Regeneration
Common Core Database (Reg. 2158)
Products:
•Cartography
•Tables
•Statistics
Customer and user:
EP
Member States
EC
Joint Research Centre
Institute for Environment and Sustainability


EUROPEAN COMMISSION
Joint Research Centre
EFFIS - Forest Fire Risk Forecasting System
Modules
Fuel/Biomass
Products:
•Cartography
•Tables
•Statistics
Customer and user:
EP
Member States
EC
Joint Research Centre
Institute for Environment and Sustainability


EUROPEAN COMMISSION
Joint Research Centre
EFFIS – Fuel Model Map
Fuel Models
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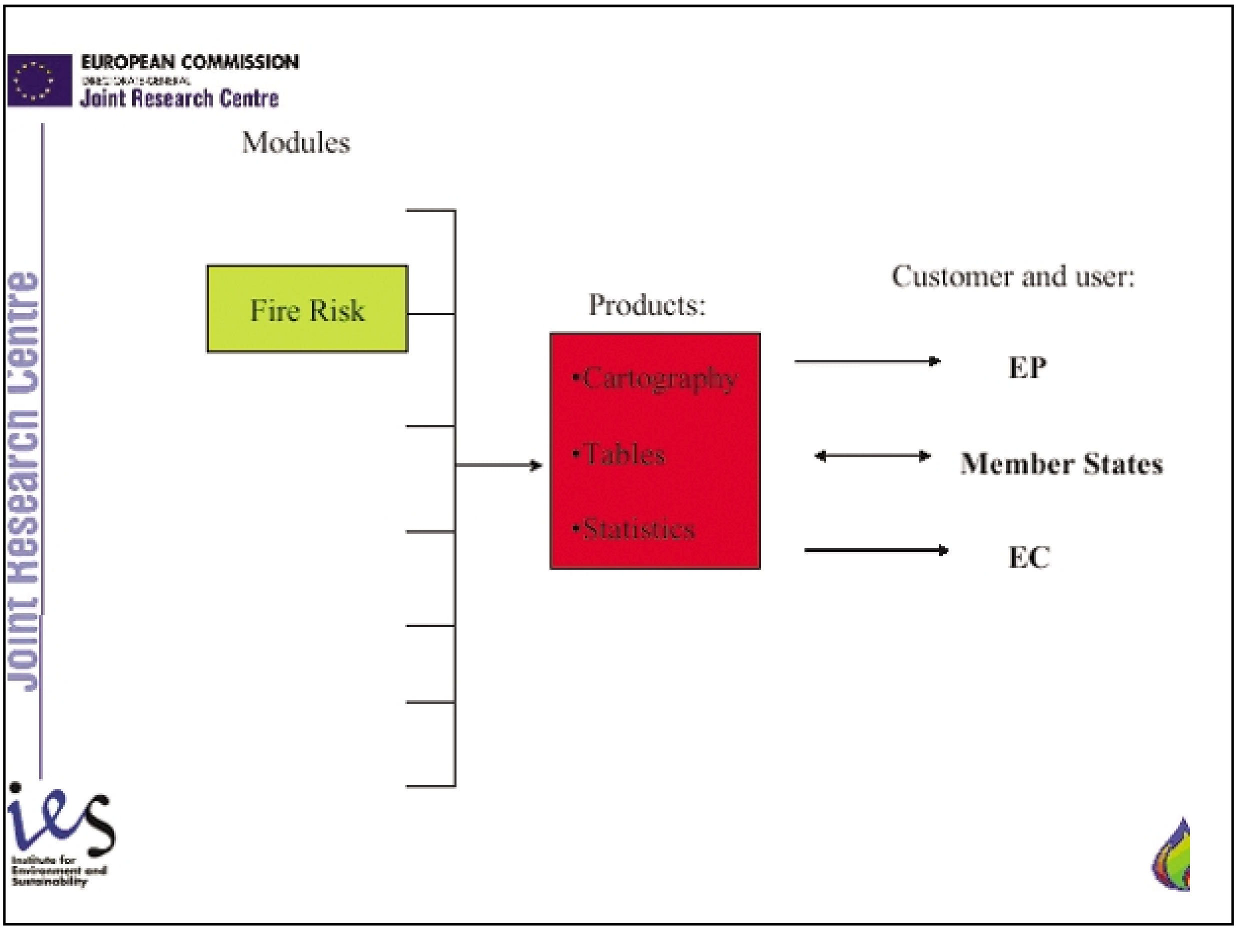
Joint Research Centre
Institute for Environment and Sustainability


EUROPEAN COMMISSION
Joint Research Centre
Joint Research Centre
Modules
Fire Risk
Products:
•Cartography
•Tables
•Statistics
Customer and user:
EP
Member States
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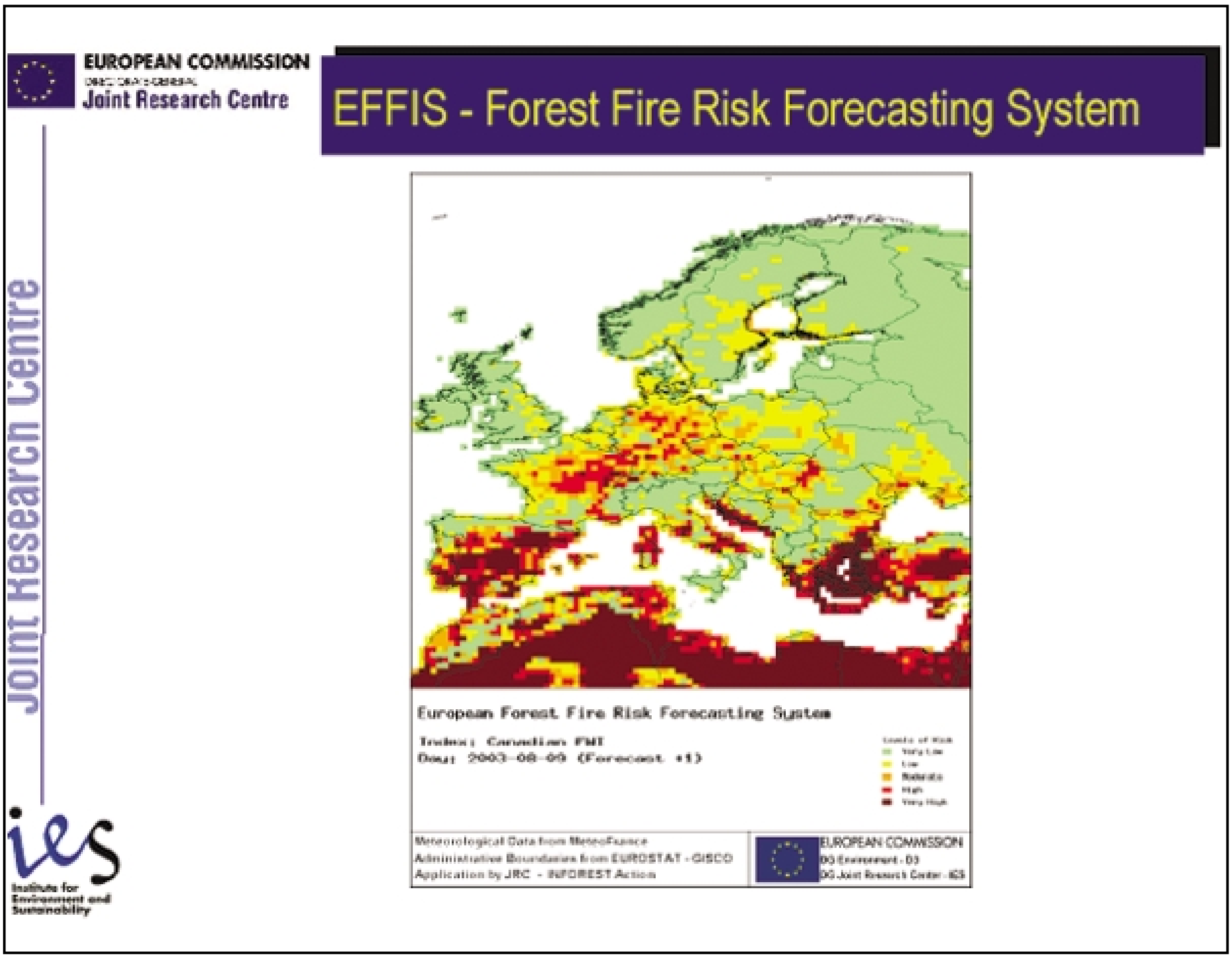
Institute for Environment and Sustainability


EUROPEAN COMMISSION
Joint Research Centre
EFFIS - Forest Fire Risk Forecasting System
Joint Research Centre
European Forest Fire Risk Forecasting System
Index: Canadian FWI
Day: 2003-08-09 (Forecast +1)
Meteorological Data from MeteoFrance
Administrative Boundaries from EUROSTAT - GISCO
Application by JRC - INFOREST Action
EUROPEAN COMMISSION
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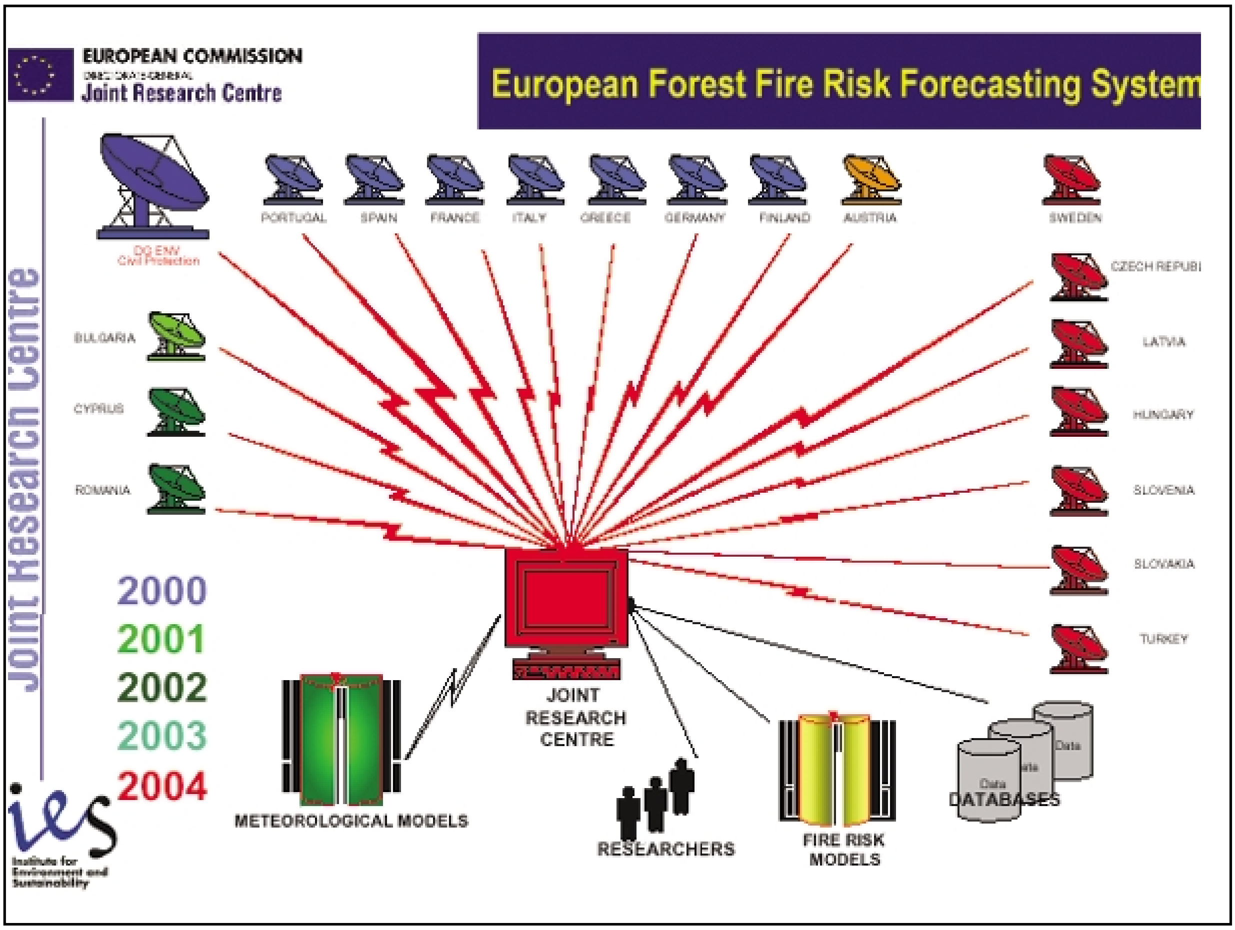
EUROPEAN COMMISSION
Joint Research Centre
European Forest Fire Risk Forecasting System
PORTUGAL
SPAIN
FRANCE
ITALY
GREECE
GERMANY
FINLAND
AUSTRIA
SWEDEN
DG ENV
Civil Protection
CZECH REPUBI
BULGARIA
LATVIA
CYPRUS
HUNGARY
ROMANIA
SLOVENIA
SLOVAKIA
TURKEY
Joint Research Centre
2000
2001
2002
2003
2004
JOINT RESEARCH CENTRE
METEOROLOGICAL MODELS
RESEARCHERS
FIRE RISK MODELS
DATABASES
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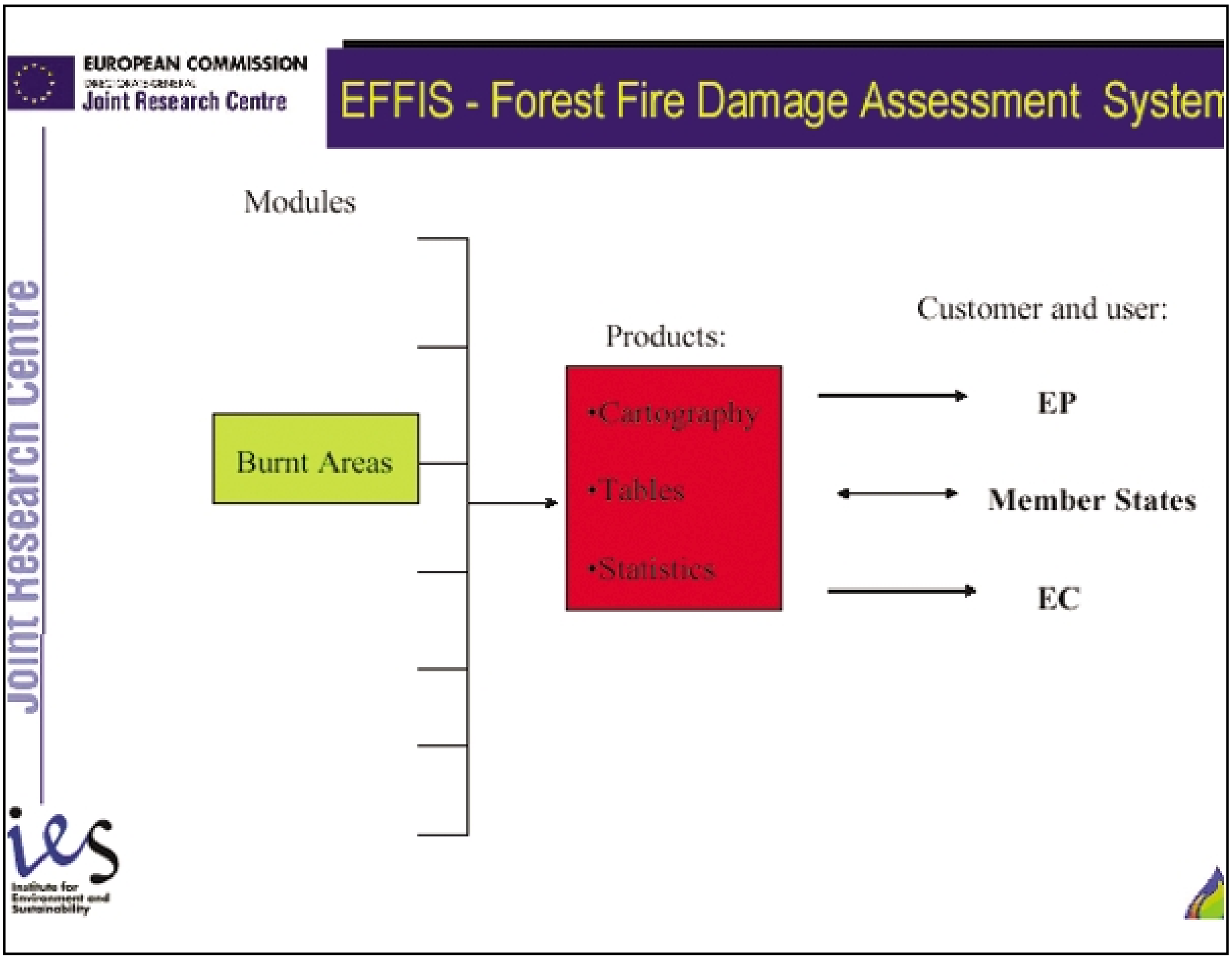
Institute for Environment and Sustainability


EUROPEAN COMMISSION
Joint Research Centre
EFFIS - Forest Fire Damage Assessment System
Modules
Customer and user:
Products:
Burnt Areas
•Cartography
•Tables
•Statistics
EP
Member States
EC
Joint Research Centre
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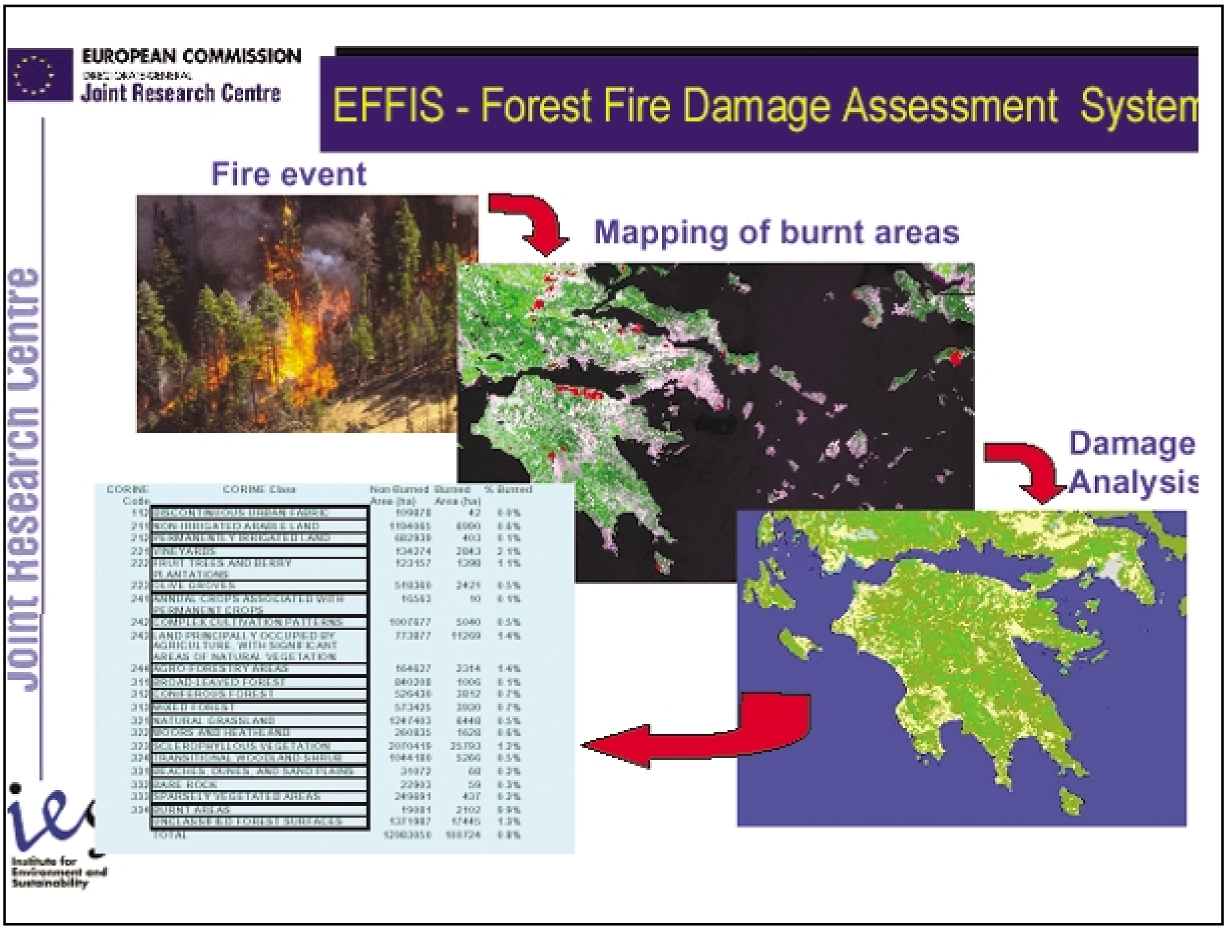
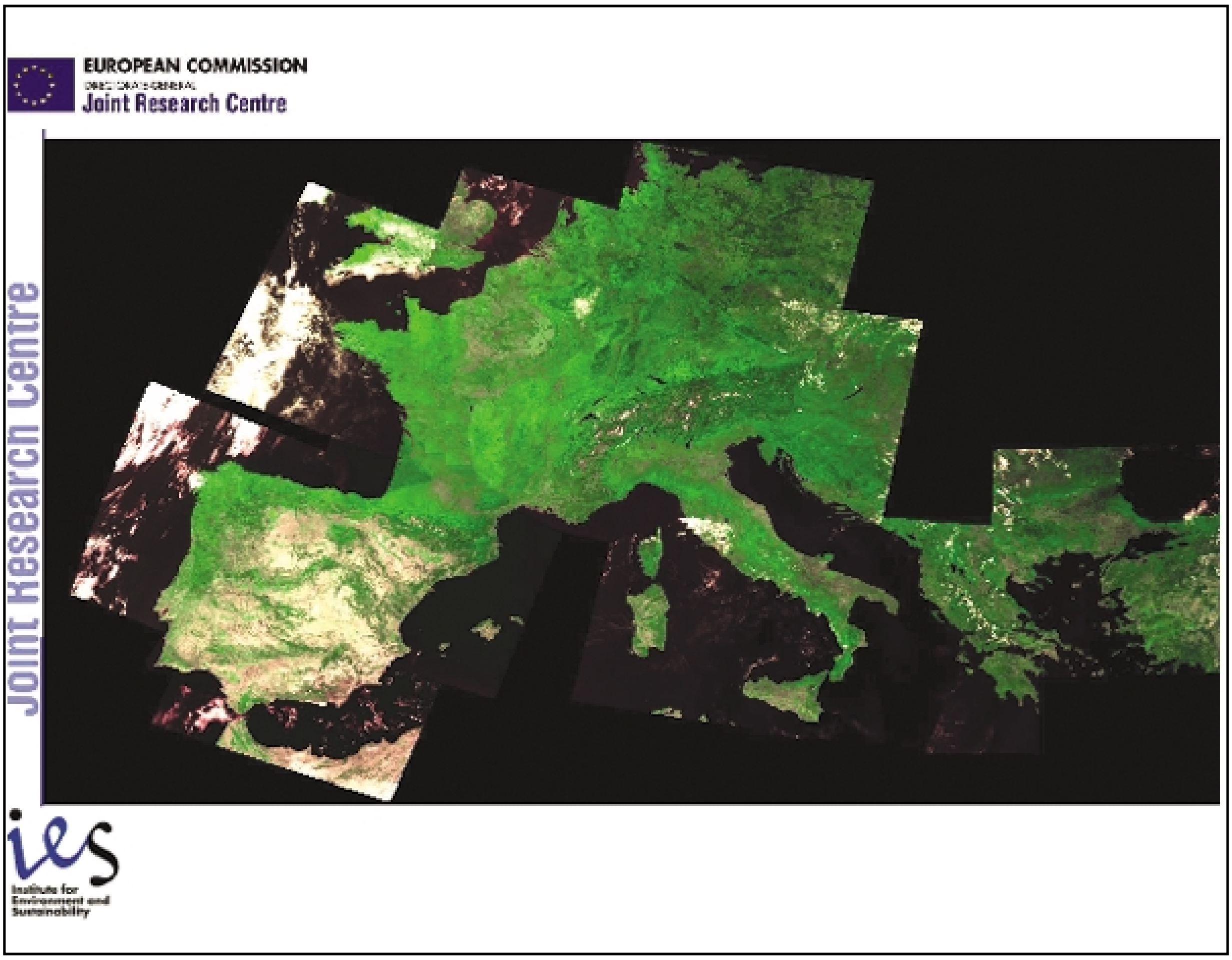
Institute for Environment and Sustainability



CORINE Code	CORINE Class	Non Burned Area (ha)	Burned Area (ha)	% Burned
112	DISCONTINUOUS URBAN FABRIC	109878	42	0.0%
211	NON IRRIGATED ARABLE LAND	1194665	6990	0.6%
212	PERMANENTLY IRRIGATED LAND	682936	403	0.1%
221	VINEYARDS	134274	2843	2.1%
222	FRUIT TREES AND BERRY PLANTATIONS	123157	1398	1.1%
223	OLIVE GROVES	510360	2421	0.5%
241	ANNUAL CROPS ASSOCIATED WITH PERMANENT CROPS	16563	10	0.1%
242	COMPLEX CULTIVATION PATTERNS	1007677	5040	0.5%
243	LAND PRINCIPALLY OCCUPIED BY AGRICULTURE, WITH SIGNIFICANT AREAS OF NATURAL VEGETATION	773877	11269	1.4%
244	AGRO-FORESTRY AREAS	164627	2314	1.4%
311	BROAD-LEAVED FOREST	840208	1006	0.1%
312	CONIFEROUS FOREST	526436	3812	0.7%
313	MIXED FOREST	573425	3930	0.7%
321	NATURAL GRASSLAND	1247403	6448	0.5%
322	MOORS AND HEATHLAND	260835	1620	0.6%
323	SCLEROPHYLLOUS VEGETATION	2070419	25793	1.2%
324	TRANSITIONAL WOODLAND SHRUB	1044188	5266	0.5%
331	BEACHES, DUNES, AND SAND PLAINS	31972	68	0.2%
332	BARE ROCK	22983	59	0.3%
333	SPARSELY VEGETATED AREAS	249891	437	0.2%
334	BURNT AREAS	19081	2102	9.9%
	UNCLASSIFIED FOREST SURFACES	1371987	17445	1.3%
	TOTAL	12983056	108724	0.8%



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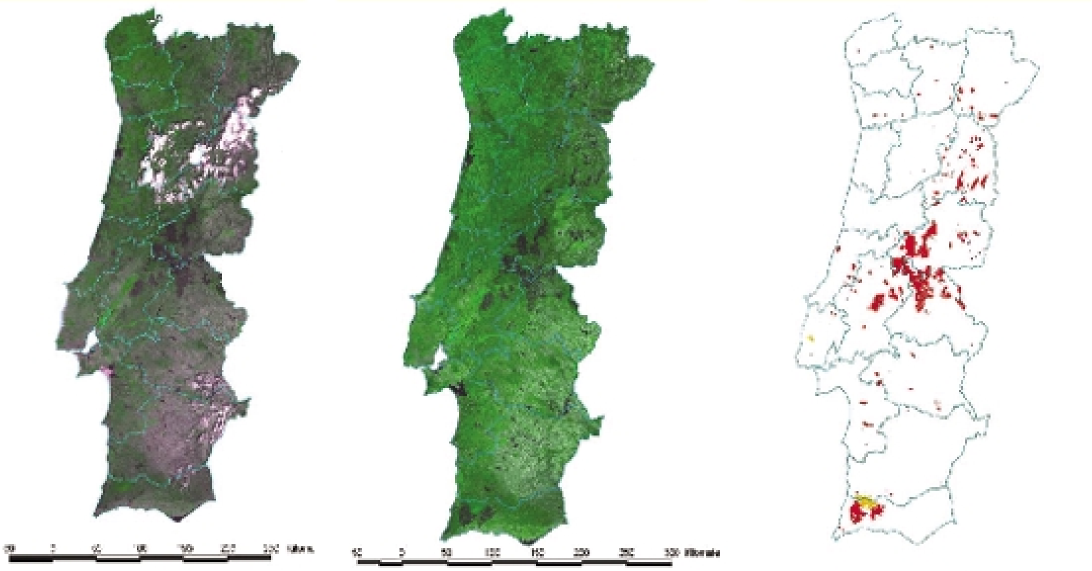
DIRECTORATE-GENERAL
Joint Research Centre

Joint Research Centre

Burnt area in Portugal: Aug. 8th – Sept. 15th, 2003

216 184 ha (Aug. 8) | 355 976 ha (Aug. 20) | 379 038 ha (Sept. 15



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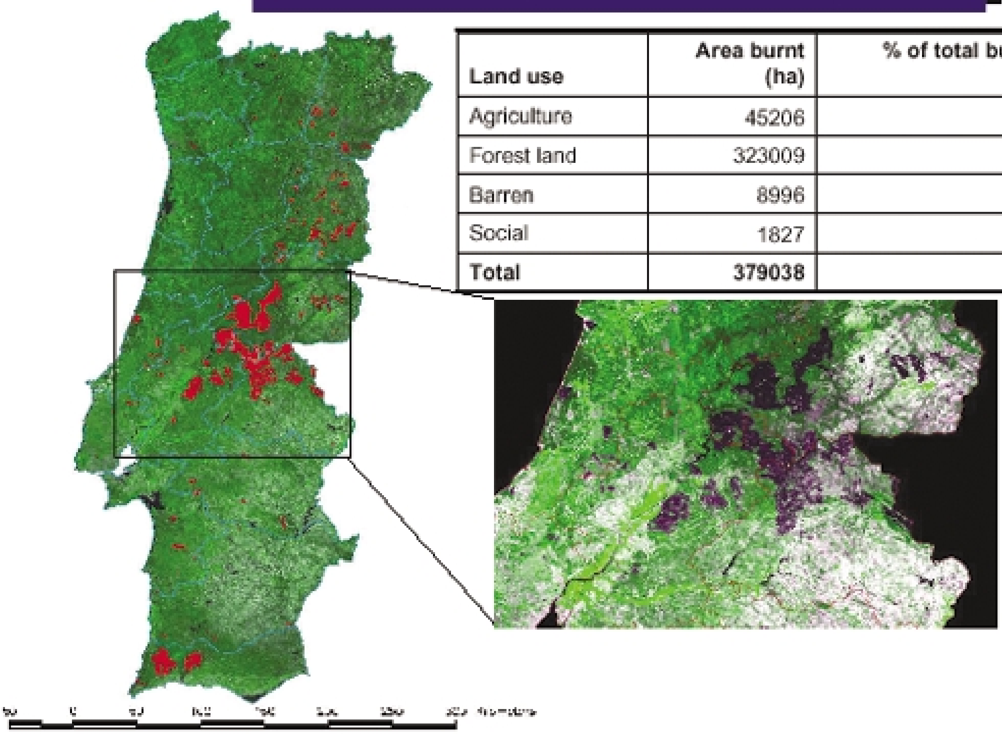
Joint Research Centre

Joint Research Centre

EFFIS - Damage assessment System

Land use	Area burnt (ha)	% of total burned
Agriculture	45206	11.9
Forest land	323009	85.2
Barren	8996	2.4
Social	1827	0.5
Total	**379038**	**100.0**



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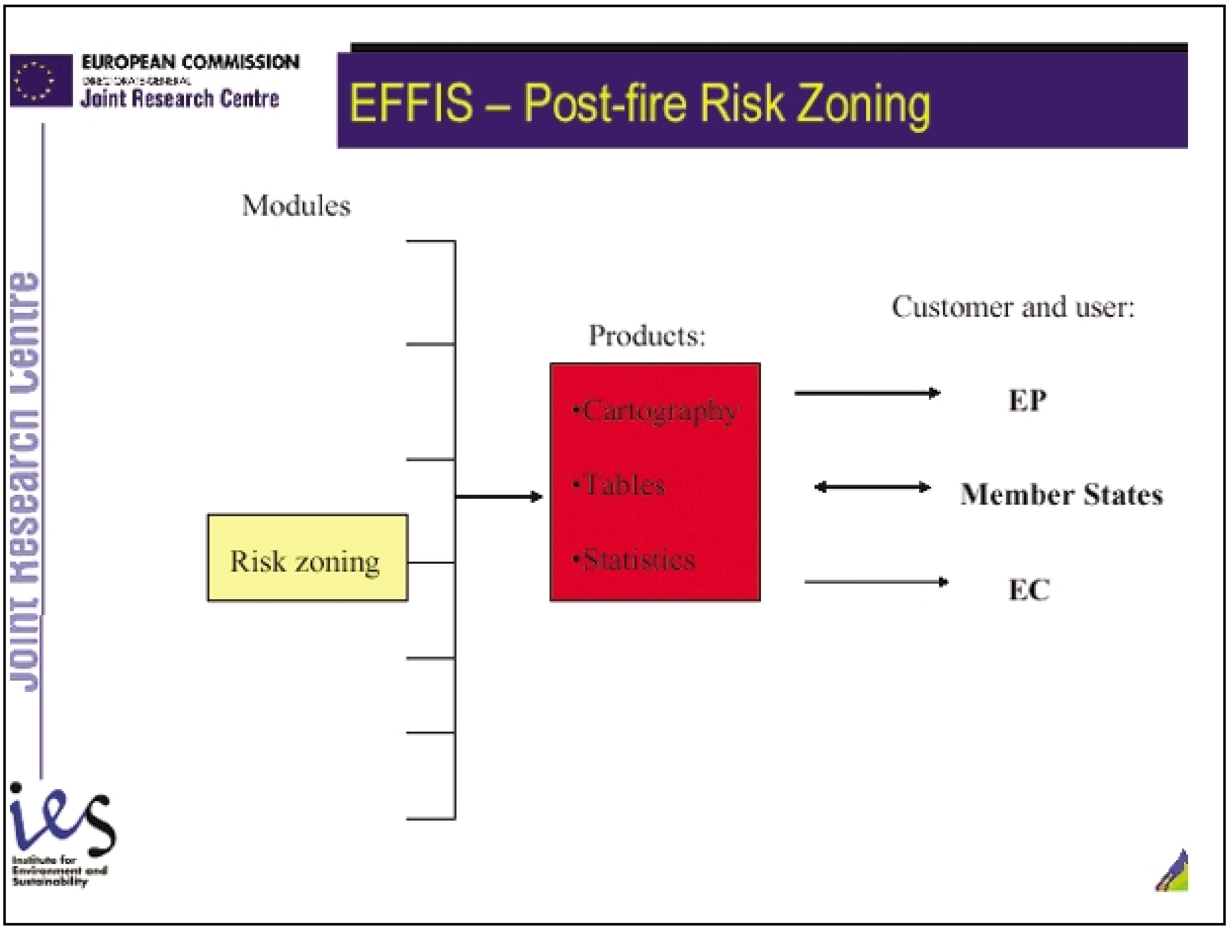
EUROPEAN COMMISSION
Joint Research Centre
EFFIS – Post-fire Risk Zoning
Modules
Risk zoning
Products:
•Cartography
•Tables
•Statistics
Customer and user:
EP
Member States
EC
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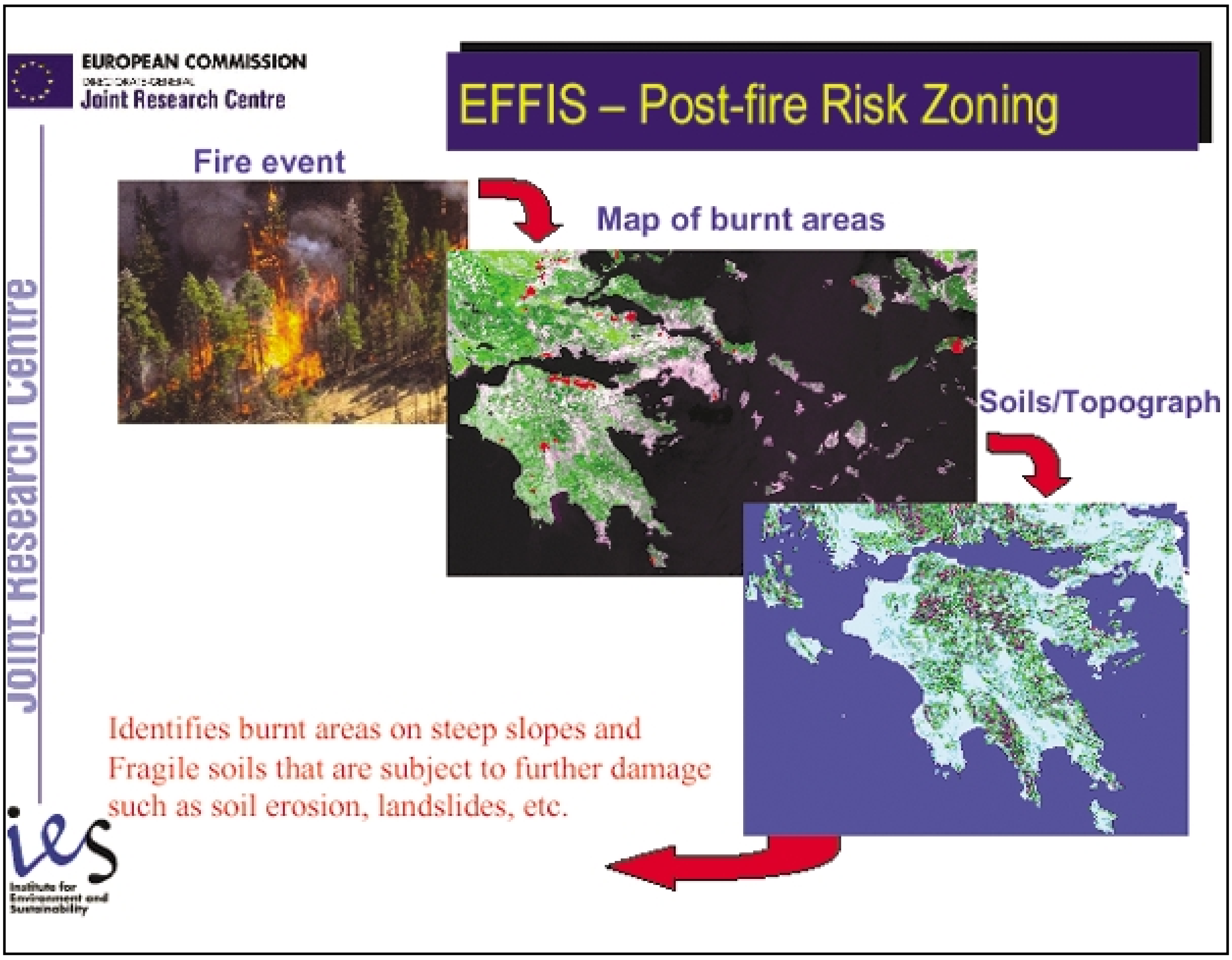
EUROPEAN COMMISSION
Joint Research Centre
EFFIS – Post-fire Risk Zoning
Fire event
Map of burnt areas
Soils/Topograph
Identifies burnt areas on steep slopes and
Fragile soils that are subject to further damage
such as soil erosion, landslides, etc.
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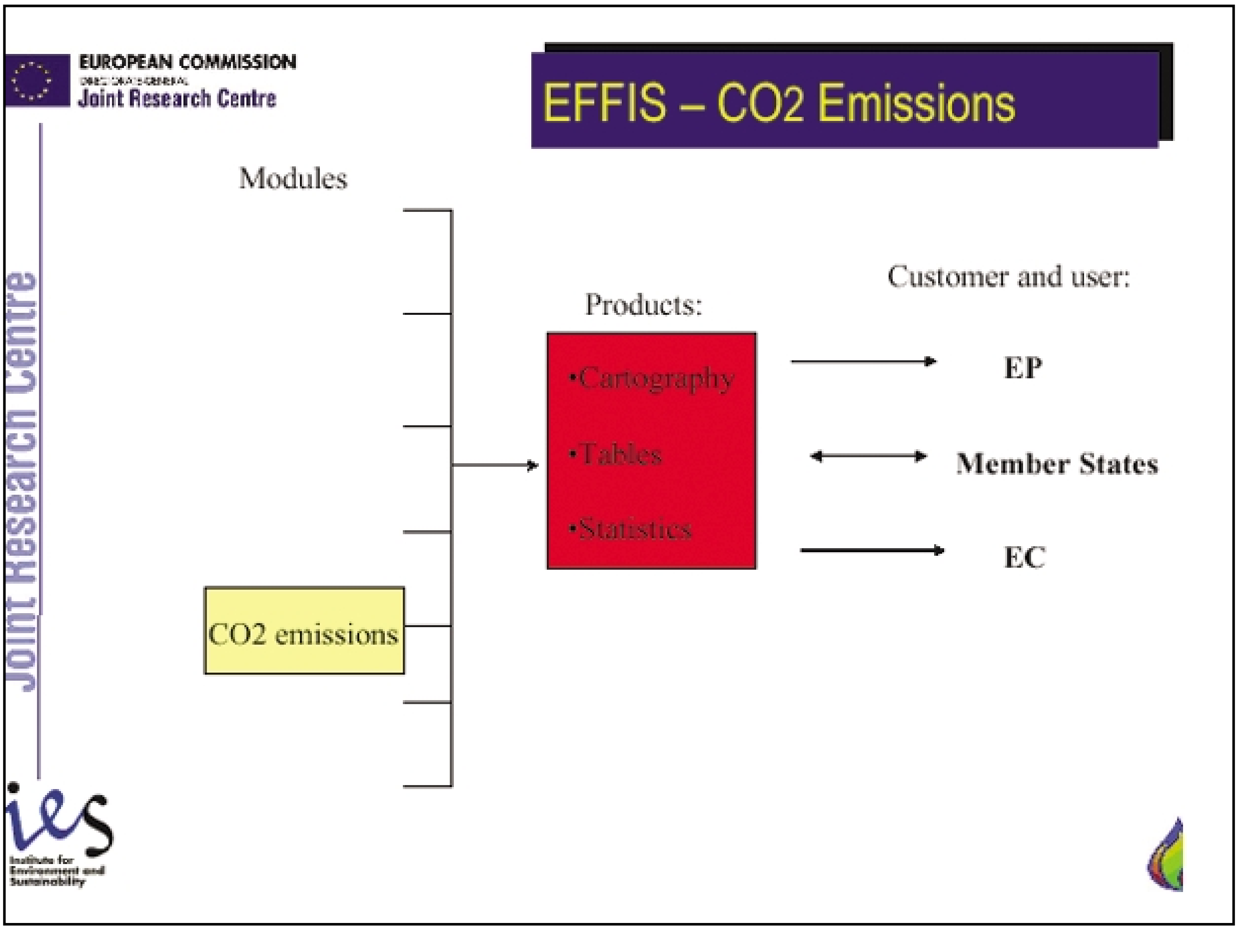
EUROPEAN COMMISSION
Joint Research Centre
EFFIS – CO2 Emissions
Modules
Products:
•Cartography
•Tables
•Statistics
Customer and user:
EP
Member States
EC
CO2 emissions
Joint Research Centre
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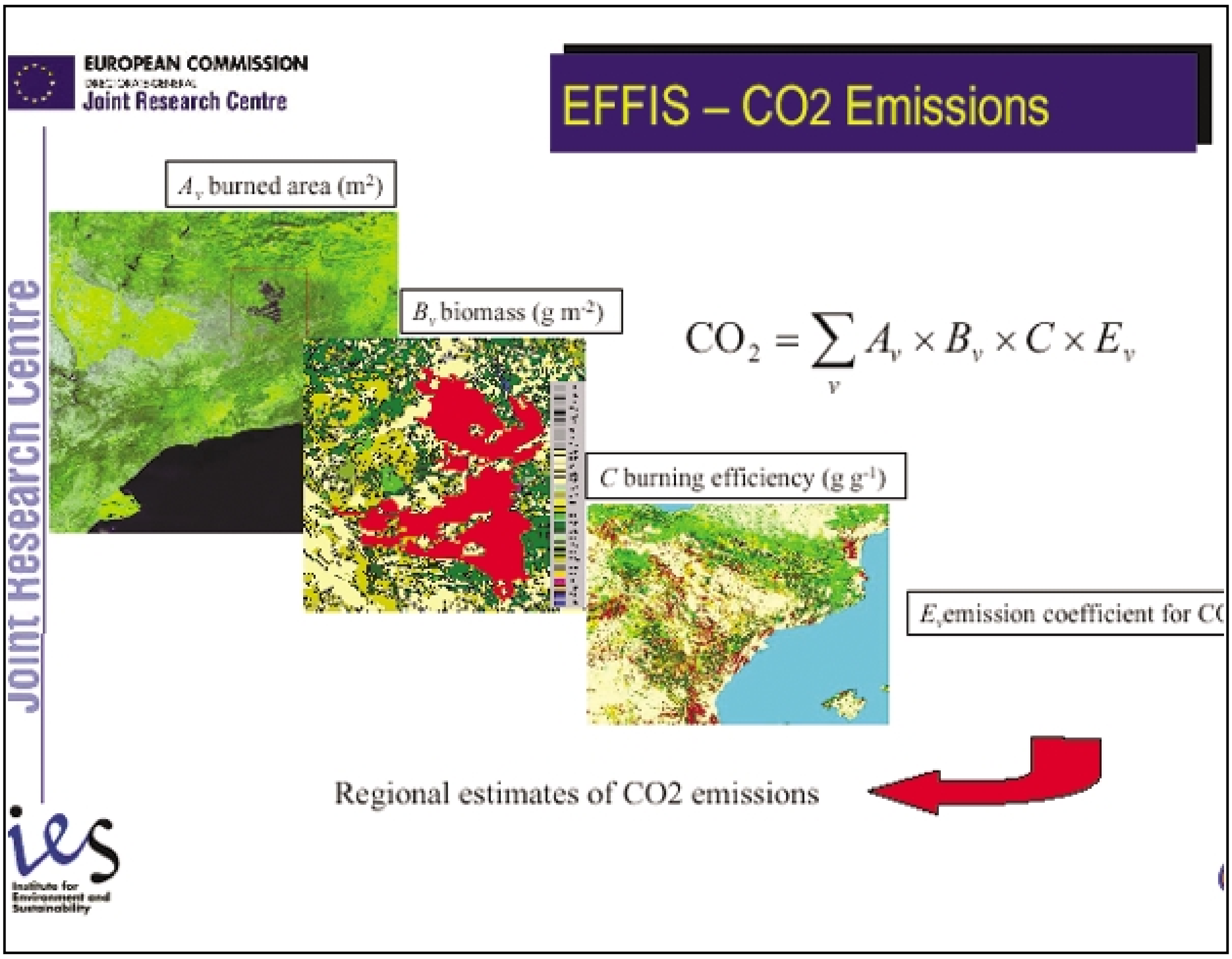
Institute for Environment and Sustainability


EUROPEAN COMMISSION
Joint Research Centre
EFFIS – CO2 Emissions
A_v burned area (m^2)
B_v biomass ($g\ m^{-2}$)
C burning efficiency ($g\ g^{-1}$)
E_v emission coefficient for CC
$$CO_2 = \sum_v A_v \times B_v \times C \times E_v$$
Regional estimates of CO2 emissions
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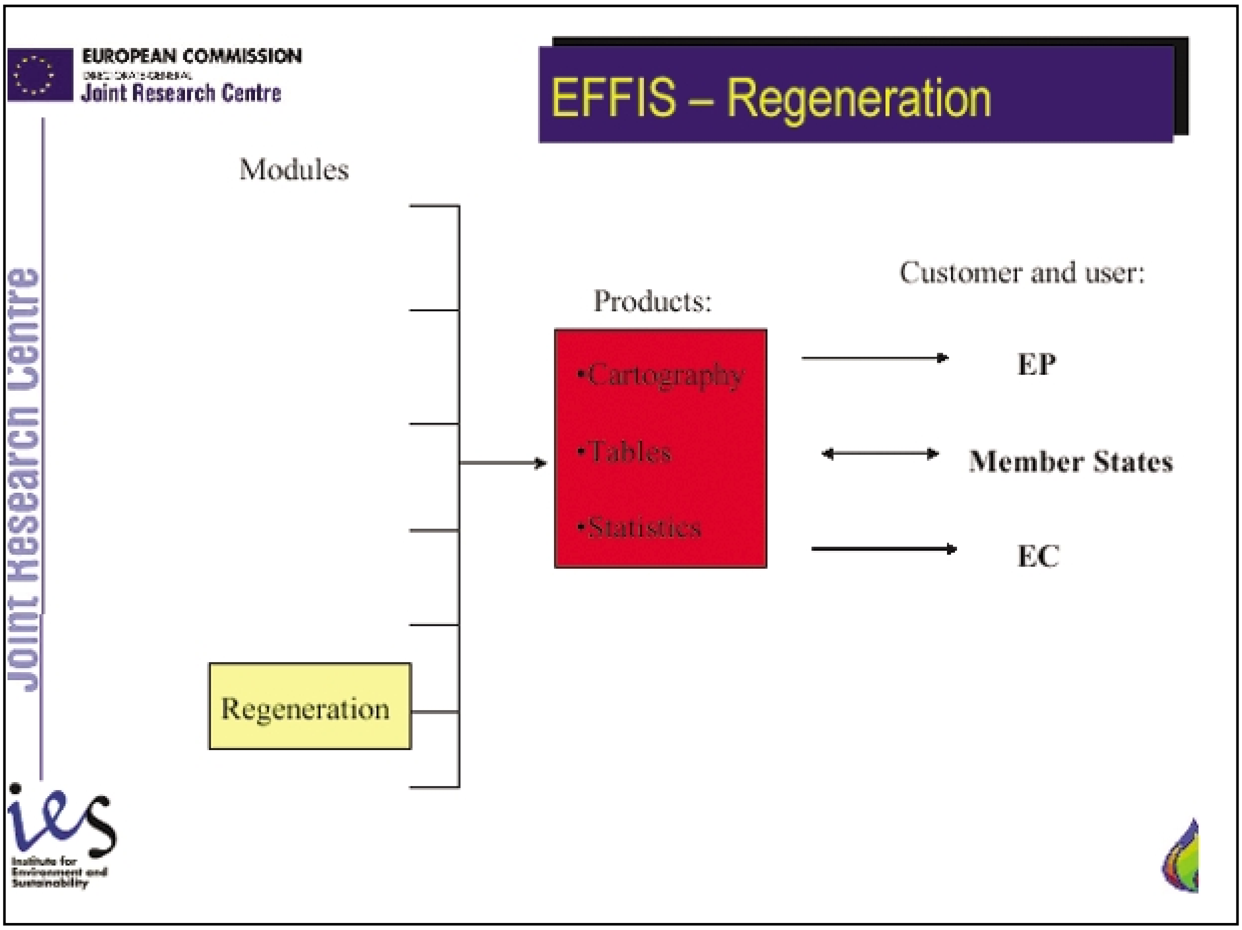
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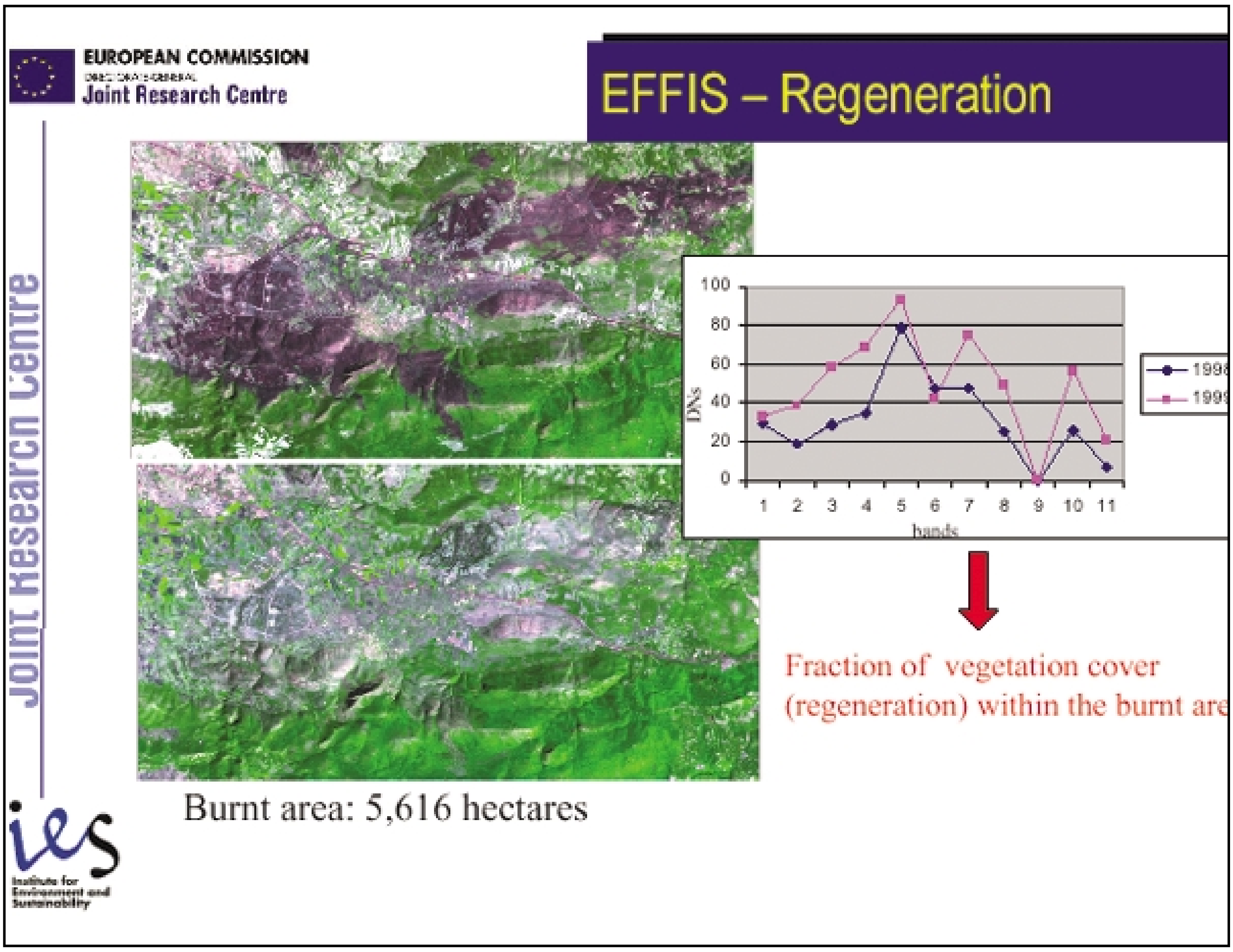
EUROPEAN COMMISSION
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EFFIS – Regeneration
100
80
60
40
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DNs
1 2 3 4 5 6 7 8 9 10 11
bands
Fraction of vegetation cover
(regeneration) within the burnt are
Burnt area: 5,616 hectares
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Health impacts of forest fires smoke on fire-fighters and populations (Article)

1. Introduction

Forest fires consist an environmental disaster with global consequences (ecological, eco nomical, medical). More specifically, large scale forest fires, such as the ones which take place in various places of the world (e.g. Borneo, Sumatra in 1997-98), usually contribute to a significant percentage of global air pollution, threatening not only the populations in the vicinity of the fire front, but the populations on a global basis. More specifically, forest fire smoke has short and long term health impact, due to its physical, physicochemical and chemical characteristics.

[1]Forest fire smoke is a two phase mixture, consisting of both gaseous and particulate components. Over 150 chemical species have been detected in the smoke of forest fuel combustion and pyrolysis experiments, including permanent gases such as CO, CO_2, NO_x , SO_x , Volatile Organic Compounds (VOCs) such as hydrocarbons, aldehydes, substituted furans, carboxylic acids, Benzene, Toluene, Xylene (BTX), Semi Volatile Organic Compounds (Polyaromatic Hydrocarbons, as well as Trace Elements such as Na, Mg, Ni, Cu, Pb, Fe, Mn). Many of those species can have acute or long term health implications on the exposed populations, according to exposure limits given by official Organizations for health protection such as OSHA (Occupational Safety and Health Administration), NIOSH (National Institute for Occupational Safety) and ACGHI (American Conference of Governmental Industrial Hygienists).

More broadly, it should be noticed that in real forest fires the chemical species will be greater in number and quantity than those determined in experimental scale. In adittion, the type and size in which those species are formed, can have significant health impacts. Generally speaking, the physical (condensed liquids or dust), physicochemical (e.g PH) and chemical properties of the forest fire smoke has to be studied thoroughly to determine the possible health consequences.

Forest fires impact includes health and safety issues, environmental issues and natural hazards. In case of a big fire incident it is very important for the crisis managers to estimate the severity of the situation and take fast and effective decisions, so as to protect the fire personnel and the civilians. For example, if a situation will be considered as an emergency one, then perhaps there will be the necessity of taking special measures, such as to wear masks or to evacuate an inhabited area, which is very close to the fire. According to all these, the operational value of an effective decision chart for crisis managers is very significant.

A large forest fire is considered as a crisis situation, especially when it expands and put in fire rural /urban constructions, rural fields or waste disposals. In these cases the smoke produced might be the additive or the synergistic result of the combustion of all materials burned. If a forest fire spreads and burns e.g a landfill nearby the forest, then possible organic products can be PCDDs, PCDFs and PCBs might be evolved from pyrolysis and / or combustion of materials of the landfill.

Consequently, for a crisis manager it is necessary to change the perception of what components to expect in the forest fire smoke; combustion and pyrolysis of forest fuels should be considered as an addition or synergism of the combustion or pyrolysis of other materials too (cement, glass, plastics, paints, fertilizers, pesticides, waste disposals).

2. Health impact of forest fuel smoke

Generally, the smoke from biomass burning consists of permanent gases VOCs, SVOCs and Inorganic components with different physical, chemical and physicochemical characteristics (gases, particles, size, shape, PH). The most hazardous permanent gas produced in a forest fire is CO. The NIOSH Recommended Exposure Limit TWA (REL Time-Weighted over 10-hour work-shift) and OSHA Permissible Exposure Limit for General Industry TWA (PEL Time-Weighted over 8-hour work-shift) is 35 and 50 ppm respectively. [2] The CO concentration measured in various field measurements ranged between 4 and 23 ppm. Also, in other measurements during a forest fire nearby an urban area, the CO was measured in several spots close to the flame front. The median max concentration of CO measured for one hour, ranged between 1 ppm and 8 ppm. Though, under very smoky conditions CO concentration topically exceeded 40 ppm. However, there are no systematic measurements of CO in the fire front during a fire incident.

[2]A protocol was designed to study the health effects of CO and irritants on forest fire fighters taking into consideration that a small percentage may experience adverse health effects due to individual susceptibility, a pre-existing medical condition and/or hypersensitivity (allergy). Also, some substances are absorbed by direct contact with skin and mucous membranes and thus, potentially increase the overall exposure. In unusual work schedule, such as in case of a forest fire, the working conditions for the fire fighters are heavy. Using a work-shift length of 12 hours the recommended CO exposure limit for forest fire fighters is calculated 17 ppm, by using the pharmacokinetic model (CFK equation) that it had been used in developing the NIOSH REL. The initial symptoms of CO poisoning may include headache, diziness, drowsiness and nausea. Reasearch has been shown that there is a correlation between the concentration of inhaled CO and the %COHb (Carboxyhemoglobin) in blood. A normal percentage of COHb in blood is 1% for non-smokers and 2-10% for smokers or residents of big cities. Loss of consciousness occurs at about 50% COHb level and death can occur at levels of 70%.The NIOSH REL of 35 ppm is designed to protect workers from health effects associated with COHb levels in excess of 5%. For forest fire fighters 5% of COHb could be reached with CO exposures of 17 ppm.

[1]It should be emphasized that traditional exposure limits for CO may not be protective for the work environment encountered by forest fire fighters. This information is important to properly protect fire fighters from the deleterious health effects associated with CO intoxication.

CO_2 is another abundant product of forest fuel combustion. Typically, the outdoor, ambient concentration of CO_2 is approximately 350 ppm. [2]During fire incidents it was found that CO_2 exposures were approximately 3 times higher than the normal background concentration. Though, according to Table 1, CO_2 was below the applicable occupational exposure limits, as long as the NIOSH REL (Time-Weighted over 10-hour work-shift) and OSHA PEL (Time-Weighted over 8-hour work-shift) are 5.000 ppm and 10.000 ppm respectively.

[3]In case of using commercial forest fire retardants, such as a mixture of ammonium phosphate and ammonium sulfate, NH_3 exceeded the ACGHI recommended level of 35 ppm in the vicinity of the fire. [4,5]The effect of fire retardants on the pyrolysis products of forest fuels, such as cellulose and pine needles, has been studied in lab scale. Broadly speaking, $(NH_4)_2HPO_4$ and $(NH_4)_2HSO_4$ used as forest fire retardants produce an acid (phosphoric or sulfuric) prior to the flaming temperatures, which favor the dehydration process leading to increased quantities of char, water vapor and CO_2 and reduced volatile products.

[6]Forest fire smoke is also consisted of Volatile Organic Compounds (VOCs) such as hydrocarbons, (alkenes, alkynes), aldehydes (acetaldehyde, formaldehyde, furfural, acrolein), substituted furans, phenol, carboxylic acids, BTX, alkyl-benzenes. The most abundant compounds produced are BTX (Benzene, Toluene, Xylene). [7] The on-line monitoring of the fire-front emissions from pine needles combustion in lab experiments, resulted in maximum benzene and toluene concentrations of 1050 and 2050 ppm respectively. The combustion considered as of low oxygen content, a scenario which usually occurs in real forest fires. [8] Benzene, toluene, and xylene were also measured 3, 5 km, 5 km and 10 km from the fire front of a large-scale forest fire and the concentrations in μg/ m^3 for each of these compounds ranged between 0.4 -24.8, 0.3-15.5 and 3.7-28.7 respectively. [1]Though, there are no strong correlations evident between VOC levels and the incidence of active forest fires. While biomass combustion does lead to emission of BTX, their levels may have been overwhelmed by those from fossil fuel sources. According to Table 1, the NIOSH REL and OSHA PEL for benzene are 0,1 ppm and 1 ppm, for toluene are 100ppm and 200 ppm and for xylene 100 ppm and 100 ppm respectively.

Forest fires also produce a large number of organic compounds, which are partitioned between the gaseous and liquid or solid phase at ambient temperatures, so called semi-volatile organic compounds (SVOCs). PAHs (Polycyclic aromatic hydrocarbons) are among those SVOCs produced. They are hazardous compounds because many of its members are carcinogenic. PAHs can be condensed or absorbed onto the surface of fine particles. [9] Benzo (a) pyren [BaP], a PAH known for its carcinogenic properties, occur in most combustion emissions and is commonly used as indicator for PAHs. In urban areas, motor vehicles are the major source of PAHs in atmosphere, followed by residential wood/ (char)-coal combustion and industrial production processes. In medium polluted areas in European Countries the annual average [BaP]- level estimated 5-12 ng/m^3 and at locations close to traffic, coal heating or industrial areas, the daily average BaP- concentration ranged between 4-69 ng / m^3(max. 300 ng/m^3). According to literature, PAHs concentration decreases with the distance from the forest fire due to photochemical degradation processes. The OSHA has established a legally enforceable limit of 200 mg /m^3 of all PAHs.

[10]Forest fire smoke is also consisted of particulate matter with significant contribution to health implications of the exposed populations, by damaging respiratory system. [11] OSHA standards allow workers to be exposed to 5.000 ug/m^3 of respirable particles averaged over 8-hour shift, 5 days per week. The allowable exposures rely on the assumption that workers will spend 16-hours per day breathing clean air to allow them recover from exposures experienced at work. Obviously, this is not always the case in a fire situation where firefighters work shifts as long as 16 hours and spend any free hours at fire camps that are often smoky. [2]Since a large portion of the Total Particulate Matter (TPM) exposure is a product of combustion of the surrounding vegetation, possibly containing carcinogenic and /or otherwise substances (e.g. absorbed PAHs, [12]levoglucosan, retene, vanillin), neither OSHA PEL nor ACGHI TLV may be appropriate evaluation criteria.

The most hazardous particles are the very small and respirable, such as PM_{10} and $PM_{2,5}$, due to their enhanced effect on the lungs. Particles less than 10 micrometers in diameter tend to pose the greatest health concern because they can be inhaled into and accumulate in the respiratory system. PAHs can condense or be absorbed onto the surface of fine particles, as well as elements such as S, Cl, K, Na, Mg, Fe, Cu, Zn, Pb and others, so that they become more harmful matrixes. There is evidence that fine particles ($PM_{2,5}$, PM_1) can have epidemiological effects and that exposure to fine particles is associated with several serious health effects, including premature death. This does not mean that coarse particles like PM_{10} could be considered as harmless, in fact they can aggravate respiratory conditions such as asthma. The ACGIH TLV-TWA 24-h for PM_{10} and $PM_{2.5}$ are 150 μg/m^3 and 65μg/m^3 respectively. In field experiments during a forest fire nearby an urban area, $PM_{2.5}$ median for 1 hour was 335 μg/ m^3 and PM_{10} median for 1- hour was 1.300 μg/m^3, though in very smoky conditions very close to the fire front the $PM_{2.5}$ median for 30 sec was 6.865 μg/ m^3.

[11]Generally, exposure to air pollutants (permanent gases, VOCs, SVOCs, Particulates) in significant concentrations, can increase health risks. The air pollutants of greatest concern are those that cause serious health problems or affect many people, for example in the case of a large scale forest fire nearby an urban or rural area. Health problems can include respiratory irritation, nervous system problems and even cancer in some cases. There are some acute symptoms after a person inhales smoke, such as watery eyes or cough, but other health problems may be more serious and appear many months or years after a person's first exposure. For the fire-fighters, the continuous exposure for many years in such heavy conditions of smoke can become very hazardous, as well as for the exposed populations which could suffer from long-term epidemiological effects e.g asthma. So, emphasis should be given on the proper operational measures that should be taken under severe smoky conditions, like in case of a large-scale forest fire, where the emergency plans for risk management should be the most effective.

3. Forest fires and combustion of other materials

It is quite often the forest fire to expand to rural /urban areas, landfills e.t.c. Therefore, forest fire smoke could be considered as the addition or the synergism of the smoke due to the combustion of construction materials, fertilizers, pesticides and waste disposals. As a result, the smoke produced becomes more complicated and possibly more hazardous, due to its composition. In order to support decision making in a forest fire, a road map has been developed, which includes different scenarios that could occur in case of a forest fire (Table 2).These scenarios include the expansion of a forest fire in rural fields which will cause combustion of pesticides or fertilizers, in rural or urban constructions, which will cause combustion and pyrolysis of structurally materials i.e. cement and in waste disposal and illegal waste disposal which will cause waste incineration. The scenarios also include the combustion of chemically pretreated forest fuel with retardants, so as to prevent the fire spread (ground application) or fling of retardant either sea water, during the fire incident, for suppression (aerial application). Heavy environments such as those of urban or industrial areas that could contribute a significant percentage of pollution in case of a forest fire, are also included as scenarios.

In the road-map the expected organic and inorganic products, due to the combustion or pyrolysis of each fuel type (scenarios 1-5) or due to the existed chemical species in the atmosphere (scenarios 6-7), are presented. They are also presented the type of materials generated (i.e. soot, tars, particles) as well as their size, chemical composition, physical and chemical properties and also the meteorological data and operational information that have been found in literature.

It should be emphasized that filling in the details of this road map (Table 2) needs further experimentation and field experiments. Consequently, the proposed road map is considered as a first version and more elaboration is needed.

4. Field Analytical Chemistry and Technology

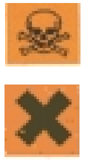
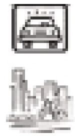
Monitoring the type and levels of forest fire smoke components, needs instrumentation, methods and procedures of field analysis. Field chemical analysis and technology is using mobile and portable instruments for on-site analysis. Field analysis is based on chemical measurements in time and space, which make it the appropriate tool for on-line monitoring the air quality during a forest fire. It also consists of procedures which make it possible to integrate those methods in operational procedures. Field analysis using by sensors, particle analyzers and various methods, such as Gas Chromatography – Mass Spectrometry, can provide with instrumentation of different complexity. A number of these instruments are automated and can be used directly from operational personnel near the fire front and from other civil protection services, for measuring air quality.

Table 1. Permissible exposure limits according to various Organizations for specific compounds and particulates

No	Compound	MW	TLV-TWA	STEL	PEL	STEL	REL	STEL	IDLH
1	Acetylene	26		Simple Asphyxiant			2500 ppm (Ceiling) (15 Min)	Not determined	
2	Formaldehyde	30	-	0,3 ppm	0,75 ppm	2 ppm	0,016 ppm (8-hour)	0.1 ppm Ceiling (15 min)	
3	Acetaldehyde	44	25ppm	-	200 ppm	-	25 ppm	-	2000 ppm
4	Propane	44	2500 ppm		1000 ppm		1000 ppm		
5	1,3 Butadiene	54	2 ppm	-	1 ppm	5 ppm	Lowest Feasible Concentration, Potential Carcinogen		
6	Acrolein	56	0.1 ppm		0.1 ppm		0.1 ppm	0.3 ppm	2ppm
7	Acetone	58	500 ppm	750 ppm	1000 ppm	-	250 ppm		
8	Propanal	58	20 ppm						
9	Crotonaldehyde	70	0.3 ppm Ceiling		2 ppm		2 ppm		
10	Butanone	72	200 ppm	300 ppm	200 ppm		200 ppm	300 ppm	
11	Benzene	78	0,1 ppm	2,5 ppm	1ppm	5ppm	0.1 ppm	1 ppm (15 min)	500 ppm
12	Pentanone-2	86	200 ppm	250 ppm	200 ppm	-	150 ppm	-	-
13	Toluene	92	50 ppm	-	200 ppm	300 ppm Ceiling for 10 minutes	100 ppm	150 ppm	
14	Phenol	94	5 ppm	-	5 ppm		5 ppm	15.6 ppm Ceiling (15 min)	
15	Furfural	96	2 ppm		5 ppm		2.0 ppm		
16	Cyclohexanone	98	25 ppm	-	50 ppm	-	25 ppm		
17	Naphthalene	128	10 ppm	15 ppm	10 ppm		10 ppm	15 ppm	
18	Styrene	104	20 ppm	40 ppm					
19	Ethyl Benzene	106	100 ppm	125 ppm	100 ppm		100 ppm	125 ppm	
20	Xylene	106	100ppm	150ppm	100 ppm	-	100 ppm	150 ppm (15 min)	900 ppm
PERMANENT GASES									
21	Ammonia	17	25 ppm	35 ppm	50 ppm	-	25 ppm	35 ppm (15 min)	300 ppm
22	Carbon Monoxide	28	25 ppm	-	50 ppm	-	35 ppm (8-hour)	200 ppm Ceiling	
23	Sulfur Dioxide	64	5 ppm	5 ppm	2 ppm	5 ppm	2 ppm	5 ppm	
24	Carbon Dioxide	44	5000 ppm		10000 ppm		5000 ppm		
PARTICULATE MATTER									
PM 10			150 μg/m3 24-h						
PM 2,5			65 μg/m3 24-h						
PAHs			200 $\mu g/m^3$						

TLV-TWA: *(Time -Weighted average assuming 8 h/day ACGIH)*
STEL: *(short term exposure limit) ACGIH*
PEL: *Permissible Exposure Limit for General Industry, TWA: (Time -Weighted over an 8-hour workshift) OSHA*
STEL: *(short term exposure limit 15 min) OSHA*
REL: *(Recommended Exposure Limit TWA (Time -Weighted over an 10-hour workshift) NIOSH*
STEL: *(short term exposure limit) NIOSH*
IDLH: *(NIOSH Immediately Dangerous To Life or Health Concentration)*

Table 2. Air-quality in forest fires: Decision chart for crisis managers

No		1	2	3	4		5	6	7
Road-map of forest fire front & smoke	**Forest Fire Front** 	**Rural Fields** 	**Rural or Urban Constructions** 	**Waste Disposal** 	**Illegal Waste Disposal**	**Smoke Front**	**Supression by aerial means** 	**Urban Area** 	**Industrial Urea** 
Scenarios		Combustion of: Pesticides, Fertilizers (MCPA, Maneb, Dimethoate, Methyl Parathion)	Combustion and pyrolysis of: Spruce wood, cardboard, plywood, bed mattress, foam sofa, gasoline, varsol, solid white foam, polymers (polystyrene),glass, cement asbestos, plaster, paper ,paint, glue, plastic	Landfill fires, Waste Incineration (paper, cardboard, kitchen & garden waste, plastic, rubberwood & textile metal, glass, non burnable waste)	Poor oxygen Waste Disposal Incineration (waste wood, organic residues, electric appliances, PVC)		Na Cl Retardants (Ammonium phosphate, Ammonium sulfate)	Mobile sources, fireplaces, oil-fired boiler emissions, cigarette smoke, paved road dust,waste incineration, industrial processes	Industrial processes
Chemical Species	**Vapor** CO, CO_2, CH_4, NOx (NO, NO_2), SO_2 , VOCs (C_2-C_7) Aldehydes, H/C, Substituted Furans, BTEX, Carboxylic Acids, Naphthalene **Vapor and/or Particulate** Substituted Naphthalenes, Oxygenated Monoaromatics (phenol, guaiacol and derivatives), Oxygenated PAHs, PAHs	**Organic products** PCDDs/PCDFs, CH_4 DCDBF,DCX, CBF **Inorganic products** CO, CO_2, HCl, SO_2, NOx, POx, NH_3 CS_2, H_2S, $(CH_3S)_2$, HCN	**Organic products** Non polar VOCs, BTEX, Styrene, 1,3 butadiene, phenol PAHs, PCDDs/PCDFs **Inorganic products** CO, CO_2	**Organic products** Mainly PCDDs, PCDFs, PAHs, PCBs, **Inorganic products** CO, CO_2, heavy metals(As, Cd,Ni,V,Hg, Pb)	**Organic products** PCDDs/PCDFs, CoPCBs, HPCDFs, OCDF **Inorganic products** CO, CO_2		**Organic products** Propenanitrile, Pyridine, Dimethyl, Sulfide, 4-Nitro phenol **Inorganic products** NH_3, CO, CO_2, SO_2	**Organic species** VOCs, Alkanes (C>15), Aldehydes, BTEX, Styrene, Furans, Chloroform Carboxylic and Alkanoid Acids(>8), OPAHs, PAHs, NPAHs, MethyleneChloride, terpenoids PCDDs/PCDFs **Inorganic species** CO,CO_2,O_3,NO_x SO_2,	**Organic species** VOCs Alkanes(C>13), H/C, PAHs, Nonylphenol(NP), NPnEO, Mercaptans, CH_3Cl PCDDs/ PCDFs **Inorganic species** Sulfur compounds (H_2S) NO_x, O_3

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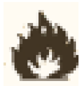
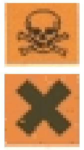
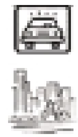
Road-map of forest fire front and smoke	**Forest Fire Front** 	**Rural Fields** 	**Rural or Urban Constructions** 	**Waste Disposal** 	**Illegal Waste Disposal** 	**Smoke Front**	**Supression by aerial means** 	**Urban Area** 	**Industrial Urea** 
Type of Materials	Soot, tars, SVOCs, particles	Condensation aerosols,smoke particles	Soot, tars, SVOCs, carbonised particles	Particulate pollutants	Ash		Salts, Increased amounts of residual char Soot, tars, particles	Organic aerosols, vapor-phase organics, Tar organometallic dust, particles	Atmospheric aerosols, Total Suspended Particles (TSP), Dust
Size	Coarse (PM_{10} TLV 24h, 150 μg/m³) Fine ($PM_{2.5}$, TLV 24h, 65 μg/m³)	Large cluster agglomerates, respirable particles	Coarse Fine	Fine			Coarse	Fine ($PM_{2.5}$) Coarse(PM_{10})	Coarse (Fe, Mn) PM_{10} (Cd, Zn)
Chemical Composition of materials	Organic Carbon (OC), Elemental Carbon(EC),Total Carbon(TC),n-alkanes(C_{24}-C_{30}), Cyclic di-and triterpenoids, Trace Elements: kations(K,Na ,Fe, Cu,Al,Si,Cr), anions(F,Cl,N,S) alkaline earth metals (Ca,Mg,Zn,Mn), heavy metals (As,Cd,Ni,V,Hg,Pb)	High molecular weight toxic species absorbed on smoke particles	$NiCl_2$, $PbCl_2$, VCl_4, $SiCl_4$ Pb, Cu, Zn, S, Cl	$PbCl_2$, VCl_4, $SiCl_4$ Pb, Cu, Zn, S, Cl			NaCl $(NH_4)_3PO_4$	SiO_2, Al_2O_3, Ca, Mg, Ba, Cu, Sn, Iron compounds, S, V, C	Fe, Mn, Cd,Zn, Ca,Ti,Fe, Cu, Cr, Al, Ni,K,Na, Mo, Co, Cd,Pb
Chem. Propert.		Interaction of condensation aerosols with smoke particles	Alcaline (pH 9-11.5) ($Ca(OH)_2$, $CaCO_3$ $CaSO_4$)					PH<9	PH<9

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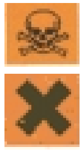
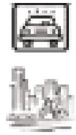
Road-map of forest fire front and smoke	**Forest Fire Front** 	**Rural Fields** 	**Rural or Urban Constructions** 	**Waste Disposal** 	**Illegal Waste Disposal** 	**Smoke Front**	**Supression by aerial means** 	**Urban Area** 	**Industrial Urea** 
Physical properties (Physical state,Color, Visibility Odor, Shape)	Vapors, Vapors and/or Particulates, Particulates (at ambient conditions)	Aerodynamic diameters of the smoke particles affect smoke transport more than the physical particle size	Solid grey to black particles	Dry deposition Wet deposition (rain snow,fog)					
METEO Temper. Effect Wind Effect Sun Effect Rain Effect				Air temperature during sampling (25 – 800 °C) Wind speed and direction, humidity			Relative angular positions of the collecting aperture, sun, water and aerosol content influenced sky radiance spectra	Photochemical reactions(H/C reaction with OH^- in NOx and sunlight presence	Air temperature Wind speed and direction, rainfall Photochemical reactions(H/C reaction with OH^- in NOx and sunlight presence
OPERATIONAL Land Shape Severity (I, II, III)	Serious effect of respitratory system	Highly contaminated aerosol with serious health implications		Sampling from different points around the fire center (Different concentrations)			Different NH_3 concentrations at different sampling points		Epidemiological health effects
Health(symptoms) Field Analysis				Necessary the use of respiratory equipment from firefighters			Necessary the use of masks from firefighters in the vicinity of the fire		

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Organizations Profile

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The State Key Laboratory of Fire Science (SKLFS) is the only national research institution in the field of fire science in China. The construction of SKLFS was initiated by Prof. Fan Wei-Cheng, motivated by the well-known Great Xingan Mountains forest fire in 1987. Prof. Fan, who is the academician of China Engineering Academy (CEA), has served as the director of SKLFS since 1989.

Prof. Fan Wei-Cheng

His research interests include computer modeling of fire and combustion; dual-nature (deterministic and probabilistic) model of fire science; nonlinear fire dynamics; fire risk assessment; methodology of fire safety performance-based design.

He also serves the executive committee of the International Association on Fire Safety Science (IAFSS), and the honorary president of the Asia-Oceanian Association of Fire Science and Technology (AOAFST). Until now, SKLFS has been one of the most well-known fire science laboratories in the world, with a staff of 52 persons, including 35 researchers, 15 technicians and 2 executive managers. There are 60 Master's candidates, 55 Ph. D. candidates and 11 postdoctoral fellows in SKLFS, devoted to fire safety science or engineering. An academic committee, which is composed of 14 senior scientists in China, directs the research mission and goals of SKLFS.

State Key Laboratory of Fire Science

Mission of SKLFS

The mission of SKLFS is to study the fire dynamics & key fire safety technologies, train qualified personnel and endeavor to cater for the growing national demand in fire safety so as to make achievements in fire safety science research and make fundamental, strategic and forward-looking contributions to the national fire prevention and protection.

Major Research Areas

Fire dynamics

1. The occurrence and spread of surface fire and the fire growth in compartments
2. The production mechanism and heat/mass transport of fire smoke and toxics

Key technology of fire protection

1. Clear and performance-optimized fire retardant
2. Multi-signal sensing and intelligent recognition of early-stage fires
3. Fire suppression technology of water spray/mist

Theory and methodology of fire safety engineering

1. Fire risk assessment based on fire dynamics and statistical theories
2. Performance-based fire safety designs

Research Departments

SKLFS include six research departments as follows:

1. Building Fire Research

The research areas of this department mainly include:

- Pyrolysis and ignition of combustibles
- Fire growth and smoke movement
- Special building fire behaviors;
- Fire smoke toxicity and its effect on human evacuation;
- Performance-based design

2. Forest Fire Research

The research areas of this department mainly include:

- Kinetic model of thermal decomposition of biomass
- Modeling of forest fire behaviors
- Smolder propagation and its transition to flame
- Self-organized criticality of forest fires
- Nonlinear dynamic model of special forest fire
- Forest fire decision-making system based on GIS

3. Fire Simulation and Modeling

The research areas of this department mainly include:

- Advanced methods for numerical simulation of reactive turbulence
- Expert system of numerical prediction of building fire
- Simulation for fire using field, zone and network numerical methods
- Complicated non-linearity in fire
- Computer simulation and virtual reality

4. Fire Detection

The research areas of this department mainly include:

- Fire Detection Theory and Algorithm
- Sensor Technologies for Fire Detection and Alarm
- Long Distance Communication and Monitoring for Fire Safety
- Automatic Fire Suppression and Control
- Communication and Command System for Fire
- Remote Sensing for Large Scale Fire Monitoring

5. Industrial Fire Safety

The research areas of this department mainly include:

- Simulation of typical industrial fires
- Diagnostic methods for thermal disasters
- Clean and effective fire suppression techniques

6. Fire Risk Assessment

The research areas of this department mainly include:

- Theoretical analysis and numerical simulations on human evacuation in typical fire cases
- Statistical theory on small sample fire events
- Fire risk assessment coupling Fire Dynamics and Small Sample Statistical Theory

7. Fire chemistry

The research areas of this department mainly include:

- Synthesis of novel flame retardants, flame retardant polymer materials, polymer nanocomposites
- Effect of flame retardant additives on the properties of various polymers
- Flame retardant mechanism and structure of flame retardant polymer materials

USTC/POLYU Fire Test Atrium

- Toxicity of combustion products of the materials;

Facilities

Since fire science is a new and interdisciplinary research field short of standard experimental and research equipments, SKLFS designed and built 8 large scale experimental systems including

- USTC/PolyU High Building Fire Test Atrium
- Combustion Wind Tunnel
- Platform of Full-scale HRR (heat release rate) Testing
- Fire Emulator/Detector Evaluator System
- Experimental system for fire characteristics at the early stage
- Backdraft Experimental System
- Water Mist Fire Suppression Experimental System
- Five-floor Model Building

The laboratory has also been equipped with the many advanced scientific apparatus, including Infrared ther-

Water Mist Fire Suppression

Combustion Wind Tunnel

Backdraft Experiment

Five-floor Model Building

mal image, three dimensional laser particle dynamics analyzer, Cone calorimeter, Monochromator, Simultaneous Thermal Analysis, On-line gas analyzer, Accelerating rate calorimeter, etc.

Achievement

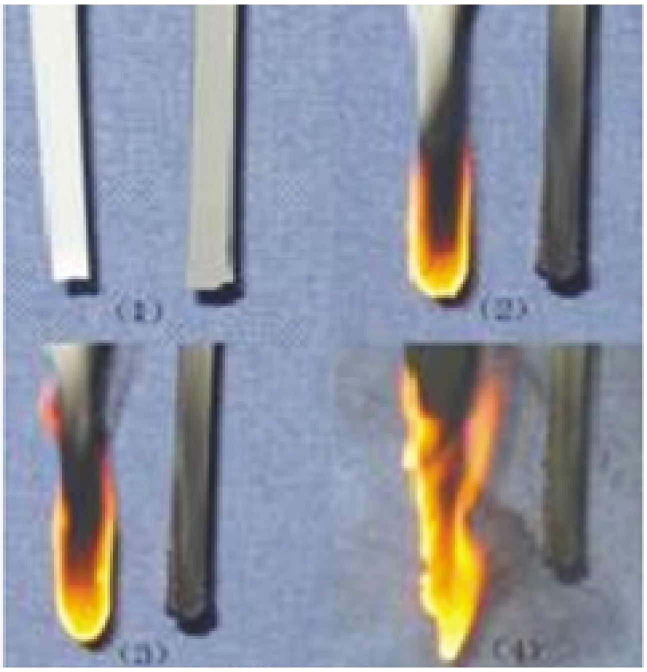
SKLFS has been contributing to the national fire safety scientific and technological innovation, and has already made essential innovative contributions to fire safety in China. The laboratory has so far undertaken many important scientific research projects under "Programme 973", "Programme 863", Key Technologies R&D Programme, etc. which are mainly funded by the Natural Science Foundation of China (NSFC) and the Ministry of Science and Technology of China (MOST). The laboratory was responsible for the fire research project of the Sino-Japanese Core Universities Exchanges Program, which was supported by the Chinese and Japanese governments. As one of the research institutions invited by BFRL, the labora-

USTC/PolyU Fire Test Atrium

Fire Early Stage Expeirment

tory participated in the cooperative research on Fire Safety of Tall Buildings after 911.

The achievements of SKLFS in fire research have been honored with many national or provincial awards, including National Award for Scientific and Technological Progress of China; Award for Natural Science by the Chinese Academy of science (CAS); Award for Scientific and Technological Progress by the CAS; National Award for Educational Achievements; etc. During the past 6 years (1997-2003), 460 research papers finished by researchers at SKLFS have been published, within which 160 papers were indexed by Science Citation Index (SCI expanded) and 50 by Engineering Index (EI). SKLFS has achieved more than 30 inventions and 7 of them have been authorized as patents.



Parallel combustion picture of conventional polymers (left) and retardant nanocomposites (right).

Forest Fire Research Department

This is one of the eldest and largest research departments in SKLFS, devoted to forest fire propagation modeling and making decision system for forest fire protection. The major member of this department include:

Dr. LIU Nai-An

He Entered Department of Thermal Science and Energy Engineering of University of Science & Technology of China (USTC) in September 1991, and graduated July 1995, with the degree of Bachelor of Engineering. As the Top One Student during the undergraduate period, he entered SKLFS in September 1995, with Prof. Fan Wei-Cheng as the supervisor, achieved Ph. D. Degree of Engineering Thermophysics in July, 2000. His research interests include Thermal decomposition of forest materials, Forest fire spread, Thermal stability of forest combustibles, and kinetic analysis methods of solid decomposition. So far he has published more than 15 international journal papers. He successfully developed a simple but accurate kinetic model to describe the thermal decomposition of forest materials in air atmosphere. Recently, he successfully developed a smoothing strategy for the pre-treatment of the decomposition data of forest materials, in order to achieve accurate results for differential kinetic analysis. He promotes the cooperation between SKLFS and European Center of Forest Fires (ECFF) which is led by Prof. Milt Statheropoulos.

Dr. SONG Wei-Guo

He studied in the Department of Thermal Science and Energy Engineering of the University of Science and Technology of China (USTC) from 1991 to 1996 and got the degree of Bachelor of Engineering. Then he entered SKLFS in 1995 as a Ph.D candidate supervised by Prof. Fan Wei-Cheng, and got Ph.D degree in 2001. From 2001 to 2003, he worked in the Department of Statistics and Finance of USTC as a postdoctoral fellow. In 2003, he worked in SKLFS as associate professor. His study interests include: Forest fire danger rating method and system, Self-organized criticality of fire system, Emergency evacuation and Performance-based fire safety design. He has published 20 journal papers and 10 conference papers. He found the power-law relation of forest fire distribution in China and gave explanation of the heavy-tail phenomenon by developed models. He utilized ANN method in analyzing multi-correlation between fire probability and impaction factors, and developed forest fire danger-rating method of Japan with cooperative scientists. He is a member of the cooperation between SKLFS and European Center of Forest Fires (ECFF) which is led by Prof. Milt Statheropoulos.

Dr. Zhu Ji-Ping

He Entered Department of Thermal Science and Energy Engineering of University of Science & Technology of China (USTC) in 1989, and graduated 1994, with the degree of Bachelor of Engineering. He entered SKLFS in September 1994, and got his Master of Engineering Degree in 1996, Ph.D Degree in 2004 with Prof. Fan Wei-Cheng as the supervisor. His research interests include: GIS-based fire management decision-making system, Performance-based fire protection, Experimental study and computer simulation of forest fire. He has published 15 journal papers. By the combination of GIS and modern software technology, he developed "The Simulated Command System of Forest Fire Extinction" which is of high reliability and application throughout the country. He is a member of the cooperation between SKLFS and European Center of Forest Fires (ECFF) which is led by Prof. Milt Statheropoulos.

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