



UNITED NATIONS  
ECONOMIC COMMISSION FOR EUROPE



FOOD AND AGRICULTURE ORGANIZATION  
OF THE UNITED NATIONS



# **INTERNATIONAL FOREST FIRE NEWS**

**No. 20 – March 1999**



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## NOTE

The statements made in the articles are those of their authors and do not necessarily correspond to those of the secretariat or the official views of the author's home countries. Furthermore the designations employed and the presentation of the material of this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

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The International Boreal Forest Research Association (IBFRA) Fire Working Group

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→ Due of the timelag between editing and print/distribution of IFFN, readers interested in meeting announcements are kindly requested to visit the Internet version of this issue for update and short-term announcement of meetings (continuously updated) on < <http://www.uni-freiburg.de/fireglobe> >



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Readers of the International Forest Fire News are warmly invited to send written contributions to the editor at the above address. These may be in the form of concise reports on activities in wildland fire management, research, public relations campaigns, recent national legislation related to wildfire, reports from national organizations involved in fire management, publications, personal opinions (letters to the editor). Photographs (black and white) and graphs, figures and drawings (originals, not photocopies, also black and white) are also welcome. Contributions are preferably received by e-mail (text as non-encoded ASCII file, Word Perfect 5.1 or Word 6.0, Word97/8; graphic files saved as .JPG, .GIF or similar) or on diskettes. Hard copies of figures and photographs should be submitted by mail.

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## EDITORIAL

## 1998 - A Year of Losses - and of Opportunities

At the end of 1998 a press release of the largest reinsuring company, the Munich Re, attempted to summarize hard facts on damages caused by natural disasters. More than 50,000 human lives were lost during that year, and the economic losses as a result of the catastrophes exceeded US\$ 90 billion in 1998, compared with only \$30 billion in 1997, when 13,000 people lost their lives as a result of natural disasters. As a result of "the generally low insurance density in the countries affected, the international insurance industry again had to pay only about 15 percent of the (1998) amount, although the bill of some \$15 billion was still the fourth highest ever," Munich Re said in a statement. Munich Re recorded more than 700 "large loss events" in 1998, compared with between 530 and 600 during recent years. The most frequent natural catastrophes were windstorms (240) and floods (170), which accounted for 85 percent of the total economic losses. Earthquakes and volcanic eruptions and *other events, such as forest fires, droughts, heat waves, cold spells, landslides and avalanches* *"were less frequent and again caused much less damage in 1998,"* the company said.

Comments by the Editor: The number of ca. 500 fatalities during the fire and smoke episode in South East Asia was relatively low as compared to the high number of flood and hurricane victims. The estimated immediate losses of ca. US\$10 billion seem to be a minor fraction of the total losses caused by natural disasters. However, during the smoke-haze episode in South East Asia alone more than 40 million people were affected by smoke pollution. There are no counts for the Americas during the same time period. There are numerous uncounted victims of the drought in Asia-Pacific during the 1997-98 El Niño-Southern Oscillation Event - those who suffered and died because of water pollution or shortage, delayed or failed harvests. People living in the backyards of the megacities in the tropical countries do not seem count: They are not insured, and nobody quantifies in terms of money how much they suffered from smoke, fire, or drought. And the forests and their inhabitants, the rich wealth of flora and fauna which disappeared in flames and smoke? The values of the biodiversity assets do not have any standard economic measure which would make their losses comparable to the insured goods of wealthy societies. There is little awareness how much it will probably cost to rehabilitate the terrestrial carbon pool which became distorted when flames mobilized the carbon, removed it from its benign function in the tropical soils, peat layers, timber volumes, and animal life, by injecting it into the atmosphere where it will stay for ever - unless ....

.... unless action is taken. And it seems that more action at international level is underway than ever before. Several UN agencies, UN programmes and other international organizations, notably FAO, IDNDR, UNEP, UNESCO, WHO, WMO, the World Bank, and several NGO fora have taken decisive steps to investigate their role and future involvement in the global fire theatre. For the first time in history joint conferences were organized which allowed sharing of responsibilities to address the complex issues of global fire. The latest UN meeting organized by the FAO convened an international fire expert consultation to investigate the role of public policies on forest fires and to prepare the future strategy of the organization and to prepare a meeting of the ministers of forestry in Rome, March 1999. The results of both events are reported in detail in this current issue of IFFN. Reports of the WHO and WMO activities, mainly related to the question of atmospheric smoke pollution and its effects on public health, are provided in the virtual pages of the Global Fire Monitoring Center (GFMC) information system on the internet. This will soon include the full contents of the **WHO Health Guidelines on Episodic Vegetation Fire Events**.

On the GFMC website we provide now the last two issues of IFFN in full length (October 1998 and this issue). All issues between 1990 and January 1998 are archived in 56 country files, by "specials", and research and technology news. IFFN as a fire information platform for the United Nations system is now in its 13th year of production and distributed to more than 1000 agencies and individuals all over the world. With the internet version IFFN becomes easily accessible to everybody worldwide. The internet version is available as soon as the editorial preparation has been finalized. Printing and distribution of the hard copies usually takes some months. Those readers who wish to have faster access to IFFN and other global fire information should have a look at:

<http://www.uni-freiburg.de/fireglobe>

## SOUTH ASIA FIRE SPECIAL

### CAMBODIA

### *Forest and Land Fire Prevention in Cambodia*

#### Introduction

Cambodia, a tropical country in continental South East Asia, is situated North of Equator within latitudes 10° and 15°N and longitudes 102° and 108° E. It has common border with Thailand in the Northwest, with Lao in the North, with Viet Nam in the Southeast, and with the Gulf of Siam in the South, with a total area of 181,155 km<sup>2</sup>, a total population of 10.2 million people (1995), and with a population growth rate of 2.8%. The settlement of the population is concentrated to the central plain. The population of this area is about 318 per km<sup>2</sup>. The coast region has a density of region has density of 60 per km<sup>2</sup> and the upland regions decrease as low as 1 per km<sup>2</sup>. Furthermore, 85% of the population are rural farmers who depend on agriculture and forest products for their subsistence.

For the national development the forest is one of Cambodia's most significant natural resources which covered 13.2 million ha or 73% of the country's total land area in 1969. It has been reduced by 2 million ha in 1993. The main cause of deforestation are growing population and the increase of shifting cultivation, fuel wood harvesting, logging and fire.

**Climate** Most of Cambodia's territory is in the tropics and its climate is greatly influenced by the tropical monsoon circulating system and its topography. There are two well-defined seasons, namely the rainy and dry seasons. The raining season begins in May to October followed by dry period from November to April. The average annual rainfall ranges from 1,500 mm to 3,000 mm. The average annual temperature ranges, in most part of the country from 25°C in late December to 30°C or over in early May, with humidity ranging from 15 to 70% in the early part of the year, rising to 85-90% in August and September.

**Forest Resources** Forest resources are one of most important natural resources of the country. Following an inventory implemented before 1970 with the help of the U.S. AID, the forest cover was 13,227,100 ha or 73% of the country's total land area. The forest cover data are summarized in Table 1.

Changes in forest cover that has occurred over that last twenty years are shown in Table 2. The 1993 estimates are from FAO/UNDP/MRC Land Cover Atlas (1994). The forest are increasingly at risk, because of the demand for agricultural lands, timber and fuel wood due to accelerated development programs and increase in population and forest fire.

Declining of forest cover during the last two decades is 11.23%, of which about 1,110,000 ha are dry land forests and 316,900 ha edaphic forests. In percentage terms the loss in forest cover is about 0.56% per annum compared to about 1% average for neighbouring countries. Land-use encroachment is the leading cause of new conversion. In addition fires, often set by shifting cultivators and other forest dwellers, are a major cause of forest degradation and impede regeneration of woody plants causing erosion and drought.

**Forest Fire in Cambodia** Fire, though not widespread and considered not a serious threat to the forests of Cambodia, could become a threat if the degradation continues at the current rate creating favourable conditions for large-scale forest fire. Fires occur annually in the natural hardwood forests, pine forests, bamboo forests and forest plantations during summer months.

There are three main natural forest types: evergreen, mixed evergreen and deciduous. Fire occur frequently in the deciduous, pine and bamboo forests during the dry season. Most of the species that constitute the deciduous forest shed their foliage almost 100% during the dry season that lasts from December to August, building up a heavy inflammable fuel load on the ground. In addition the leaf shed opens the ground surface to a greater sun exposure leading to condition conducive to a high degree of fire hazard.



**Tab.1.** Forest cover of Cambodia before 1970

Forest Type	Area (ha)	(%)
Dry deciduous forest	5,296,700	40.04
Dense moist evergreen forest	3,955,300	29.90
Dense semi-evergreen forest	2,504,000	18.93
Dwarf evergreen forest	288,700	2.18
Mangrove forest	38,300	0.29
Rear mangrove forest	57,500	0.43
Bamboo forest	387,400	2.95
Flooded forest	681,400	5.15
Pine forest	17,800	0.13
<b>Total</b>	<b>13,227,100</b>	<b>100.00</b>

**Tab.2.** Change in forest cover of Cambodia by forest type between 1973 and 1993

Forest Type	1973	1993	Change for the last two decades (ha)	Change for the last two decades (%)	Annual change (%)
<b>Dry land forest</b>	11,678,600	10,568,600	-1,110,000	-9.50	-4.8
Evergreen	6,876,400	4,763,300	-2,113,100	-30.73	-1.5
Mixed		977,300	977,300		
Deciduous	4,792,900	4,301,200	-491,700	-10.26	-0.51
Coniferous	9,300	9,800	500	+5.38	0.27
Secondary		517,000	517,000		
<b>Edaphic forest</b>	1,032,500	715,600	-316,900	-30.69	-1.53
Flooded	937,900	370,700	-567,200	-60.48	-3.02
Flooded secondary		259,800	259,800		
Mangrove	94,600	85,100	-9,500	-10.04	-0.50
<b>Total</b>	12,711,100	11,284,200	-1,462,900	-11.23	-0.56
<b>%</b>	70	62			



## Root Causes of Forest Fire

There are many causes of fire most of which can be attributed to local people related to customs and traditions:

- \* Fire spreading from shifting cultivation that is widely practised still on a large scale in Cambodia especially by the hill tribe people
- \* Wilful igniting grass growth to clear oxcart roads and footpaths leading to the forests
- \* Setting of fire just before rains in open lands close to forests to promote grass growth (pasture) with the rains for feeding cattle
- \* Setting of fire underneath dipterocarp trees to obtain higher yield of resin from the tree
- \* Setting of fire to trap or poaching wildlife or chase away bees to collect honey
- \* Setting of fire from throwing cigarette light butt or other fire along forest roads and boundaries of forest or in the forest
- \* Carelessness of workers when starting chainsaws and other machinery
- \* Carelessness of people abandoning cooking fires



**Fig.1.** Public fire prevention education in Cambodia address the main causes of careless fire starts, e.g. the use of fire underneath dipterocarp trees to stimulate resin yield, hunting, and cigarette smoking.

**Fire Prevention Measures** The prevention of forest fires and other wildland fire management measures in Cambodia are as follows:

- \* Every year each province has to establish a forest fire commission during the dry season which includes Provincial, District, Village and forestry authorities

- \* Cooperation and active involvement of local communities, the private sectors
- \* Local communities live near or in the forest has responsibility to assist in the suppression of fires and report to nearest forest or local authorities
- \* Member of public, students, monks, police and armed forces should assist forest authority in the suppression fire
- \* Those who cause fire will be arrested and sent to the prison for 3-15 years (i.a.w. the Cambodian Forest Law No.35)
- \* Posters displayed at local markets, in museums, trade fairs and along heavily travelled roads and trails are often effective ways to convey fire prevention messages to the public. There is also a series of photographs with explanatory captions that demonstrate damages resulting from forest fire
- \* Forest fire prevention education programmes are provided to communities villager, schools and universities
- \* Public information and education programmes utilize the media (television, radio, newspapers, posters)
- \* Identification of forest areas with high fire risk
- \* Protection of these forests by surrounding them with fire lines
- \* Promote the active participation of concession holders, contractors, local communities on the base of their capabilities and their enhancement through fire management training in fire, provision of appropriate equipment and incentives whenever feasible
- \* Rewards and incentive to those who report forest fires and assist in the suppression forest fire
- \* Annual letters to local leaders or influential people, within a letter sent for another purpose, or to all residents in an area of particularly high risk or hazard

## Conclusions

Forest and Land Fire in Cambodia are not a serious threat to the forest area, but it occurs every year and damages many hectares of forest area. Beside the lack of expertise, funding and equipment for assisting suppression fire it is a matter of fact that a lot of these fires could be prevented by an enhanced knowledge of the value of the forest by the local community.

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## INDIA

### *Forest Fire Prevention and Control Strategies in India*

#### Abstract

Forestry is in the concurrent list of the constitution of India. Both the central the state Governments can make laws relating to forest management. Forest fire prevention is an important function of the Forest Protection Division in the Ministry of Environment and Forests, Government of India. This paper gives in brief the mandate of the Union and State Governments on forest fire prevention and control measures, methods adopted by the various agencies in forest fire prevention, detection and control. The Government of India proposes to effectively monitor forest fire incidences in the country in order to create sound data base and quick detection infrastructure. It is also proposed to set up a National Institute of Forest Fire Management in the country for proper research, extension of technology and training of personnel.



## Introduction

The total geographic area of the country is 328.7 million ha. out of which the recorded forest cover is 76.50 million ha. The Forest cover thus, constitute 23.4% of the total geographic area of the nation. As per the latest state of forests report of the Forest Survey of India (FSI 1997), the actual forest cover exists only over 19.27% of the geographic area (63.3 million ha) out of which only 38 million ha of forests are well stocked (crown density > 40%). The forests of India are endowed with rich fauna and flora. The plant wealth of India is about 45,000 species (12% of the global plant wealth). The standing timber stock in the country is estimated at 4740 million m<sup>3</sup>, and the annual increment of the forests is estimated to 87.62 million m<sup>3</sup>.

This resource has to meet the demand of a population of 950 million people and around 450 million cattle. As such, country has to meet the needs of 16% of the world's population from 1% of the world forest resources. The same forest has also to cater for the 19% of the world cattle population.

The forests of the country are, therefore, under tremendous pressure. On the one hand the poor are heavily dependent on the forests for their subsistence needs, on the other, the growing liberalisation, industrialisation and fast spreading economic activities at the national and regional levels are putting pressure on the resource base. Over the years country's forests have suffered serious depletion due to unrelenting pressure from increased demand for fuelwood, fodder, timber, inadequacy of protection and diversion of forest lands to agriculture and pastoral uses etc.

## Forest Fire Damages in India

Forest fires are a major cause of degradation of India's forests. While statistical data on fire loss are weak, it is estimated that the proportion of forest areas prone to forest fires annually ranges from 33% in some states to over 90% in others. About 90% of the forest fires in India are started by humans. Forest Fires cause wide ranging adverse ecological, economic and social impacts. In a nutshell, fires cause

- \* Loss of valuable timber resources and depletion of carbon sinks
- \* Degradation of water catchment areas resulting in loss of water
- \* Loss of biodiversity and extinction of plants and animals
- \* Loss of wild life habitat and depletion of wild life
- \* Loss of natural regeneration and reduction in forest cover and production
- \* Global warming resulting in rising temperature
- \* Loss of carbon sink resource and increase in percentage of CO<sub>2</sub> in the atmosphere
- \* Change in micro climate of the area making it unhealthy living conditions
- \* Soil erosion affecting productivity of soils and production
- \* Ozone layer depletion
- \* Health problems leading to diseases
- \* Indirect affect on agricultural production: Loss of livelihood for the tribals as approximately 65 million people are classified as tribals who directly depend upon collection of non-timber forest products from the forest areas for their livelihood.

India has about 1.7 million hectares of productive coniferous forests with such valuable timber and pulpwood species as fir (*Abies* spp.), spruce (*Picea smithiana*), deodar (*Cedrus deodara*), kail and chir pine (*Pinus wallichiana* and *P. roxburghii*). The estimated growing stock of these forests is over 200 million cubic metres the monetary value of which could be anywhere between Rs.40,000 to Rs.60,000 million (US\$ 976 to 1464 million). In other states precious deciduous forests rich in bio-diversity get largely damaged by forest fires. The forests of North-East region of the country are hotspots of biodiversity. To safeguard these precious forests and their value, it is necessary to have more rigorous protection from fire damage than that has been accorded hitherto.

## Major Forest Fire Disasters in India During the Past few Years

The normal fire season in India is from the month of February to mid June. India witnessed the most severe forest fires in the recent time during the summer of 1995 in the hills of Uttar Pradesh & Himachal Pradesh. The fires were very severe and attracted the attention of whole nation. An area of 677,700 ha was affected by

fires. The quantifiable timber loss was around Rs. 17.50 crores (US\$ 43 million; Rs. 1 crore = 10 million rupees). The loss to timber increment, loss of soil fertility, soil erosion, loss of employment, drying up of water sources and loss to biodiversity were not calculated by the Committee appointed by the Government to enquire into the causes of fires, as these losses are immeasurable but very significant from the point of view of both economy as well as ecology. The fires in the hills resulted in smoke in the area for quite a few days. The smoke haze, however, vanished after the onset of rains. These fires caused changes in the micro-climate of the area in the form of soil moisture balance and increased evaporation. Lack of adequate manpower, communication and, water availability in the hills helped this fire spread rapidly reaching the crown level. The thick smoke spread over the sky affecting visibility up to 14,000 feet.



**Fig.1.** Open southern tropical dry deciduous forest in Central India (Maharashtra State): Frequent fires burning through these stands prevent the development of fire-sensitive trees and favour fire-tolerant species. Photo: J.G.Goldammer (GFMC)

### **Estimation of Losses from Forest Fires**

The statistics on forest fire damage are very poor in the country. In the absence of proper data, it is difficult to arrive at the accurate losses from the forest fires. Moreover, the losses from fires in respect of changes in biodiversity, carbons sequestration capability, soil moisture and nutrient losses etc. can not be measured but, nevertheless, are very significant from the point of view of ecological stability and environmental conservation. To a certain extent, the loss due to forest fires can be estimated based on the inventories made by the FSI as reported in the state of forest report 1995 and subsequent field observations conducted by them. The statistics of losses from forest fires from the various states of the union is still very sketchy and fragmented. Much of the data available does not reflect the ground situation and is grossly under reported. The total reported loss from the states of the union is around Rs 35 crores (US\$ 7.3 million) annually.



The Forest Survey of India, data on forest fire attribute around 50% of the forest areas as fire prone. This does not mean that country's 50% area is affected by fires annually. Very heavy, heavy and frequent forest fire damages are noticed only over 0.8%, 0.14% and 5.16% of the forest areas respectively. Thus, only 6.17% of the forests are prone to severe fire damage. In the absolute term, out of the 63 million ha of forests an area of around 3.73 million ha can be presumed to be affected by fires annually. At this level the annual losses from forest fires in India for the entire country have been moderately estimated at Rs 440 crores (US\$ 107 million). This estimate does not include the loss suffered in the form of loss of biodiversity, nutrient and soil moisture and other intangible benefits. Based on the UNDP project evaluation report of 1987, the benefits of pilot project at today's prices if 40 million ha of forests are saved annually from forest fires due to implementation of modern forest fire control methods the net amount saved at today's prices would come to be Rs 280 crores (US\$ 6.8 million).



**Fig.2.** The annually occurring surface fires in the open deciduous forests are carried by the grass and leaf litter layer. Many forest sites are burned over two or three times per year. Photo: J.G.Goldammer (GFMC)

### **Forest Fire Prevention in India**

The subject of forests is in the concurrent list of the Constitution of India. The Central Government and State Governments are both competent to legislate on the issue. The issues relating to policy planning and finance is the primary responsibility of the Government of India. The field administration of the forests is the responsibility of the various state governments. The state Government thus have the direct responsibility of the management of forest resources of the country. The fire prevention and control measures are, therefore, carried out by the state forest departments. Each State and Union Territory has its own separate forest department. At the Government of India level, Inspector General of Forests & Special Secretary to the Government of India is the head of the professional forest service in the country. Inspector General of Forests & Special Secretary is assisted by additional Inspector General of Forest and Deputy Inspector Generals. Forest Fire prevention is looked after by the Forest Protection Division in the Ministry, which is headed by a Deputy Inspector General of Forests. The Ministry is implementing a plan scheme "Modern Forest Fire Control Methods" in India under which the state governments are provided financial assistance for fire prevention and control.



India has a history of scientific forest management for over 130 years. Forestry practices have been developed for a large number of forest types and species in India. The forests are managed through well prepared forest working plans and fire prevention and control has always constituted an important component of the working plan. Mostly, the prescriptions relate to employing traditional practices like creation and maintenance of fire lines, fire tracks, control burning, engaging fire watchers during the fire seasons etc. The villagers situated in and around forest areas are also legally supposed to assist the forest department staff in extinguishing the fires. These methods proved quite effective in controlling forest fires in the country, but gradually due to population pressure on forests and resultant conflicts and resource hunger, it became difficult to check forest fires in India through these methods. More and more biotic pressure increased the fire incidences resulting in poor regeneration in forest areas. In view of this, it was felt necessary to implement a modern forest fire fighting regime in the country. A UNDP project was implemented during 1985 to 1990 in the country to address the problem of resource damage from uncontrolled forest fires. The project primarily focused on involving a systematic approach to deal with forest fire damages through tapping of the knowledge gained by some developed countries in preventing, detecting and suppressing forest fires, and its transfer to India. Under this project, a pilot project was launched in two states viz: Uttar Pradesh and Maharashtra, where severe fires had affected around 50% of the forest area. The two states offered different ecological and physical characteristics and therefore, offered a good opportunity to try the technologies of forest fire prevention and control.

The project yielded excellent results both from the angle of technical suitability and economic efficiency. It clearly demonstrated that the fire incidents can be reduced drastically as in some cases the incidents were reduced by 90% in selected areas.

Based on the success of this project, the Government of India, Ministry of Environment & Forests initiated a scheme entitled "Modern Forest Fire Control Methods" since 1992-93. The scheme was launched during the 8<sup>th</sup> Plan period in 11 states where the major forest fires occur. The project covered 60% of the forest areas of the country. Under the scheme, the Government provided financial assistance to state forest departments for procurement of hand tools, fire resistant clothes and fire fighting equipments, wireless sets, construction of fire watch towers, fire finders, creation of fire lines and for research, training and publicity on fire fighting. Under the Central Government an air operation wing was maintained. The project has been continuing during the 9<sup>th</sup> plan period (1997-2002) and four more states are being added to the list. The Central component of the scheme envisages closing the Air Operation Wing (as it is felt to strengthen the traditional and cost effective methods) and introducing a component of close monitoring of forest fires for creation of data base through Forest Survey of India and involvement of research institutes and other agencies for generating more information on forest fires for better planning and management. Yet another dimension is being added to the project by involving the village forest protection committees constituted under the Joint Forest Management (JFM) programme. The JFM programme is being implemented in 22 states through 35,000 village forest protection committees over an area of 7 million ha. It is proposed to invoke the people's interest and enlist their support for fire prevention and fire fighting operations. The Government is considering setting up of a **National Institute of Forest Fire Management** with satellite centres in different parts of India to bring the latest forest fire fighting technologies to India through proper research, training of personnel and technology transfer on a long-term basis. Notwithstanding the existing efforts, it is still felt that there is an acute shortage of resources for forest fire prevention, detection, and control and also for research, training and equipments. All attempts need to be made to obtain more financial resources and technical assistance within the country and also to tap the external funding sources for developing permanent fire fighting capabilities.

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*Controlling Forest Fire Incidences by Generating Awareness  
A Case Study from Nilgiri Biosphere Reserve, Coimbatore, India*

The peninsular India constitutes one of the mega biodiversity zones of the world which is abundant with unique and diversified floral and faunal wealth. The prevailing tropical climate coupled with physical and environmental factors have unitedly evolved impact on resources pattern and many eco-subsystems which is highly complex and fragile in nature. The land ecosystem is facing mounting problems in the cruel hands of human beings. One of the causative factors is forest fire, either natural or man-made, which periodically covers larger areas in the tropics destroying timber, other properties and life beyond measures.

In India the ecosystems are under severe threat due to the recurrent fires apart from the anthropogenic pressure on the forests which is attributed to the degradation, soil erosion, reduced productivity etc. Every year some or other part of the forests in India is facing the agony in the cruel hands of mankind by putting fire intentionally in the forests which causes severe damages to the regeneration as well as the soils.

Forest fires and indiscriminate grazing are among the most important factors that affect natural regeneration in the forests. According to the Forest Survey of India, an average of 54.7% of forests are affected by fire and 72.1% of the forest area is subjected to grazing. More than 95% of the forest fire incidents in India are human-caused, the main fire starters being the graziers.

In India forest fires are a significant and one of the increasing contributory factors in this degradation process, although the extent of total damage is widely disputed. According to the study by Srivastava, during the sixth five year plan (1980-85) 17,852 fires were reported affecting an area of 5.7 million ha or an annual average of some 1.14 million ha (Sangal 1989). Even this range may be regarded as conservative. Data collected by the Forest Survey of India indicate that the forest area that is affected by annual fires may be as high as 37 million ha (Ministry of Environment & Forests 1987).

Forest fire and its management have long history in Indian forestry. The traditional method of fire protection in the past was used to be an elaborate network of fire lines, block lines, and guidelines. Though it was successful when the population pressure was low, it no longer works effectively against the will of the person to put fire now-a-days. Therefore intensive management to prevent, detect and suppress forest fires is the need of the hour by evolving latest strategies to protect the environment and the atmosphere, with the use of modern fire equipments and other mechanical aids, apart from involving local people by creating awareness in regard to biodiversity.

The existing human resources pattern in the forest department at present disproportionate with its vastness in extent and undulation to be handled by the forest staff against illicit cutting, poaching, sandalwood smuggling and more so from forest fire. On an average 500 ha of forests have to be patrolled by one forest guard, and it does not seem to be likely that this human resource will be sufficient to detect and prevent all forest fires.

The forests of India are characterized by high biodiversity with approximately 35,000 plant species and 75,000 animal species. India is also a place where scientific forestry has been in practice for more than 130 years. From time immemorial, forests were looked upon both tangible and intangible benefits. However, from the 1970's the stress or focus on tangible benefits has slowly shifted to indirect aspects of forests such as environmental and ecological benefits. From 1972 Stockholm Conference onwards, the central theme of every department issue is on environment and ecology. This does not mean that the production aspects of forestry are less important. India has approximately one fifth of the land area under control of the State Forest Departments. Nearly 600 million rural people depend on forest either for their sustenance or for livelihood. Almost 30% of India's population still live below poverty line.

Hence, the rich land resource in the custody of the forest department is important to meet their basic needs of firewood, fodder and non-wood forest produces. As a result of uncontrolled forest utilization, however, forests are rapidly degraded and depleted.

India is predominantly an agrarian society with extended agricultural systems which border and merge with reserved forest areas. From Jammu-Kashmir (northernmost part of India) to Kanniyakumari (southernmost part

of India), the villages are located on the fringes of forest. More than 70% population are dependent directly or indirectly on the forest. For example, cattle has free access to forest for grazing throughout the year. Fuel wood for cooking comprising of many species comes out from the reserved forest.

In general the people living on the fringes of forests are unaware of the biodiversity concept. Their concept of forest is just confined to big animals such as elephants, tigers, panthers, etc., as well as big trees such as Teak, Sal, Deodar, Rose wood, and others, and they are totally unaware of the micro-flora and micro-fauna which are of least or no value to them. In the recent past even when the scorching sun has given a severe impact on the rain forest, one can imagine the fate of Indian Forest which are put on flames every year whether intentionally or unintentionally due to heavy pressure of the population all along the reserve forests boundaries. One or the other part of the forest area from northernmost to southernmost region is facing agony of the forest fire incidences in the hands of human beings at the peak period of summer (from December to May in Southern India and March to June in Northern India) in the process of which regeneration composition of the land is getting changed slowly and slowly and paving way to emergence of only fire hardy species.

In the process of civilization, modern humans have emerged out with developmental processes which causes so much agony to the 'Nature God', it is badly reflecting in the form of environmental degradation and causing global warming. The recent fires in Indonesia, Australia and South Mexico has drawn the attention of the environmentalists to the sufferings of human beings as well as wild animals. Most endangered species for example Orangutan have lost habitats in some parts of Indonesia and it was forced to rehabilitate in some other place. One can imagine the fate of unrecognised flora and fauna.

### Implementation of an innovative scheme

Considering the disastrous impact on the forest wealth an innovative scheme was launched to prevent forest fire by involving the local rural masses in creating environmental awareness. The Scheme was implemented in Coimbatore division of Tamil Nadu, India which is a part of Western Ghats and also one of the important biospheres of the world. The selected area used to get affected with fire by the graziers, illicit cutters, poachers, etc. Western Ghats constitutes prominent and fascinating features of peninsular India. It runs parallel to West coast ranging from Tapti valley in Gujarat to Kanniyakumari of Tamil Nadu covering a distance of 1600 km covering a total area of 51,185 km<sup>2</sup> out of which Western Ghats of Tamil Nadu cover an area of 12,760 km<sup>2</sup>.

On account of its geographical position it intercepts South west monsoon winds which is the chief source of rain for the greater part of the country. Due to prevailing tropical climate the variability in the altitude and amount of rainfall the region enjoys the boundary of biological resources. Physical and environmental factors have unitedly evolved impact on resources pattern and many sub ecosystem. They have become highly complex and very fragile under the sub systems. This Western Ghats include one of the important biosphere of India viz, Nilgiri biosphere which is the unique and richest bio-geographical zone and fascinating feature in the Indian subcontinent holding multifarious endemic floristic and faunal wealth. The Western Ghats are occupied by more prominent species viz *Tectona grandis*, *Dalbergia latifolia*, *Terminalia paniculata*, *Terminalia chebula*, *Terminalia bellarica*, *Terminalia arjuna*, *Pterocarpus marsupium*, *Adina cordifolia*, *Grewia tilifolia*, *Gmelina arborea*, *Santalum album*, *Syzygium cumini*, *Mangifera indica*, *Shola* spp., etc. The Nilgiri biosphere reserve also forms part of important corridors for the movement of elephants with regional connectivity. It is having fragile ecosystem of *Shola* grasslands which face mounting problems due to over-utilization. One of the most important causative factors of degradation is wildfire which has contributed to the alteration of these ecosystems.

The Coimbatore Division selected for this programme has a size of about 680 km<sup>2</sup> with headquarters in Coimbatore City. Most of the forested region is located on the eastern slopes of the Nilgiri Hills with altitudes ranging from 245 m a.s.l. in the Bhavani valley up to 1450 m. Most of the Division, including the forested areas, lies in the rain shadow of the Western Ghats, with an annual rainfall of about 750 mm; the high elevations receive about 2000 mm precipitation mainly during the Northeast monsoon rains in October-November. Bhavani, Moyar, Noyilar and Walayar are the major rivers. The Division encloses six forest ranges (Coimbatore, Boluvampatti, Mettupalayam, Perianaickenpalayam, Karamadai and Sirumugai)



The Division is an important part of the Nilgiri Biosphere Reserve with many areas, even though small in extent, forming important corridors ensuring regional connectivity for large mammal populations. Nearly 60% of the forests are dry deciduous and hence highly vulnerable to fire. Most of the remaining moist forests have open grasslands that are highly flammable in the dry months. The Division is rich in commercial timber species such as teak, rosewood and sandal wood and in non-timber forest products such as tamarind (*Tamarindus indica*), Soapnut (*Sapindus emarginatus*), gallnut (*Terminalia belirica*), Nellikai (*Phyllanthus emblica*), seekai (*Acacia sinuata*), neem seeds (*Azadirachta indica*), avaram (*Cassia auriculata*), and bark of *Cassia fistula*.



**Fig.1.** In India nearly 600 million rural people depend on forest either for their sustenance or for livelihood. The vast majority of forest fires are caused by people, mostly as a consequence of utilization of wood and non-wood forest product utilization. Photo: J.G.Goldammer (GPMC).

Forest fires are a major recurrent management problem, even though the incidence and extent may vary from year to year depending primarily on rainfall during the dry fire season. Fire mostly affects the dry deciduous forests on the eastern slopes in January-March. It is believed that most of the fires are deliberately started by graziers (to get a fresh growth of grass), fuel wood and charcoal collectors, non-timber forest produce (NTFP) collectors, poachers, etc. Control of forest fires in this Division had followed traditional forestry practices of maintaining a network of firelines, and clearing them and conducting controlled burning before the fire season. Early detection of fire by a large number of seasonally appointed fire watchers, and once detected its containment with some level of local participation were standard and regular practice during the fire season. Even though relatively successful in the long past, for the last many years there has been a progressive failure in the prevention and control of forest fires. It has been felt that the incidence and intensity of fires have been on the increase, particularly considering the reduction in forest area that has taken place. This failure is attributed to several reasons: a progressive reduction in the allocation of resources for fire prevention and control (in terms of funds, personnel, equipment etc); there has been an increase in the interaction between people and forests (e.g. grazing, fuelwood collection) that leads to fire; there has been an alienation between people and forests in their neighbourhood due to various reasons so that the local people are no longer interested in cooperating in the control of forest fire.



In this background a project was launched in Coimbatore Forest Division, Western Ghats, to generate awareness among the rural masses and a greater success was achieved in the control of forest fire through the participation of local people. We did not however decide upon the form or extent of participation, leaving it to the course of events that would follow once we initiated an interaction with the local people.

We began in mid 1994 with a survey of human and cattle population inside and in the periphery of the reserved forests. We identified 49 human settlements inside the reserved forests with human population of about 10,000 people and a livestock population of about 5000 animals (goats, sheep, cows, buffaloes). We also identified 97 villages adjoining reserved forests, with a human population of about 240,000 people, and a livestock population of about 15,000 animals. A survey was made of the incidence and extent of forest fire from 1991 to 1995, based on records that are maintained by the forest department. These records are likely to underestimate both incidence varied from 10 (in 1994 and 1995) to 55 in 1992. The area affected varied from about 20 ha in 1992 to about 40 ha in 1994. The percentage of area affected by fire varied from 0.06 to 0.30%. This is not a realistic figure since most of the forest fires are not reported by the lower staff due to various constraints. Some of the reserved forests were more affected than others and consistently so across the years. Villages inside and adjoining these reserve forests (23 in all) were selected for a campaign against forest fire.



**Fig.2.** Posters and billboards are important carriers of fire prevention messages throughout India. Photo: J.G.Goldammer (GFMC).

The campaign to enlighten the villagers covered all media; by way of dum-dum in settlements deep inside the forest, pamphlets and posters, marches with loud speakers and placards, and local cable TV net work. Following this, public meetings were held in the centre of villages in which villagers were encouraged to speak extempore about forests and forest fire. From the forest department we explained the importance of forests at the local, national and global scale and the havoc that forest fire can play. The need to control forest fire, the necessity of local people's participation in the fire control, and the background in which stiff penalties were imposed on people who deliberately started forest fires were explained. We found that villagers were keen to listen to their own people speaking rather than uniformed forest department staff. In most of the villages there was a good response during the meetings with many people coming forward to speak about their perception of forest fires and their impacts, and ways of controlling them. Many offered their full cooperation and some in return requested for specific services to be rendered by the forest department. Most of these requests related to long standing demands of the villagers that did not come within the jurisdiction of the forest department such



as a tube well, periodic visits by a doctor etc. Meeting most of these demands required the role of forest department to coordinate with other government departments with no major financial commitments. Efforts were made by us to get these requests fulfilled, in many cases with success.

The initial meetings in the villages and attempts at fulfilling their genuine long standing demands often successfully, was followed by another round of meetings, one in each village. The major purpose of these meetings was to form a fire protection committee in each village. The major objective of forming such committees was for them to follow up on decisions on action needed to be taken at the local level in fire protection. No particular direction was given by us towards the composition of such committees, except that the local Range officer was the president. The number of members varied from 10 to 46, consisting of men and women from different walks of life. A register was opened which kept a record of the meetings and their outcome.

Massive campaigns was taken up by the forest department only during the fire season. Person to person canvassing is being done by the committee members, with support from the local forest department staff in the form of educational materials and training sessions conducted by the Range officers.

In 1994-95, the incidence of forest fire was minimal due to unseasonal rains. The campaign was also taken in the beginning stages. Other than an increase in the voluntary participation of local people in the fire control, it is difficult to evaluate the impact of the campaign at that juncture. In 1995-96, the incidence of forest fire was very low throughout the Western Ghats. Among the 23 committees that were formed in the villages, some were very active in campaigning against forest fire, and in participating in its control. In some villages the response was lukewarm and in the others none. A participation and its impact on the prevention and control of forest fire is yet to be made, partly because it is too early to make such an assessment.

### Lessons

We have learnt three important lessons from the above small experiment in eliciting peoples' participation in forest fire control. The first is about village committees. We found that committees are best formed after a period of interaction with people, and not as a first step. Committees formed without a period of interaction often contained many members whose initial enthusiasm withered away too soon. An initial period of interaction, on the other hand, often brought forward individuals who had a long term commitment to the cause.

The second lesson was that the forest department representative was a critical person whose presence in committee meetings was necessary to sustain the interest of committee in forest fire control. Without him the committees itself tended to underestimate its importance, and with his continued absence the committee tended to wither away.

A third lesson was regarding the sustainability of this initiative. It is only two years since this experiment began. In order to judge whether it is effective and worth emulating elsewhere, it is necessary to continue for a number of years. Whether this would happen or not depends to a large extent on the interest of forest department itself, especially the local and middle level staff.

### Conclusions

Forest fire and its management have long history in Indian Forestry. In 1954, the Chief Conservator of Forests of Madhya Pradesh, Mr. C.E.Hewetson, stated that the conception of forest fire protection was one of the most creative and far reaching in its effects. Not only it was essential to allow the drier forest to regenerate, but also it was and it is the most powerful single weapon in soil conservation. It was a tragedy that this idea of complete fire protection gradually eroded away by the urge for economy in expenditure. The most successful method of fire protection in the past used to be an elaborate network of fire lines, blocklines and guidelines, and their early clearing and burning. This system used to work very well and still does when population pressure on the forest is low. With increasing human population in and around forest areas, and their dependence for fodder, fuel wood and other non-timber forest produce, the traditional systems of fire control no longer works effectively. The human resources available with the forest department have not increased with increasing human pressure on the forest. On an average in India, nearly 500 ha of forest is patrolled by one guard and one

watcher. It is practically impractical to monitor and control the forest fire in such a large area which is having free access by the intruders from all sides. Unnatural forest fire causes imbalance to the nature which reflects very badly on the biodiversity and reduces floral and faunal wealth. Forests in developing countries which are adjoining the habitat of rural settlements where the people are not aware of the importance of the forests. The whole stretch of the forest area is not fenced and it is having a free access from all sides by the intruders causing tremendous pressure on these forests. Unless man himself realises the importance of forests it is not going to work effectively for the conservation of natural forests. At this juncture awareness campaign will go a long way to bring down the forest fire incidences through the pioneer leaders who comes forward for the cause of conservation of natural resources.

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## **INDONESIA**                      *Wide Area Surveillance System (WAS) Phase I: Transboundary Haze Pollution Control and Monitoring System (THPCM)*

### **Abstract**

The Government of Indonesia (GOI) in cooperation with the United States Trade Development Agency has been conducting a Feasibility Study for a Wide Area Surveillance System (WAS) for Indonesia since July 1997. Phase I of WAS, the Transboundary Haze Pollution Control and Monitoring System (THPCM), addresses the critical and devastating forest fire problems of Indonesia and proposes a system-based solution to respond to forest fire events.

WAS is a state-of-the-art monitoring system to collect real-time environmental, natural resources, and natural hazards data. As currently proposed, WAS is a system that will collect and process environmental data and use it to respond to a directly or indirectly threatening situation from a human, environmental or natural resources point-of-view. The objective of WAS is to provide real-time monitoring of natural hazards, environmental conditions, and environment-affecting activities in Indonesia and use this information to respond and act upon the situation. Real-time monitoring means providing data as events or changes occur, generally in a matter of minutes or hours, to permit rapid identification of and response to problems. Early assessment results of the feasibility of WAS for Indonesia identified that implementation of the proposed solution ("system") should be split in phases. The WAS Phase I (THPCM), which addresses land and forest fires, is the focus of this conference.

### **Objectives of THPCM**

The objective of the THPCM is to improve the Government's capabilities to predict, prevent, and respond to land and forest fires, and thereby reduce the severity and frequency of hazardous smoke and haze conditions in Indonesia and neighbouring countries.

## Description

The THPCM will consist of four major functions:

- \* Pre-fire planning
- \* Monitoring
- \* Communication and information exchange
- \* Fire suppression

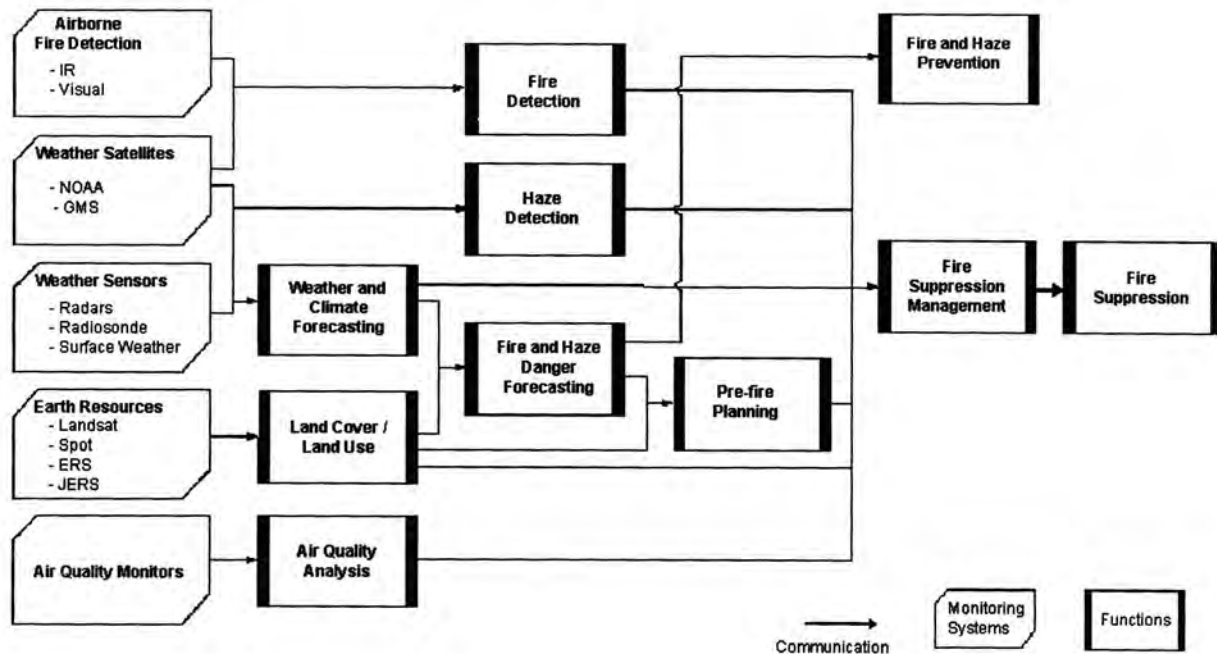


Fig.1. THPCM System Functions

## Pre-Fire Planning

The pre-fire planning component will enable the GOI to allocate and direct fire suppression resources to the most likely areas of need and to establish procedures to ensure that all related aspects of fire and haze suppression are well integrated and coordinated. Monitoring fire and haze monitoring will use a variety of data analysis technologies to predict and monitor fire hazards on an on-going and sustained basis. When fires do occur the information collected by the various monitoring systems will provide for early detection and rapid response. The major monitoring functions are:

- \* Fire and haze danger forecasting
- \* Fire detection
- \* Haze detection
- \* Weather and Climate forecasting
- \* Land use/land cover assessment
- \* Air quality
- \* Suppression management

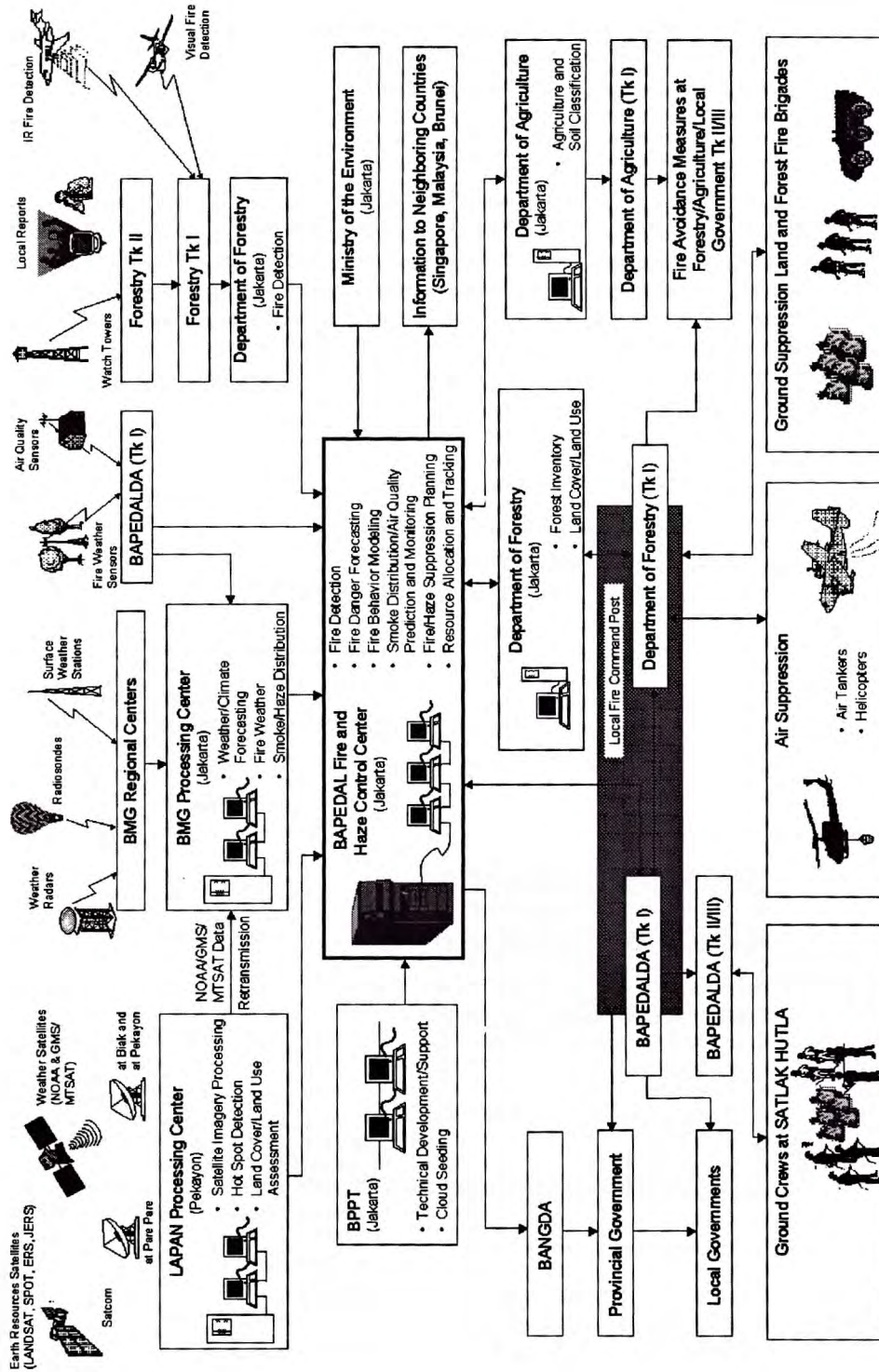


Fig.2. THPCM System Architecture



## Communications and Information Exchange

Communications and information exchange are critical to the effective operation of any fire management system. In Indonesia, fire management is the shared responsibility of several institutions, each of which is responsible for a specific analysis and/or response component. The THPCM will provide both a communications infrastructure (e.g., intranet, SATCOM, radio, etc.), as well as a system for cataloguing and exchanging data so that it can be easily and quickly accessed and disseminated. Information from environmental sensors will be communicated to and between data analysis centers in digital format. This will allow for rapid decision making and information exchange with field personnel.

## Fire Suppression

Coordinated fire suppression operations will be conducted using a combination of air and ground suppression techniques. The effectiveness of fixed-wing and rotary-wing aircraft used in combination with ground crews has been proven to be successful in suppressing fires in many countries throughout the world. Existing fixed-wing and rotary-wing aircraft will be modified with retardant/water delivery systems and supported by both mobile and fixed retardant mixing facilities. Ground suppression will be carried out at the local level by trained crews equipped with basic fire fighting equipment, including portable retardant pumps, shovels, axes, paraugs. A key component of the THPCM is to provide basic fire fighter training at the Satlak Hutla level and fire management training to at the TKI, II, and III level.

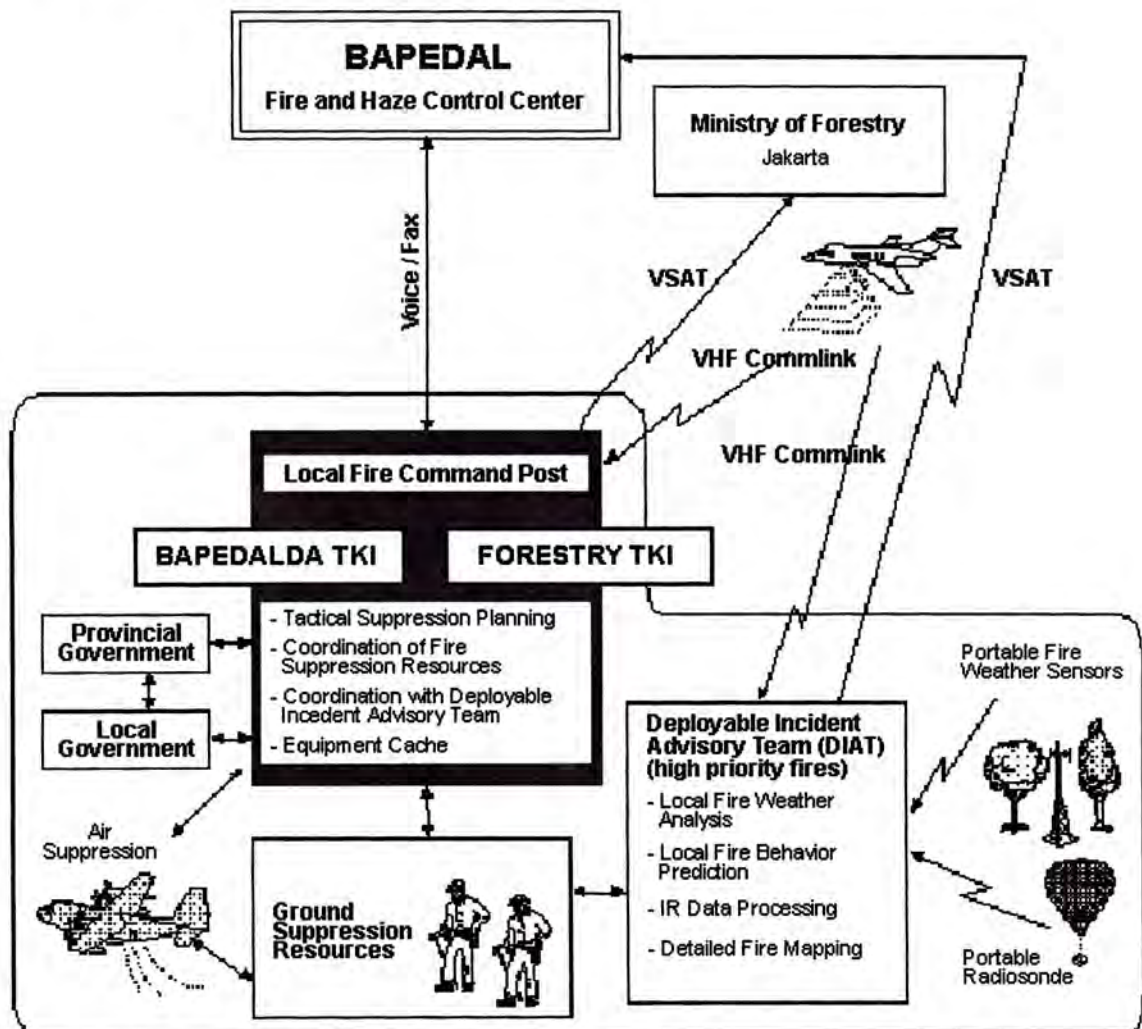


Fig.3. Local Fire Command Post Operational Concept



## Operational Concept

While many institutions in Indonesia currently perform functions related to fire and haze monitoring and suppression, experience in the 1997 fire season demonstrated that these were ineffective. The THPCM will provide a more systematic and operational approach to integrate the capabilities of GOI institutions. The overall architecture for the THPCM project is illustrated in Figure 2. The architecture is modeled after fire monitoring and suppression systems that have been successfully implemented in other parts of the world, including The United States and Canada. The heart of the system will be the Fire and Haze Control Center located at BAPEDAL in Jakarta. BAPEDAL will collect data from other agencies and/or institutions on a regular basis, and integrate and analyze it to conduct:

- \* Pre-fire Planning
- \* Fire detection
- \* Fire danger forecasting
- \* Fire behaviour modelling
- \* Smoke distribution and air quality monitoring
- \* Fire suppression planning
- \* Suppression resource allocation and trading

Fire suppression activities will be coordinated and managed at local fire command posts that will be established as needed at airports in the fire prone provinces of Kalimantan, Riau, Jambi, Lampung and South Sumatra (Fig.3). The Local Fire Command Posts will be operated through a close coordination between BADEDALDA TKI and Ministry of Forestry TKI, and will be responsible for performing the following functions:

- \* Local tactical fire suppression operations management
- \* Air and ground suppression operations management
- \* Local suppression resource tracking
- \* Communications with air and ground suppression units and support personnel

## Conclusion

The THPCM makes use of existing, already proven technologies and management systems. The approach outlined will require coordination between multiple Government agencies and administration levels and a variety of fire suppression methodologies. All of these components have been shown to be technically sound, organizationally visible and effective elsewhere in the world. The project will strengthen the capabilities of GOI institutions, by enhancing data collection, management, and analysis as well as by providing proper training for local, provincial and national agency staff. The project will supply equipment and provide training of fire fighting personnel to improve the capabilities for suppressing fires in Indonesia. The THPCM will provide coordination of fire suppression operations between national level institutions, local governments and field personnel.

**Bibliography:** Extended bibliography is available on the GFMC internet version of this paper.

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**LAO*****Forest Fires in Lao PDR*****General Information**

Lao PDR is an independent country which covers a land area of 236,800 km<sup>2</sup> and is bordered by China, Myanmar, Viet Nam, Cambodia, and Thailand. All the country is located in the watershed of the Mekong river which originates in China and traverses from the north to the south of country. About 75 % of the land area is located in hills and mountains. The number of the total population of Lao is 4.8 million (1997 census). 80 % of the population are living in rural villages, and the population growth rate is about 2 %.

**Forest and Land Use**

It was estimated that in the 1940s about 70 % of the country was covered by forest. During the 1960s the forests were largely destroyed mainly as consequences of the war. According to the estimation made in 1973 the forest coverage was reduced to 54 %, and in 1981 the total forest cover was about 47 % or 11.2 million ha. During the past the forest was still gradually destroyed by shifting cultivation practice of the rural populations. It is recognized that the forest in Lao PDR are under pressure by people lacking alternative for survival other than shifting cultivation or encroachment on forest land.

The statistics of 1992 reveal that 277,000 families practice shifting cultivation on 1.6 million ha. In 1998 this number was reduced to 142,745 families and 132,500 ha. In 1999 the government plans to reduce shifting cultivation to 130,000 families on a total area of 128,000 ha.

**Main Causes of Forest Fire in Lao PDR**

The main causes of forest fire in Lao PDR are:

- \* Slash-and-burn cultivation practice without firebreak, and
- \* Traditional hunting to drive out animals

It is estimated that 90 % of the forest fires originate from slash-and-burn cultivation practice of upland farmers. The degradation caused by fire is repeated year after year. No reliable statistics are available.

**Forest Fire Control in Lao PDR**

Obviously, there are no appropriate methods available for forest fire control. The government also lacks forest fire control equipment. It is particularly difficult to find suitable methods to control fire in mountainous and less inaccessible area. In order to prevent and control wildfires the following measures have to be taken:

- \* Provide sustainable land-use and job opportunities for shifting cultivators
- \* Motivate the shifting cultivators to understand about how to prevent how to detect and control fires
- \* Prepare standard working groups and set up an organization for coordination of regional fire control organization or other government agencies
- \* Prepare materials and guidelines for forest fire prevention and suppression.

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**MYANMAR*****Forest Fire Prevention and Management in Myanmar*****Profile**

Myanmar is the largest country in mainland Southeast Asia, with a total land area of 676,553 km<sup>2</sup>. It is situated between 9°58'N-28°29'N and 92°10'-101°10'E. Its length from North to South is approximately 2090 km; the width is up to 925 km. Myanmar possesses a broad spectrum of ecosystems, ranging from snow-capped peaks to tropical rain forests, the semi-arid belt and coastal marine ecosystems. It has a total coastline of about 2,832 km.

**Climate**

Because of its length from North to South, Myanmar possesses several variant climatic zones. Its climate is principally of the Tropical Monsoon type, which is mainly influenced by the seasonal Southwest Monsoon.

Three distinct seasons occur: the Hot Season from mid-February to mid-May; the Rainy Season from mid-May to mid-October; and the Cool Season from mid-October to mid-February.

Apart from the Temperate and Sub-Temperate regions to the North and higher altitudes to the West and East, the mean temperature ranges from 32°C in the Coastal and Deltaic areas and 21°C in the inland lowland areas. Maximum temperatures reach up to 40°C in the central Dry Zone during the peak Hot Season.

Annual rainfall ranges from 500 mm to 1000 mm in the central part of the country, to 5000 mm and above in the coastal and wetter regions. Apart from a few scattered showers in late May and June, the highest precipitation is during July to September, with the monsoon tailing off around mid-October. Rainfall does occur occasionally in November, as fall-out from storms that come in from the East.

Unlike those countries that lie within the Equatorial Climatic Zone, Myanmar does not receive rainfall all the year round. It has instead a wet period that lasts for about five months and a dry spell for the remaining seven months. This pattern has remained more or less unchanged.

**Topography**

The country is traversed from North to South by three major mountain ranges, which are extensions of the eastern extremity of the Himalayan Range. About two-thirds of the country is mountainous.

These ranges form four major river systems flowing from North to South; and the cultivable lands lie mainly along these river valleys and their expansive deltas.

**Forest Situation**

Influenced by a wide range of latitudes, topography and climatic factors, the forests are diverse and vary in composition and structure; and constitute invaluable ecosystems that conserve a wide range of plant and animal species, genes and micro-organisms.

The actual forested area is about 344,237 km<sup>2</sup> or 50.87% of the total land area, of which 43.34% comprises closed forests and 7.53% degraded forests. The remaining 49.13 % comprises 22.82% forests affected by shifting cultivation, 2.01 % water bodies and 24.30% non-forested areas.

Of the actual forested area, 16% is Tropical Evergreen, 26% Hill and Temperate Evergreen, 34% Lower Mixed and Moist Upper Mixed Deciduous, 10% Dry, 5% Deciduous Dipterocarp, 5% Dry Upper Mixed Deciduous and 4% Tidal, Beach and Dune Type forests. The actual forested areas are predominantly natural.

Scientific Forest Management was initiated in Myanmar around 1856, when the **Exploitation-cum-Cultural System** known as the **Myanmar Selection System (MSS)** was established, in order to assure the sustainability of natural forests in perpetuity. This system is still being adhered to steadfastly.



In spite of the large resource base, the Ministry of Forestry has prescribed an extremely conservative yearly quota of timber to be harvested from the forests. The Annual Allowable Cut (AAC) for Teak (*Tectona grandis*) was put at 609,500 cubic metres, and that for non-Teak-hardwoods at 2,463,600 cubic metres. Timber elephants still play the major role in stumping and dragging of logs, as they cause the least disturbance to the environment and the biodiversity, and do not necessitate the construction of extensive road networks.

Establishment of forest plantations applying the "*Taungya*" method which was in fact the fore-runner of Agro-Forestry and Community Forestry originated in Myanmar. At the beginning, plantations were thought to be the answer to forest rehabilitation; but with time, Myanmar foresters came to realize the adverse impact plantations brought upon the soil and water resource, the environment and biodiversity conservation as a whole. Likely plans for large-scale plantations were abandoned and they were established instead on a small scale as compensatory measure, with Teak being the choice species.

Plantations are thinned heavily till they reach the age of about 25 years, leaving only around 40 trees per acre. Silviculture operations are carried out till the trees reach the age of 40 years, after which they are regarded as natural forests and allowed to merge with their natural surroundings.

Myanmar foresters have never supported the contention that forest resources are easily renewable, but have held onto the belief that they are in fact critical. This being the reason why Myanmar today is one of the few countries that can claim possession of expansive natural forests, a wealth of biodiversity, a stable environment and a balanced climate.

### Evolution of Forest Fire Prevention Concepts

Basic concepts regarding forest fire prevention were initiated in Myanmar together with the advent of scientific forest management. Due to the experiences of severe forest fires in the North American continent, it was deduced that forests definitely needed to be protected from fires. It was generally accepted that prevention of forest fires was very important, and that invaluable benefits could be accrued from this vital function.

In 1896, the Inspector-General of Forests of India and Burma stated in an article published in the "*Indian Forester*", that the Government of British India and Burma commended the forest officials and their subordinates for their stalwart efforts in protecting expansive areas of all types of forests. That through promulgation of laws, educating the people, issuing relevant instructions, penalizing offenders etc., the public have become aware of their obligation to cooperate and actively participate.

In the May 1896 issue of the "*Indian Forester*", a forester by the name of Mr. Slade wrote an article titled "*Too Much Fire Protection in Burma*". Hitherto, fire protection had generally followed plantation work and there was no doubt of the benefit derived from the protection of plantations in their early years. But Slade's argument was against the marked tendency to advocate the enlargement of fire protected areas and fire protection of "all" Teak forests. Slade pointed out that forest fires in Burma in no way resembled the huge fires of America; that forest fires in Burma were mere ground fires, slowly but surely advancing and consuming the dry leaves which cover the ground to a depth of a few inches or less; that as a rule fierce fires are quite exceptional; that a fire once started, may burn for weeks and travel from one end of the country to the other.

Slade reasoned that as annual fires had become so constant and regular, it had become natural to Teak, transforming it into a fire-hardy species. He also rationalized that as all other vegetation suffers very much more severely in their younger stages than Teak, the annual fires cannot be considered other than as an agent favouring the growth of Teak at the expense of almost all other species; concluding that natural regeneration of Teak over large areas without the prior assistance of fire, is an impossibility. He further pointed out that by allowing the mature plantations to be burnt over annually, the cost of protection could be saved, as the cost of subsequent weedings would be reduced. Also that though forest fires do destroy a certain amount of valuable material such as logs and dead trees, they do an immense amount of good by destroying decayed stumps and branches, which in a fire protected forest would be sources of fungoid growth and the breeding grounds of many insect pests.

Finally, he recommended that the general extension of fire protection over thousands of acres which cannot be watched over in detail, not be undertaken; and that existing firelines be curtailed so as to exclude older

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plantations and that effective protection be prescribed for small defined areas on which a fairly good stock of young Teak seedlings had been revealed. Also that as the saplings on each protected area reach the stage of immunity to fire, protection should be stopped and other areas be put under protection. That the total area be limited by the number of seedlings and the amount of supervision available.



**Fig.1.** Open dry dipterocarp (indaing) forest in Central Myanmar: These forests are subjected to annual fires, often burning two or three times per year on the same site. Photo: J.G.Goldammer.

Slade concluded by stating that he did not mean to advocate the abolition of fire protection; but rather desired to deprecate its general extension to huge areas of forests, irrespective of the state of forest as regards natural regeneration. He held the view that the annually recurring ground fires should be considered as friends and not natural enemies, except during a certain period (of the existence of Teak); that fire is one of the forest officer's most useful agents as long as it is his servant and not his master.

Slade's article stirred a great deal of controversy, leading to two schools of thought. One was for the general expansion of fire protection to large forested areas; while the other was for exclusion of natural forests and mature plantations, and the inclusion of only young plantations and areas on which fairly good stocks of young seedlings had been revealed.

### **Subsequent Developments**

In 1897, it was decided upon the advice of the then Inspector-General of Forests, that fire protection should be extended only as far as funds and administrative considerations permitted. This resulted in an increase of areas under protection, provoking a great deal of dissention among the Burma Forest Officials, and opposition to continued protection of all classes of forests steadily increased.

In 1905, a forester named Mr. Troup published the enumeration of the stock carried out in two adjoining plots in the Tharyarwady forests. One plot had been protected successively for 19 years, and the other had been burnt over annually. The findings were as follows:



- \* A much larger proportion of unsound and dead stems to sound stems in the protected plot.
- \* Ten times as many seedlings in the unprotected plot as in the protected plot.
- \* About half of the sound stems in the protected area were in danger of suppression and would probably disappear, while those in the unprotected area were mostly sound, well grown, without sign of fire damage, and in little danger of suppression.

He concluded that with continued protection, Teak must eventually disappear from the protected plot.

In 1906, Mr. Beadon-Bryant, the then Chief Conservator of Forests visited the above areas, and arranged to have further counting in the previously counted plots and in six others. This generally confirmed the conclusion reached at by Mr. Troup.

In 1907, Mr. Beadon-Bryant compiled a memorandum on fire conservancy in Burma. As a result of many tours, he held the view that the combination of the Selection System with fire protection was gradually but surely killing out the Teak in the moist forests of Burma. He recommended to classify the forests of Burma into three categories:

- \* Forests in which the valuable species are found with an undergrowth of evergreen, dense, periodically and gregariously flowering Bamboos, as well as forests of a moist evergreen nature, where with the aid of fire protection, evergreen species are encroaching on Teak.
- \* Forests with an undergrowth of less dense Bamboos which flower sporadically as well as gregariously and therefore are more favourable to reproduction.
- \* Forests with an undergrowth of shrubs, herbaceous plants and grasses only, in which the more valuable species occur in a mixed or pure state.

He recommended that fire protection should be abandoned in the category (a) forests; that it would most probably be beneficial in many category (b) forests, though perhaps not possible to maintain owing to the manner in which categories (a) and (b) are intermixed; that protection would certainly be beneficial in category (c) forests where it should be continued and extended. In October that same year, the local government issued orders that in each Circle or Division, suitable areas of sufficient size should be selected, where the abandonment of fire protection could be carefully watched and the system extended from year to year, if results justified such action.



**Fig.2.** Wildfires sweeping into villages and townships are a common problem all over the dry tropics. The economic damages and humanitarian implications are very severe and must be encountered by public education and information campaigns. Photo: J.G.Goldammer

In 1911-12, the Inspector-General of Forests, Sir George Hart, recommended that the classification advocated by Mr. Beadon-Bryant be carried out in every Forest Division of Burma, and that subject to certain reservation, fire protection should be abandoned in category (a) forests. He suggested that fire protection should be given up for a period to be followed by a period of protection; and pointed out that the results of fire protection might likely prove to be incommensurate with the expenditure involved.

Reduction of fire protection was slow in spite of the opinion of a vast majority of forest officers in favour of considerable abandonment. In 1923-24 however, the fire-protected area was a mere 142 square miles.

A section of foresters was even in favour of giving up protection of young regeneration areas in favour of early burning and repeated burning. But the disadvantages of this method, in that it delays the closing of the canopy had already been proven. At the same time it was felt that unless fire protection in young regeneration areas can be absolutely certain, early burning formed a better insurance against the damage from late fires.

Regarding fire protection in dry forests, it had already been proven beyond a doubt that protection was beneficial; but the view was that it still needed to be proven that such operations were financially justifiable.

As a result of the above developments and the global economic depression, fire protection in the Natural Forests of Burma was totally stopped from 1930 onwards; and protection was carried out only in plantations. However, protection was continued in the young regeneration areas, and measures were undertaken to prevent fires from occurring in the Reserved Forests and adjacent forest areas whether intentionally, accidentally, or through negligence; and also to alleviate the scale of damage and loss in the event of a forest fire occurring.

### **Forest Fire Conservancy Measures**

Since the late 1880s, it had been decreed that the Forest Department was obligated to liaise with the Local Administrative Bodies in order to coordinate the issuance of Forest Fire Prevention Instructions for compliance by forest officers. Based on those instructions, the Local Administrative Bodies would issue general instructions for officials from other ministries to comply with, and to support the Forest Department's efforts at fire protection.

In 1944, The Statesman Press of Calcutta published the Forest Manual which included the Instructions for the Control of Fire Conservancy Operations that formed the basis for future Fire Protection Measures. Forest officials were held responsible for the prevention of fires in the fire-protected areas within their domain. They were also to be directly responsible for fires that encroached from adjoining areas. As such, they were obligated to construct fire lines, fire traces and safety strips as necessary.

**Fire Conservancy Plans:** All Forest Regions had to draw up Fire Conservancy Plans once every five years. In doing so, they needed to liaise and coordinate between adjacent regions. Detailed maps indicating relevant information had to be prepared and attached. There also had to be a clear understanding as to who would be responsible for what and to what extent.

**People's Participation:** The strong point of Fire Conservancy in Myanmar has always been the awareness and willing cooperation of the people. From the onset, foresters had been instructed to do their utmost to win the support of the local people; to refrain from restricting the people unnecessarily, not to obstruct the people from going into the forest to harvest their daily needs; most importantly, to avoid any action that would cause the people to want to harm the forests; and to at all times, work to make the people understand the multiple benefits that could be accrued from the forests. In situations where Divisional Forest Officials felt that certain rules laid down were too stringent, they were obligated to report their observations to their superiors in writing.

On the other hand, people who lived in villages near the Reserve Forests, especially those who were employed by the State or received financial support from the Government, were responsible to report incidences of forest fires and to suppress any fires occurring in adjacent areas, so that the fires did not spread into the Reserve areas. People who had permits to earn a livelihood within the forests, or practise shifting-cultivation (Taungya) were likewise responsible. In the event that any of the above individuals were found to be responsible for causing fires for any reason, they were likely to have their permits revoked. Finally, it was clearly stated that any responsible persons found lacking in their duties would likely be prosecuted legally.



**Assistance from Police Officers:** The Governor-General issued official instructions to all departmental officials from the respective ministries, including Police Officers, prescribing official responsibilities relating to forest fire protection. Any Police Officer who had reason to believe that a person or persons held intentions to cause forest fires, was empowered to apprehend anyone without a warrant. The Governor-General also issued requests to all Divisional-level Police Officers, to enlighten their subordinates, village headmen and village elders, regarding the essence of the Forest Law and other forest fire related instructions. Thus, the Police Force has traditionally played a vital support role in strengthening the functions of the Forest Department.

**Awarding of Rewards:** Divisional Administrative and Forest Officials were authorized to offer monetary rewards for information and assistance that would enable them to apprehend culprits who were guilty of causing forest fires. At the same time, officials were made to understand that they should not depend solely on the enforcement of the tenets of the Forest Law; that although it was important for the people to be aware of the legal implications regarding fire protection, it was even more important that the goodwill of the people not be impaired; that departmental officials from various ministries, together with the Divisional Administrative Officials and their subordinates could play a constructive role in achieving those goals. This was in fact, the inception of an integrated approach towards Forest Fire protection and Forest Management in general.



**Fig.3.** Fire suppression training in Myanmar: Handtools are most useful in combating low-to medium-intensity surface fires. Photo: J.G.Goldammer

### **The Post-Independence Period**

When Myanmar gained its Independence in 1948, it was infested with widespread insurgencies, as several politically oriented parties and ethnic groups started rebelling against the Government. As a result, Forest Management and Forest Fire Protection was restricted to the assessable forest areas.

Forest Divisions were the basic management units, and their territories were demarcated according to the Watersheds. Based upon the Five Year Plans drawn up by the Forest Regional Headquarters, The Forest Divisions had to draw up yearly Fire Protection Plans, to be in line with unique situations prevailing within their divisions. They also had to issue local Fire Protection Orders and Instructions annually.



In 1959, the Forest Management Guidelines for Subordinate Staff was published in the Burmese language. It was mainly based upon the Forest Manual, and fire protection likewise was based upon the Fire Conservancy Operation Instructions.

Although fire protection plans excluded natural forests, and focused on plantations, young regeneration areas and ecologically sensitive areas, special emphasis was placed upon the protection of successfully regenerated areas in the Central Dry Zone. Regarding the period that fire protection should be provided to plantations, it was decided that according to Myanmar's situation, it should be five years for Teak, and ten to fifteen years for Eucalyptus and Pine.

### Contemporary Trends

Fire Conservancy in Myanmar has more or less followed the old trends. As in the days of old, fire protection being a costly undertaking, available resources is still the determining factor as to the extent that protection can be achieved. According to available data, in 1997-98 the planned target to be put under protection was 3,79,230 acres, out of which 53.05% could be protected effectively.

As had been indicated earlier, peoples' awareness and wilful participation has been the strength behind successful protection from forest fires in Myanmar. But slash-and-burn cultivation (Taungya) has been an age-old practice with many ethnic races who live in the mountainous areas of the country, and is still being practised widely. This is the main cause behind forest fires occurring in Myanmar. However, as it is carried out merely on a subsistence scale, and as the areas that fall under this practice are buffered in by the natural forests, the spreading of fire to adjoining areas is minimal. Besides, burning is normally done under close supervision of the villagers.

As all forest estates, apart from those on private lands and community forests, are owned by the State, Forest Fire Brigades are not organised by the private sector as is the case in many countries; but protection measures are instead undertaken solely by the Forest Department, in cooperation with other ministerial departments and the local people. The fire hazardous period is normally for about four months, from mid-January to mid-May, when public awareness campaigns are carried out through various mediums, and villagers are rallied to partake in fire-watch duties and assist in various pre-emptive activities such as construction of fire lines and fire traces, prescribed burning, etc.

In 1992, the new Forest Law was enacted, defining the offenses clearly and prescribing more severe penalties for offenders. In 1992-93, Forest Conservation Committees were formed at the National, State/Division, District and Township levels, thus involving the related ministries, the Chairmen of the State/ Division, District and Township Administrative bodies as well as the local military commanders in forest management and forest fire conservancy responsibilities. In 1996-97, a new directorate called the Dry Zone Regreening Department was formed and it is to be solely responsible for the rehabilitation of once forested areas of the Central Dry Zone, and fire protection measures.

Myanmar Foresters have traditionally placed prevention above suppression of forest fires, as they had understood that forest fires once out of control were nigh on impossible to suppress. The priority focus was therefore placed upon the monitoring of combustible fuel, and this was normally controlled by prescribed burning in situations where surface fires had not consumed them.

Because the forests are predominantly natural, and mostly of the Tropical Evergreen type, the forest floor is naturally damp and the undergrowth mostly moist and green. The leaves and branches that fall each year are consumed by the annual surface fires, so fuel does not normally accumulate enough to pose a threat. Also, as the annual fires are mostly running fires they cause very little or no adverse impact to the soil, and do not consume the forest litter to the extent of depriving the forest soils from its nutrients or its capability to conserve the water resource.

The forest fires that do occur are mostly localised and peter out in the moist surroundings. However, realization that the climate change factor and abnormal climatic occurrences could bring about changes to the forest situation, has led to cause considerable concern. The Forest Divisions have been instructed to conduct

detailed inventories of their forests, so that Forest Management and Fire Conservancy Operations can be reappraised and redesigned to suit prevailing situations.

## Conclusions

The frequency and intensity of forest and bush fires around the globe in recent years have become alarming. Even developed countries with all their scientific and technological advances have not escaped the wrath of severe fire disasters. Modern methods such as aerial spraying of chemicals, water bombing have proven to be ineffective when applied against fires that have run out of control; and even the most developed of nations have ultimately had to rely on nature to intervene or to take its course.

It is universally accepted that forest fire threats and incidences had increased as a result of the depletion and degradation of the forests; as canopies of once densely forested areas are open up to the sun, it leads to the drying of and change in the soil texture. Myanmar's good fortune in not having ever experienced severe forest fires, nor rampant natural disasters, lies in its having preserved the forests in their natural state.

It is heartening to learn of recent positive developments advocating the preservation of natural forests, promotion of natural regeneration, establishment of plantations with mixed species so as to recreate nature in place of the old monoculture practice, and to give preference to native species above exotic ones. In the tropical regions, preservation and replication of nature alone can alleviate the threat of severe forest fires and natural calamities.

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## 1. Introduction

Sri Lanka is a tropical island with a land area of 65,000 km<sup>2</sup>. Current population is estimated at 18 million and the population growth is around 1.1%. The economy is predominantly agriculture and the annual per capita income is around US\$ 740.

The total area of natural closed-canopy forest in 1992 is estimated at 1.58 million hectares or 23.9% of the total land area. Sparse and open forests occupy a total of 463,842 ha or 7% of the land area while the total extent of well established forest plantations amounts to 72,340 ha or 1.1% of the land area. The current status of forest resources is given below.

**Tab.1.** Forest resources of Sri Lanka

<i>Forest Type</i>	<i>Area (ha)</i>	<i>As Percentage of total land area</i>
Montane Forests	3,108	0.04
Sub- Montane forests	68,838	1.04
Lowland Rain Forests	141,549	2.13
Moist Monsoon Forests	243,877	3.68
Dry Monsoon Forests	1,094,287	16.53
Riverine Dry Forests	22,411	0.33
Mangroves	8,687	0.13
Sparse Forests	463,842	7.01
Forest Plantations	72,340	1.09
<b>Total</b>	<b>2,118,939</b>	<b>32.02</b>

Source: Remote Sensing Unit, Forest Department (1992)

## 2. The Forest Fire Problem

The problem of forest fires in Sri Lanka can be summarized by examining weather conditions, fuel types in the forests, and human attitude in the area.

**Weather:** Sri Lankan climate is a monsoon climate, that is weather conditions are mainly determined by prevailing winds. There are two major monsoons; South-West monsoon prevails from April to July and North-East monsoon from September to January. SW monsoon is stronger than NW monsoon and lasts longer. During the south west monsoon rainfall concentrate on windward slopes of central highlands. So on the lee side winds arrive very dry.

The contrary is happening during the NE monsoon. But this monsoon is weak and shorter compared to the SW monsoon. Based on the rainfall the country is mainly divided in to two climatic zones; the Wet Zone where the annual rainfall ranging from 2500-5000 mm and the Dry Zone with the annual rainfall around 1000 mm . Though the rainfall figures are quite high, the distribution of rainfall is very poor especially in the dry zone. Much of the rainfall in the Dry Zone comes with the North-East monsoon during a three month period from October-December leaving 7-8 months of virtually dry period. This increases the fire hazard considerably.



The wind pattern and the topography create two marked fire seasons. A sort but important fire season from February to March in the wet zone and a longer fire season from June to September in the dry zone. In the central highlands only a short dry season prevails during the first three months of the year. But the risk of fire reaches its maximum due to the low humidity, and the topography of the area.

**Fire Hazard:** There is no significant fire hazard from existing vegetation of the country. Climax vegetation of the South and Central highlands is tropical rain forests and sub tropical montane forests. In the intermediate zone it is mainly an evergreen forests while in the dry zone it is a tropical semi deciduous forests. The land not occupied by the permanent agriculture is mainly covered with grasses such as *Imperata cylindrica* and *Cymbonogon spp.* Fuel load in this area is between 4-12 tons/ha in dry weight. Mean height of the grasses is about one metre and ready to burn during the dry season.

Fire hazard is very high in forest plantations especially in *Eucalyptus* and Pine (*Pinus spp.*) plantations. Over the past 40 years 18,000 ha of pines and 19,000 ha of *Eucalyptus* have been planted. Besides being a pyrophytcal species most of the pine plantations are situated in the steep slopes of central highlands. This situation creates a very high fire hazard

**Fire Risk:** The number of fires reported annually ranges from 50-200 depending on the prevailing weather conditions. Almost all fires are reported from forest plantations and the following table shows the forests fires reported during past 5-year period. The damage is estimated on the direct monitory value of the plantation at the time of fire.

Tab.2. Forest fires reported during 1994-1998

<i>Year</i>	<i>Number of Fires Reported</i>	<i>Area Burned (ha)</i>	<i>Estimated Damage (Rs)</i>
1994	60	191	1,282,600
1995	126	372	1,342,600
1996	136	271	1,481,100
1997	205	610	3,102,120
1998	114	204	516,153

Surface burnt by a single fire varies from 0.2 to 150 ha with the average of 10 ha. Nearly 2% of the newly planted areas are burnt annually. Most of the forest plantations are small in size and scattered over the country. Therefore, the risk is also scattered. However, the risk of a big fire is not very high due to the small size of plantations. Almost all fires are ground fires and crown fires are very rare.

Nearly 55% of all fires are reported from pine plantations while 20% is from eucalyptus plantations. Young plantations are more vulnerable compared to old plantations. Nearly 60% of all fires are reported from the plantations that are less than five years of age. Very few fires last longer than 24 hours and most are in the range of 3-10 hours.

### 3. Main Causes of Forest Fires

The agents causing natural forest fires such as dry thunderstorms or volcanic eruptions are not present in Sri Lanka. Therefore, all most all forest fires in Sri Lanka have a human origin carelessness seems to be the main cause of forest fires. Main causes reported are:

- \* Throwing cigarette butts when travelling by train or walking through forests.
- \* Burning of debris by workers who are maintaining highways and railway tracks without taking proper precautionary measures.
- \* Burning dead grass in order to obtain fresh grass for cattle. These fires often spread out to the nearby forests.
- \* Burning of degraded forests for shifting cultivation.
- \* Setting fire to the forest by hunters to make animal go out.

#### 4. Present Forest Policy

The new forest policy came in to effect from 1995 has the following three main policy objectives.

- \* To conserve forests for posterity with particular regard to biodiversity, soils, water, and historical, cultural, religious and aesthetic values.
- \* To increase the tree cover and productivity of the forests to meet the needs of present and future generations for forest products and services.
- \* To enhance the contribution of forestry to the welfare of the rural population and strengthen the national economy with special attention paid to equity in economic development.

The policy on management of state forest resources (*almost all natural forests and majority of forest plantations belong to state*) further states the following.

All state forest resources will be brought under sustainable management both in terms of the continued existence of important ecosystems and the flow of forest products and services. The natural forests will be allocated firstly for conservation, and secondly for multiple use production forestry. Forest legislation is now being formulated to provide the legal provisions to implement the new policy. The present legislation has several provision with regard to the control of forest fires through law enforcement. Section 7 and section 20 of the Forest Ordinance forbids setting fire to any forest. Regulations made under section 7 further forbid the use of fire within a ¼ mile from a reserved forest except in accordance with the regulations. Section 67 of the Forest Ordinance stipulates that all persons who exercise any right in a reserved forest or are employed by the state are bound to report the occurrence of any fire and to help in extinguishing it. So, the present policy is no fires are allowed in the forest except in accordance with the regulations. Helping to prevent and to suppress the fire is compulsory for people connected with and in the vicinity of forests and for those who are employed by the state.

#### 5. Organizational Setup

At present fire control activities are carried out by the Silviculture Division of the Forest Department. This division is headed by a Deputy Conservator of Forests and he is assisted by two Assistant Conservator of Forests at the head office level. In the field level, the Divisional Forest Officer is responsible for all fire management activities within the division. He is assisted by the Range Forest Officers and Beat Forest Officers. The Range Forest Officers and Beat Forest Officers are working very closely with the village community in controlling forest fires.

#### 6. Fire Prevention

Management plans have been prepared for both natural forests and forest plantations based on the above mentioned policy guidelines. Each management plan contains a fire control working circle under which all fire control activities are listed. The main tasks to be performed are

- \* Reduce fuel load through site preparation in case of new plantation establishment
- \* Keeping the plantations weed free through frequent and rigorous weeding
- \* Preparation of fire lines

- \* Establishment of Forest User Groups (FUG) for the prevention of fire occurrences
- \* Training of departmental personal, members of FUG and people living in the vicinity of forests on forest fire control
- \* Promotion of agroforestry practices in forest plantations

Annual work plans are prepared incorporating these activities for both natural forests and forest plantations. Both peripheral and internal fire lines are used to prevent fire spread out to the forests. Peripheral fire lines are 10 meters wide in flat areas and 20 meters in slopes. Internal fire lines are used only in valuable forest areas where the fire risk is very high. Fire watchers are also employed during the fire season to patrol along the fire lines. Their duty is to detect fires and put off fires with the help of local people. Training programs are also carried out to train the local level officers and villagers on fire fighting. Use of hand tools is the main emphasis of these training programs. These training programs consist of lectures and field demonstrations. During the fire season fire-warning signs are placed along the roads of most vulnerable areas.

**Participation of Local Communities in Forest Fire Prevention:** Forest fire prevention has been the responsibility of Forest Department and Forest Department alone over the years. As the principal causes of fire damage are human related it is imperative the involvement of local communities in fire prevention.

These communities, however, will not become involved in fire prevention activities unless they are getting some benefits. Considering these factors a new approach is being tested in pilot areas especially in *Eucalyptus* and teak plantations. Each management plan contains a "participatory management working circle" under which Forest User Groups have been formed. The following are the main features of this approach

- \* Local communities who are involved in fire prevention would allow to collect dead fire wood from the plantations free of charge
- \* Forest Department would inform them the future forestry activities in the area, so that, they are aware of the future employment opportunities in their locality
- \* Coordination of agricultural and forestry activities. This include
- \* Finding out from villagers when they intend to burn their gardens or shifting cultivation areas, so that, appropriate measures can be taken to protect the plantations from fire
- \* Permitting grazing and grass cutting without charge in plantations where there is a fire risk due to a build up of grassy vegetation

In addition regular fire control training would be provided to these communities. Once the trial period is over the most promising communities would be selected for formal participatory forest management programs. It is expected to implement a more efficient fire prevention program using the combination of direct involvement of Forest Department and community participation in fire prevention activities.

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## INDONESIA / ASEAN

### *International Cross-Sectoral Forum on Forest Fire Management in South East Asia Jakarta, Indonesia, 7–8 December 1998*

#### **Report of the Meeting**

The International Cross Sectoral Forum on Forest Fire Management in South East Asia, hosted by the Government of Indonesia and jointly co-sponsored by the Japan International Co-operation Agency (JICA) and the International Tropical Timber Organisation (ITTO) met in Jakarta, 7–8 December 1998, with the specific goals to:

- \* gather information concerning the causes of forest fires and their impacts on humans, bio-diversity, and the environment
- \* review existing land use conditions and to consider further input to land-use management reform
- \* analyze institutional development and the integration of current efforts to overcome the impacts caused by forest fire
- \* develop technology for forest fire prevention and management
- \* develop a policy and mechanism (including institutional development) to improve regional efforts to anticipate the trans-boundary impacts of forest fires
- \* develop guidelines for the drawing up of a National Action Plan for the management of forest fires and their associated impacts, applicable at the local, national and regional levels.

A total of 216 participants from 19 countries and 8 international organisations, representing a wide range of disciplines attended the Forum. The Forum was organised into plenary, one at the beginning and another at the end, and working group sessions. The participants were divided into three groups to discuss Forest Fire Prevention; Forest Fire Control and Rehabilitation; and Transboundary Issues. A total of 39 papers on various aspects of forest fire were presented at the Forum.

This report summarises the outcome of the Forum, including findings and recommendations.

#### **1. Preamble**

Wildfires have been present on earth since the development of terrestrial vegetation, playing a significant role in maintaining biogeochemical cycles and disturbance dynamics in some ecosystems. Fire and ecosystems have interacted throughout time influencing such ecosystem functions as: recycling nutrients, regulating plant succession and wildlife habitat, maintaining biological diversity, reducing biomass and controlling insect populations and diseases.

Taking a cue from nature, early humans used fire as a tool to alter their surroundings and later to prepare land for cultivation. Use of managed fire became a common practice in land conversion activities. However, once out of control, fire can lead to long-term site degradation and other detrimental impacts.

The recent major fires in Indonesia and elsewhere coincide with El Niño events; and therefore El Niño, has been blamed for the damage and devastation caused by these fires. El Niño is a weather phenomenon, which aggravates the forest fire danger situation, by creating drought conditions conducive for the spread of wildfire. El Niño by itself is not a sufficient cause for forest fire; and major fires have taken place in Indonesia not simply due to El Niño, but due to a much more complex interaction of human-induced conditions, which, among others, include availability of dry fuel load (caused by wasteful logging, land clearing), providing the material to feed the conflagration and an ignition source.

The forest fire scene in Indonesia is characterised by conditions emanating from negligence and linked both to subsistence and commercial activities. They are, among others: large scale logging, leaving a high percentage of residues in the forest, which in drought years become highly combustible; land clearing practices of HTIs, plantation companies and small holders using open, broad cast fires to dispose off the clearfelled materials

cheaply; careless use of fire by graziers, NWFP collectors, campers and others; intentional fires for staking land claims, or for other reasons. These have caused increased frequency of forest fires.

The situation is exacerbated by other constraints. They include, *inter alia*, the following: weaknesses in policies, legislation (including rules and regulations), and their implementation/enforcement; lack of funds and facilities; weaknesses of organizational structure and coordination; unclear authority and functions; inadequate infrastructure, lack of trained personnel, insufficiency of equipment; reluctance/resistance to adopt zero-burn techniques of land preparation on the part of land owners, or low-impact logging on the part of concessionaires; inadequacies in forest fire management exemplified by lapses in monitoring, fire-danger warning, fire protection/prevention measures, pre-suppression planning and preparedness, and firefighting capability; poverty, social conflicts and lack of incentives for the local community to participate in forest fire protection, and lack of awareness; institutional inability to learn lessons from past experience.

Fundamental changes in these framework conditions are required for long-term control and reduction of forest fires.

During the two spells of wildfires between September 1997 and May 1998, an estimated 6 to 10 million ha of land was burned. Official figures of forests burned is about 800,000 ha, covering primary forests, secondary forests, peat swamp forests, national parks and forest plantations. These catastrophic fires and the associated haze resulted in profound impact on economic, ecological, physical and social environment in the ASEAN region. Millions of tonnes of biomass, including timber and NWFPs were consumed by the fires. Physical infrastructure was destroyed. It affected industrial production; resulted in fishing decline; caused loss of biodiversity, disrupted commerce; registered sharp fall in tourism revenue. During the worst haze, atmospheric pollution index reached above 850 in some parts of Indonesia and Malaysia, while a reading of 300 – 500 is considered most hazardous. Health of some 70 million people in six countries were affected. The total estimated value of economic and social damages is about US\$ 6 billion. While these figures help to provide the magnitude of the calamity, many of the deleterious effects of fire on Indonesia's tropical rain forests cannot readily be cast in economic terms.

The 1997–98 fire event, from its very beginning, led to several initiatives at national, regional and international levels. Many countries and international organisations provided emergency assistance in cash and kind, including equipment, materials, medicine, service of fire fighters, and so on. The Indonesian Government reactivated and strengthened the Forest and Land Fire Control Centres at national and provincial levels and Executive Units and Fire Brigades at subdivisional and local levels. The National Coordination Committee on Forest and Land Fire Control, with BAPEDAL serving as its secretariat, was given the responsibility to: coordinate monitoring of hot spots appearing on NOAA weather satellite images, carry out surveillance, provide early warning about fire danger, transmit information and guidance regarding action to be taken at the local level and so on. Since the fire event was declared a disaster, the BAKORNAS PB undertook the overall responsibility of coordinating the activities of various agencies including activities such as water bombing and cloud seeding. In spite of it, the fire suppression efforts suffered from organisational and communication weaknesses, and it was the onset of rains that finally extinguished the fire.

At the regional level several initiatives were taken to address the problem of transboundary haze pollution – such as establishment of Haze Technical Task Force, regular meetings of the ASEAN Environment Ministers and ASEAN Senior Officers on Environment, formulation of ASEAN Regional Haze Action Plan and its implementation; and coordination of ASEAN regional level actions with support from ADB.

At the time of 1997 fires, there were four important forest fire projects ongoing (funded by GTZ, EU, JICA and ITTO) and another (UK) with a major fire related component. There are now over 35 projects (including the ongoing, new, and pipeline projects), supported by bilateral donors, UN agencies, international NGOs and others. Most of the current projects are of short-term scope, investigating the underlying causes, or addressing specific aspects, of actions required – e.g. capacity building, biodiversity conservation. A trend in new projects is the high emphasis given to sophisticated remote sensing technology for monitoring and fire prediction, compared to practical pre-suppression and suppression activities, particularly to strengthen the capability of field offices and concession units. There are also no projects which seriously address the issue of post-fire forest rehabilitation.

Integrated Forest Fire Management (IFFM) is essential to control the damaging role of fire, without unduly curtailing its beneficial aspects and to reduce the intensity of fires in cases of fire events. Scientific and planned actions for fire protection, monitoring, prediction and prevention, fire-danger warning and preparedness for fire suppression, supported by appropriate policies and strategies are essential. Forest rehabilitation, a post fire activity, is a vital component of IFFM.

IFFM can be treated in three specific phases: (i) pre-fire planning and fire prevention involving fire breaks, fuel load control, weather monitoring, fire risk assessment and early warning, equipment development, enforcement and surveillance, training in firefighting, research and extension, and infrastructure development; (ii) fire suppression, covering fire detection; quick communication; organisation of fire crews; and (iii) post fire rehabilitation and management, covering fire inventory and classification, and rehabilitation planning. In all these aspects it is necessary to strengthen institutional framework, research and public education. It is also crucial that the technology adopted is appropriate and local participation is guaranteed through proper incentives.

The concept of IFFM recognises the traditional/beneficial role of fire; it integrates the local people and communities in the system of fire management planning and implementation; it appropriately balances the level of technology; it calls for improved knowledge about resources and fire risks. Avoiding wild fires, and capacity to quickly contain fires if started are indicative of good fire management.

The participants noted with appreciation that an integrated action plan for forest and land fire management in Indonesia is ready in draft form. This plan has incorporated the action proposals contained in the National Haze Action Plan, prepared under the auspices of the Regional Haze Technical Task Force.

## **2. Forest Fire Prevention**

Knowledge about, and analysis of, causes, both predisposing and immediate, of forest fires is important to design and implement measures of fire protection. Efforts to prevent forest fires call for several related actions to control the causes of fire, involving: clearing of fire lines around forest blocks; reduction of fuel load by prescribed burning; establishment and maintenance of green belts; weather monitoring and fire danger assessment; mapping of fire-prone areas for special surveillance; fire classification, generation of management data/information, fire modelling; creation of public awareness, provision of incentives for community participation/co-operation, and so on. Preparedness for potential fire event is an aspect of fire prevention and involves control of ignition sources, development of infrastructure and communication facilities, equipment development, assessment of training needs, crew development training, and demonstration, etc. However, forest fire prevention is a weak area in Indonesia. The participants heard with interest the experiences of the different donor-assisted forest fire management projects, and how the projects are attempting to address the constraints. While remote sensing facilities for mapping and monitoring are available centrally, there is lack of an appropriate communication system to convey urgent fire related information to the field.

Evidence shows that there has hardly been any serious fire in the undisturbed primary forests, which strengthen the view of the ecologists that in the tropical rain forests fires are almost excluded, due to fuel characteristics and its moist condition.

## **3. Forest Fire Control and Rehabilitation**

Forest fire control or suppression involves actions during the fire, whereas rehabilitation is a post-fire activity. The series of activities under forest fire control include surveillance/observation, detection, quick action to put out the fire (involving organisation/mobilisation and dispatch of the crew), fire fighting logistics, and fire suppression. The response time and the effectiveness of suppression depends on the speed of relaying correct information about the fire and the organisational formalities involved. Under the existing system in Indonesia, official channels of communication are very slow. Tools/equipment and trained crew are crucial for fire control. The tools/equipment should be simple, adaptable and compatible. However, the equipment available now are of poor standard and there are very few trained fire fighters; and they are hardly provided with any protective gear. Regular drills and demonstration are lacking. There is need to considerably strengthen local



level field capability for fire fighting, but there is little motivation or incentive. There is much less preparedness to control fires in peat forests which also burns below ground and causes excessive smoke.

Lack of effective and meaningful coordination has been a serious problem during the 1977-98 fire disaster. Aerial support for fire fighting (e.g. water bombing) provided as part of emergency assistance was also not effective. Helicopters and fixed wing planes have their role in fire fighting, provided they are well integrated into the system. On the other hand, if there is no effective and efficient system in place to prevent, control and combat fires at site, any amount of technological inputs elsewhere will not be of much use. Balancing of equipment, technology and training are required for optimising benefits.

Mopping up of the burned area is to be undertaken before a post-fire inventory and classification is carried out. Plan of action for follow up has to be decided accordingly – for example, to salvage the usable materials, to carry out sanitary operations, to rehabilitate the area by natural regeneration or artificial means, etc.

Post-fire rehabilitation often turns out to be a major investment activity. For lack resources, this important aspect of forest fire management is often neglected, leaving the remnants as a source of fire in a not too long distant future.

#### **4. Transboundary Issues**

Fires do not respect national (in some cases, even natural) boundaries. Fires can spread between countries sharing common land boundaries. Smoke/haze caused by fire often spread far and wide, as was experienced during the 1997-98 forest fires in Indonesia, when it affected at least six countries in the region.

Trans-boundary haze pollution is an environmental hazard caused by fires, particularly by clusters of peat fires. Haze consists of smoke, smoke condensation and particulate matter. While the health of millions in the region was affected by fire, over 40,000 persons were hospitalized for respiratory and other haze-related ailments. Its long-term impact on health of exposed children and elderly are yet unknown.

The effect of haze on light and visibility also impacted on economic production (both manufacturing and agricultural), transport, tourism and so on. Haze-caused accidents resulted in loss of lives. Several gaseous compounds in the haze are likely to affect global environment and climate. Quantitative evaluation of impacts was however limited due to fragmentary character of the particle measurement data and methodological problems.

Inter-governmental efforts of ASEAN countries in addressing trans-boundary atmospheric pollution has resulted in a Regional Haze Action Plan which was approved for implementation in December 1997. The Regional Haze Action Plan has three major components – namely monitoring, prevention and mitigation, sub-divided into 20 activity groups and 50 specific actions.

Trans-boundary issues related to haze pollution, among others, involve the need for studies on the nature and intensity of haze, nature of pollutants and their effects; surveillance of incidences of diseases; health assessment studies, medical emergency services; dissemination of information; policies on haze mitigation, and regional co-ordination of activities. There is clear need in the health sector for long-term planning to mitigate the effects of forest and land fires, supported by a national coordination of infrastructure development, equipment and skills for air quality monitoring, health effect alleviation, community awareness raising and education programs, structured data collecting systems and rapid response mechanisms.

#### **5. Recommendations**

The forum made the following recommendations:

##### **General**

Institutional weaknesses are a paramount factor causing inefficiencies of forest fire management. The situation

calls for several measures to reorient and strengthen the institutions and institutional instruments for ensuring integrated and sustainable forest fire management, involving:

- \* Policy reforms on aspects touching on forest fire management, directly and indirectly, and assigning of appropriate priority for forest fire management. Clear policy relating to land management and land clearance which takes into account the land requirements for various purposes is an important aspect in this regard.
- \* Appropriate revision/reformulation of laws, rules and regulations and their effective implementation to support integrated forest fire management (IFFM).
- \* Organizational reforms to facilitate effective and efficient functioning of sustainable forest management including IFFM, which would call for definition of clear functions, devolution of responsibility and authority, meaningful decentralization and smooth and speedy flow of information.
- \* A comprehensive and integrated National Fire Plan within the overall framework of National Forest Programme, preferably following a landscape planning concept, and specifying priorities, locations, time schedules, scope and objectives, costs and benefits and so on.
- \* Adequate provision of funds.
- \* A single-window coordinating mechanism, fully rationalized to be capable of addressing all situations and eventualities.
- \* National fire management guidelines and specific/detailed manuals for component activities such as fire protection, prescribed burning, equipment maintenance, fire fighting operations etc.
- \* The countries are urged to consider the establishment of a national fire management unit/agency, with wider scope and responsibility, within the existing (or reformed) system of public forest administration.
- \* The countries undertake capacity building for IFFM covering related human resources development, development of science and technology, infrastructure, equipment and facilities.
- \* While acknowledging that theoretical and practical aspects of fire management need to be balanced in any curriculum for education and training, the Forum underlined the importance of practical, field-oriented training and continuous periodic drills for the fire crew. Facilities available in Fire Academies can be adapted suitably, and/or additional and adequate facilities for forest fire fighting would need to be established, depending on the situation. In addition to the regular fire crew, there is need to impart training in forest fire fighting to voluntary fire forces, police and military, Fire and Rescue Services and staff of private sector and NGOs.
- \* Considering that forest fire related research has suffered from neglect in developing countries, and to steadily improve the system of IFFM, funds, facilities and expertise be provided for undertaking research relating to the various IFFM-related aspects such as climate variation, fire monitoring, fire danger assessment, fuel characteristics, fire suppression measures, equipment systems, problems of specific vegetational types (e.g hill forests, peat swamps), fire proneness, smoke impacts, rehabilitation silviculture and so on. A related consideration is acquisition of technology from outside, suitably balanced to the situations in the country.
- \* Appropriate participatory mechanisms be developed to obtain participation/ cooperation of local people, communities, private sector and NGOs in fire prevention and suppression activities. Local people can be enlisted as voluntary fire wardens and voluntary fire fighters. Improved incentives including honorarium, access to resources and entrepreneurial opportunities, provision of off-farm income-earning activities should be provided to promote participation.
- \* Raising of peoples awareness and extension on forest fire management are required to motivate people to prevent and mitigate forest fires.
- \* Pilot scale practical demonstration of IFFM can serve multiple objectives of practical training, awareness creation and research.
- \* The Forum stressed the need for increased donor support, through financial and technical assistance, for forest fire management, and improved donor co-ordination to improve effectiveness.
- \* Regional cooperation and collaboration in forest fire and haze related activities need to be sustained and strengthened.
- \* Mobilization of additional resources for IFFM is an important requirement and can be achieved through innovative measures such as objective-oriented taxes/charges, surcharges on postage stamps and rail and air tickets, and targeted funding facilities.
- \* With respect to Indonesia's programme on forest fire management, the participants appreciated the concept and content of the newly prepared draft of the Integrated Action Plan for Forest and Land Fire Management in Indonesia, which has incorporated and refined the action proposals contained in the National Haze Action

Plan; and stressed that the plan should be made implementational without delay, duly providing budget allocation, defining responsibilities and establishing a clear time frame.

### **Forest Fire Prevention**

- \* Prevention is one of the most effective ways to tackle forest and land fires, and it should be made effective and efficient in all its aspects.
- \* Sophisticated satellite/monitoring technology provides crucial information which can be continually updated. In order to be useful, it is necessary to link the system (e.g. satellite/remote sensing, GIS) with local (on site) information needs. In this regard it is necessary to standardize data gathering, processing and forwarding/receiving systems.
- \* Establish and improve the system of fire risk assessment, fire danger warning, and code of public behaviour in high fire danger situations.
- \* Discontinue to the extent feasible, conversion of natural forests into plantations or into other forms of land uses.
- \* Wherever selective cutting is used, establish and observe appropriate annual allowable cut and low intensity of removal; practice low impact and waste-free harvesting systems.
- \* Rationalize shifting cultivation practices through introduction of improved agro-forestry systems, off-farm employment opportunities, equity participation in local enterprises and so on, to wean away farmers from destructive practices.
- \* Promote public goodwill to the cause of forest protection through help to solve local land tenure issues, to relieve local grievances caused by forestry regulations, to provide resource access and so on.
- \* Promote measures of poverty alleviation, targeting the communities living in and around forest areas, to support food and income security.
- \* Optimize size and terms of forest concessions to ensure improved fire protection measures and related infrastructural facilities.
- \* Establish land clearance and management regulations to introduce fire permit system for open burning, to promote zero-burn land preparation and other environmentally sound practices.
- \* Establish a system of fire-belts/green-belts around forest management units/blocks, as well as other practical measures of fire protection and control.
- \* Develop and enhance buffer zones of protected areas with the dual objectives of fire prevention and habitat protection.

### **Forest Fire Control**

- \* Improve the system, and capability, of fire surveillance and fire detection.
- \* Establish permanent fire crews and keep them in good fitness and field training to fight fire when one occurs. The fire crew be strengthened by local volunteers, where required. Their training should include exposure to problems of different forest types (e.g. peat swamps, coal seams, savannah and terrain).
- \* Adequate amount of the different types of tools, equipment (transport, firefighting, communications) and materials be procured and kept in good condition and readiness. The equipment should be balanced according to the level of skill and training of the crew, and should be simple and compatible to meet the needs..
- \* Involve local people, private sector and NGOs in the different aspects of fire control as appropriate.
- \* Emphasis of forest fire control should be on strengthened field capability, with other systems suitably tuned to it.

### **Rehabilitation**

- \* Fire events be followed by a detailed assessment and classification of impacts in order to design appropriate salvage and rehabilitation operations, to establish priorities and to develop/apply proper silvicultural and logistical measures.



## Transboundary issues

- \* On regional co-operation strengthen regional co-operation in addressing trans-boundary pollution and related issues, including collaborative programmes and exchange of information (e.g meteorological data).
- \* On health aspects: conduct analysis of substances/components of haze and their injurious impacts on human health in the short and long term ; establish monitoring network for collection of data on basic parameters of fire and haze; study linkages of air quality and health; establish system to inform public on pollution level and precautions required; create emergency medical services wherever necessary.
- \* On air quality: improve capability to monitor air quality and disseminate information.
- \* On meteorology and weather monitoring: promote management of relevant meteorological data and analysis of fire-weather relationship; conduct integrated studies on climate variability/change; support provision of improved early warning and hot spot information; conduct studies on "mood swings" of El Niño and on how to internalize the information for effective IFFM.
- \* Conduct research on other socio-economic impacts of haze pollution.
- \* Participate in international initiatives of wider significance in the area of science and technology (e.g capacity building and training) and research initiatives such as SEAFIRE under the international Geosphere-Biosphere Programme (IGBP).

## 6. Conclusions

In summary, the recommendations of the meeting are related to actions to fill in gaps or to strengthen the existing capability under the following important areas: capacity building; pilot demonstration (model forest for IFFM, fire suppression training, participatory methodologies); community participation (through incentives, income earning activities, involvement in production enterprises); rehabilitation of burned areas (through sanitary operations, salvage fellings and replanting); rationalization of shifting cultivation (incorporating agroforestry, skill development, crafts); optimizing the size of forest concessions (to ensure scientific management); formulation of national forest fire plans; establishment of regional and international cooperation on transboundary issues related to forest fire.

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## COUNTRY NOTES

## CANADA

*The 1998 Forest Fire Season*

The 1998 fire season in Canada will reflect a 17% increase in fires over the 10-year average but the hectares consumed will be in the top worst five years. This large consumption of forest land in part reflects the intensity of the fire activity that occurred over the course of the season. The season began with national mobilizations occurring in early May due to intense fire activity beginning in April. This set the stage for a high level of interagency dependence on mutual aid resources, through-out the fire season. By the season's end, mobilization records will have again been broken. By 31 December 1998 Canada recorded 10,838 fires for 4,710,775 ha

The 1995 mobilization record between 28 May and 7 July was shattered when over 1400 personnel were mobilized in May 1998 alone. This is now the largest mobilization of resources on record. Over 1400 fire management personnel had moved including 700 personnel from the United States. This along with large amounts of fire line equipment put Canada's cooperative system of resource sharing to the test.

Canada's El Niño winter had western fire managers anticipating an active fire season. Alberta was still fighting fire during Christmas 1997, an extremely mild and low snow winter in the west, severe ice storms and subsequent flooding in the east gave evidence of an abnormally weather pattern developing. Forest fire season began two to three weeks early with low over winter precipitation bringing portions of British Columbia (BC), Alberta (AB), Saskatchewan (SK), Manitoba (MB), northwestern Ontario and the southern half of the Northwest (NT) and Yukon (YT) Territories into the fire season, with extremely high drought codes (DC). Beginning in April above normal temperatures and below normal precipitation across portions of the western provinces and territories further increased the fire occurrence and severity potential.

Late April and early May ushered in the fire season with a vengeance. Human caused fires were being recorded in high numbers from Ontario (ON) west. AB was faced with numerous human caused fires coupled with unseasonably warm and dry conditions with high winds. Severe fire behaviour resulted in many fires escaping initial attack, growing quickly to project fire status and soaking up available resources. Due to the early fire season, many agencies did not have their full complement of human resources up to full strength, therefore these resources were quickly depleted. As early as 3 May 1998 the Canadian Interagency Forest Fire Centre (CIFFC) was required to locate large numbers of professional firefighters. Due to limited number of human resources available at this time of year in Canada, CIFFC mobilized the first five of many, twenty person sustained action crews from the National Incident Command Centre (NICC) located in Boise Idaho.

Along with the continuous flow of human resources, competition for available air tankers and helicopters was increasing rapidly and quantities of fire line equipment was being mobilized into AB. By the second week of May restricted fire zones were in place in AB, ON and QC with project fires being reported in AB, ON and PC Jasper Park. A high level infrared scanner was moved into AB from NICC to assist in the fire mapping process. Evacuations had taken place in Slave Lake AB, Gull Lake ON, and twice in Swan Hills AB. By late May the fire situation remained serious in AB and was escalating in SK, ON and QC where additional project fires were being reported and fire occurrences increasing. By the end of May resource orders were being filled for QC, ON, and SK as the fire activity and project fires increased in those areas.

Early June saw some what of a moderating effect, primarily on the lower 2/3's of the prairie provinces and ON and QC. This allowed good progress to be made on many of the project fires, but the northern portions of the prairie provinces and both territories were still experiencing drought like conditions with high fire occurrence potential. AB and SK still had a long way to go with their existing project fire situations. Crews rotation was required which necessitated large numbers of personnel mobilizations, along with maintaining adequate resources for new starts. The Yukon's fire activity was increasing. One fire near Hanes Junction escaped initial attack and grew rapidly under severe fire conditions. Internal resources already low necessitated external assistance. Overhead teams and suppression crews and CL-215 groups came in from as far away as ON along with command and support trailers from BC. Mobilizations and demobilizations continued in support of the existing fire management activities in AB and SK. By the end of June over 2100 professional fire management personnel, 38 CL-215/415 airtankers, high level infrared scanning aircraft, large transport and rotor wing a/c plus a large assortment of fireline equipment had been mobilized in support of the fire management activity in

Canada, with the bulk of the resources moving into AB. With the lightning season now underway the fire community was well on its way to another record breaking year.

By the end of the first week of July the hand writing was already on the wall. The fire severity map showed clearly the hazard increasing in the far northwest was now spreading across the northern portions of the provinces to northern ON. Resources were already moving into YT. All western provinces were experiencing multiple starts due to the increased lightning activity. Agency internal resources were becoming scarce. Over 1100 fires occurred between 4 and 12 July 1998. Requested for skimmer aircraft could not be filled. Initial attack crews were at a premium. The situation across western and northern Canada was critical. Canada was on the edge. Fortunately precipitation came across the north-central portions of the prairie provinces reducing the severity of the situation for those areas. Yukon and the Northwest Territories continued to battle the large fires that had develop in the wake of the earlier multi-start fire incidence. Many of these fires posed a potential threat to communities and other remote values. Ontario continue to respond to daily multiple fire starts throughout latter July when a moderating trend allowed them to recycle their resources. A record breaking heat-wave and the forecast of dry lightning in south central BC during the last week of July, forced BC into recalling many of their resources loaned out during the earlier stages of the summer. In anticipation of the upcoming multi-fire occurrence BC began to preposition resources into the high fire potential regions. By the end of July over 200 personnel along with 2 CL-415's and fireline equipment had been mobilized into BC. Due to the extreme fire potential across western Canada these resources were moved in from as far away as NB, QC and ON.

August brought continued fire activity to BC. Hot dry weather along with intermittent dry lightning resulted in multiple starts in the south central areas. Over 400 fire were reported over the August long weekend. This hot weather pattern spread across the prairies rising the fire potential into the extreme range in many areas. By the end of the first week of August, multiple fires occurrence due primarily to lightning was occurring in all western fire management agencies. This coupled with local wind events escalated the severity of the situation. Large fires with interface components and value losses were occurring in many areas. Evacuations or evacuation alerts were in effect in BC, YT, SK. Resource demands increased but mobilization slowed as available resources were used up. Fire activity in the USA reduced the chance of available resources from that sector. Resource orders for air tankers and large crews were backed-up awaiting availability. A state of emergency was declared around the Salmon Arm area of BC. BC called in 300 military personnel to help ease the demand for personnel.

The week from 1 to 13 August 1998 was the most active for the season with 1637 fires and 1.6 million hectares of forested land consumed. Large fires were occurring in all agencies from ON west. All available trained fire suppression personnel had been mobilized from across Canada and also the US. Requests for suppression crews, airtankers and selected pieces and fireline equipment could not be immediately met. New and existing fire activity continued well into August. Additional pressure was being placed on available personnel resources as the student firefighter began returning to school. With the cooler evening and good recovery overnight the fire activity slowed by late August although most of the north and west required substantial amounts of rain to put a final end to the 1998 fire season.

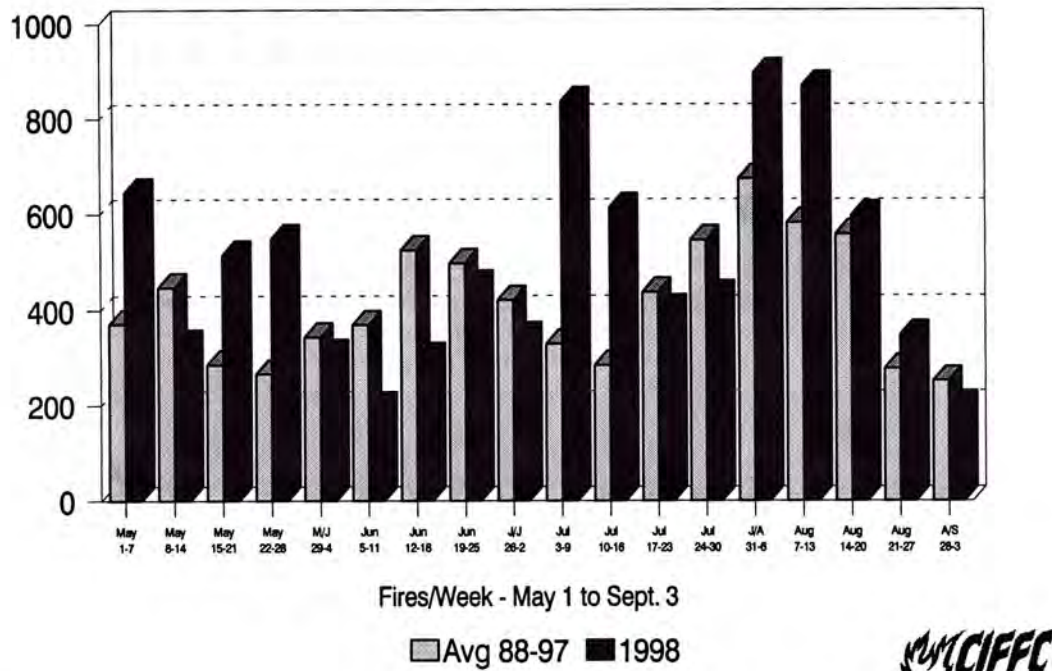
By the end of the season CIFFC had responded to 177 resource requests which resulted in approximately 3,000 personnel including over 800 from the United States, 27 air tankers groups for a total 70 air tankers, 900 fire pump kits, 20,000 lengths of hose, 1,035 sprinkler heads, 3,000 assorted hand tools plus camping gear and other items. Due to the quiet spring fire load in the United States, CIFFC was able to make extensive use of their suppression crews, large transport jet and high level infrared aircraft. The August bust was a different story, only limited personnel resources were available from the US. Once again CIFFC broke all previous records for mobilization in all resource categories. This year tested the operational procedures, agreements and exchange standards that have been developed and are in place for many of the agencies including CIFFC. The lack of large transport aircraft is a continuing national problem requiring a national solution. The continued development and acceptance of national standards for all resources and operational procedures will continue to raise the level of forest fire management in Canada.

Canada as a whole experienced an above average fire year for fire and for hectares burnt. As of 31 December 1998 10,838 fires were recorded compared to an 10-year average of 8,937. On the down side Canada has consumed 4,710,775 ha of forested land compared to a 10-year average of 3,022,613 ha



The following statistics (Tab.1) show that out of a total of 10,838 fires burning 4,710,775 ha, 798 were actioned under a Modified Response, consuming 2,599,707 ha. The fires that received a Modified Response account for only 7.4 % of the total fires, but 55 % of the total area consumed.

The following graph (Fig.1) shows the number of fire starts by week for 1998 as compared to the 10 year average. The anomalies in fire occurrence during the 1998 season can be seen.



**Fig.1. Weekly fire starts in Canada 1998**

Wildfires in which structures and or other human development have been lost or damaged, have become known as "Interface Fires." Table 2 shows the wildfire loss estimates for 1998 as compared to previous years. As of 31 December 1998 there have been no forest fire related fatalities reported. Table 3 shows total fire related fatalities in years past (Tab.3). Wildfire starts and area burned by wildfires in Canada 1988-98 are summarized in Tables 4 and 5.

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**Tab.1.** Wildfire statistics of Canada 1998

Agency	Fires			Hectares		
	Full	Modified	Total	Full	Modified	Total
BC	2,663		2,663	77,781		77,781
YT	141	55	196	222,231	163,348	385,579
AB	1,696		1,696	734,816		734,816
NT	247	152	399	482,957	976,403	1,459,360
SK	1,025	241	1,266	432,511	562,987	995,498
MB	419	97	516	28,214	380,704	408,918
ON	2,121	146	2,267	75,228	82,990	158,218
QC	797	57	854	11,846	406,472	418,318
NF	181	11	192	23,488	16,738	40,226
NB	288		288	303		303
NS	348		348	397		397
PE	26		26	77		77
PC	88	39	127	21,219	10,065	31,284
<b>Total</b>	<b>10,040</b>	<b>798</b>	<b>10,838</b>	<b>2,111,068</b>	<b>2,599,707</b>	<b>4,710,775</b>

**Tab.2.** Wildfire loss estimates for Canada 1990-98 (interface losses, not including forest resources) for 1998 as compared to previous years

Province	1990	1991	1992	1993	1994	1995	1996	1997	1998
BC	\$169,425	\$180,000	\$513,750	\$103,337	\$5,800,000	n/a	\$181,500	\$0	
YT	\$50,600	\$0	\$30,300	\$0	\$0	\$156,000	\$14,000	n/a	\$300,000
AB	\$0	\$0	\$0	\$0	\$0	\$0	\$0	n/a	n/a
NT	\$0	\$0	\$0	\$10,000	\$225,000	\$0	\$10,000	\$0	\$250,000
SK	\$0	\$0	\$0	\$0	\$81,500	\$451,800	\$0	\$0	\$350,000
MB	\$67,500	\$0	\$0	\$200,000	\$0	\$2,400,000	\$105,000	n/a	\$0
ON	\$209,150	\$217,100	\$9,500.00	\$151,200	\$0	\$500,000	n/a	\$800,000	n/a
QC	\$100,000	\$182,276	\$95,900	\$5,745	n/a	n/a	n/a	n/a	n/a
NF	\$140,400	\$410	\$680	\$3,230	\$13,500	\$20,000	\$0	\$600.00	\$150,400
NB	\$0	\$125,000	\$19,500	\$0	\$163,500	\$11,600	\$17,000	\$35,000	\$630,000
NS	\$166,650	\$109,700	\$5,200	\$100,300	\$2,750	\$50,317	\$1,000	\$24,700	\$4,000
PE	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$4,900	\$0
PC	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
<b>Total</b>	<b>\$903,725</b>	<b>\$814,486</b>	<b>\$674,830</b>	<b>\$573,812</b>	<b>\$6,286,250</b>	<b>\$3,589,717</b>	<b>\$328,500</b>	<b>\$865,200</b>	<b>\$1,684,400</b>

**Tab.3.** Forest fire related fatalities in Canada 1986-98

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Fatalities	6	3	3	0	3	4	2	0	2	4	0	0	0

**Tab.4.** Wildfire starts in Canada 1988-98 (total number of fires, lightning & human-caused)

Agency	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Ave.	1998
BC	1,951	3,537	3,257	2,037	3,809	1,503	4,094	1,489	1,343	1,198	2,422	2,663
YT	115	244	154	187	117	136	255	148	149	112	162	196
AB	872	795	1,296	923	1,055	848	872	804	376	445	829	1,696
NT	190	613	236	331	285	469	627	215	350	105	342	399
SK	1,064	1,020	897	762	701	646	700	649	428	491	736	1,266
MB	982	1,229	568	675	298	239	555	663	423	373	601	516
ON	3,260	2,430	1,614	2,560	960	743	1,053	2,121	1,243	1,634	1,762	2,267
QC	1,331	1,167	852	1,211	765	542	499	1,265	1,250	876	976	854
NF	116	192	197	166	109	83	143	103	148	110	137	192
NB	437	392	377	656	576	430	516	546	367	368	467	288
NS	328	425	496	733	299	315	245	408	272	371	389	348
PE	21	29	38	48	27	29	43	29	25	34	32	26
PC	73	131	128	56	57	58	160	57	72	51	84	127
Total	10,740	12,204	10,110	10,345	9,058	6,041	9,762	8,497	6,446	6,168	8,937	10,838

Totals as of 31 December 1998	
Full Response Fire Numbers	10,040
Modified Response Fire	798
Total	10,838



Tab.5. Total area burned by wildfires in Canada 1988-98

Agency	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Ave.	1998
BC	11,462	22,386	72,504	29,396	28,259	5,180	29,063	53,256	22,048	2,640	27,619	77,781
YT	6,310	328,910	169,601	129,370	30,123	86,115	411,397	257,280	105,935	10,120	153,516	385,579
AB	14,538	6,412	30,534	6,173	3,330	25,633	29,700	342,610	1,990	4,728	46,565	734,816
NT	66,080	577,584	104,616	225,324	36,950	858,577	3,085,977	2,827,367	371,545	126,532	828,055	1,459,360
SK	81,110	588,880	187,349	239,372	96,192	613,827	994,889	1,643,552	14,516	3,884	446,357	995,498
MB	507,782	3,281,300	19,800	142,978	433,773	67,275	1,469,258	803,299	116,724	35,009	687,720	408,918
ON	390,796	402,264	183,694	318,883	175,994	104,681	83,455	617,978	451,927	38,526	276,820	158,218
QC	275,620	2,109,513	83,345	438,299	27,112	128,243	116,035	727,727	691,590	393,079	499,056	418,318
NF	1,780	68,156	47,317	65,374	1,814	26,998	110,629	794	82,448	8,981	41,429	40,226
NB	1,975	343	6,114	3,335	5,071	551	462	472	1,770	178	2,027	303
NS	335	462	1,068	1,775	1,160	369	243	405	643	564	702	397
PE	17	216	102	120	44	87	22	36	196	107	95	77
PC	331	835	25,041	1,224	1,377	1,651	73,017	6,160	16,581	298	12,652	31,284
Total	1,358,136	7,387,261	931,085	1,601,623	841,199	1,919,187	6,404,147	7,280,936	1,877,913	624,646	3,022,613	4,710,775

Totals as of 31 December 1998	
Full Response Hectares Consumed	2,111,068
Modified Response Hectares Consumed	2,599,707
Total	4,710,775

**CHILE*****The Chilean Forest Service and its Fire Management Programme***

Chile covers 756,262 km<sup>2</sup> on the South American Continent and Oceanic Island (Easter Island and Archipelago of Juan Fernandez) territories, bordering Bolivia and Argentina in the East, Perú in the North, and the Pacific Ocean in the West. The maximum width of the country is 445 km and the minimum width is 90 km. Two mountain ranges characterize the topography of Chile, the Cordillera de Los Andes (Andes Range) on the East, separating Chile from Argentina, and the Cordillera de la Costa (Coastal Range) to the West which is lower than the Andes Range. Both ranges decrease in altitudes as they run southward. Only ca. 20% of the territory is flat terrain. The temperature is homogeneous from the extreme north to the extreme south, with a difference of 12.8°C in average temperatures, which is modest for a 37°C difference in latitude. The annual rainfall varies greatly, from <1 mm in the North to 4,500 mm in the extreme South. There are four well-defined seasons in most of the country, although there are a variety of the local climates, from hot arid in the North to subarctic in the South. Maximum temperatures in summer in the central area reach 33°C with 30% relative humidity and seldom fall lower than 0°C in winter. From the North to the South, snow is confined to the Andes Range. Only in the extreme South snow is normally present.

Close to 45% of the continental area of Chile is suitable for forestry. This area is already covered by forest or by other vegetation. Of these 39 million ha, 15.6 million ha are native forest, 20.5 million ha are brush and grassland and 2.1 million ha are plantation forests, predominantly Monterrey pine (*Pinus radiata* D. Don.) (90%), the remaining plantations are eucalypts and poplars. Almost all productive forest land belongs to private owners. Only National Parks (14 million ha) and other protected and public land (2 million ha) are under governmental administration.

The National Forestry Corporation (CONAF), the Chilean forest service, depends on the Ministry of Agriculture and is the organization in charge of forestry development, national parks, protected areas and wildlife administration, conservation and protection of forest resources, law enforcement and, mainly, in charge of Government relations with the private forestry sector, in order to apply the current general and economic policy of the Government.

There is a long history of human-caused fires in Chile, primarily caused by settlers or farmers which used fire for land clearing. This kind of land-use fires continued until the first decades of the 20th century. No records of the fire occurrence and damages were kept until 1963, when a Forest Police Force was created as a branch of the National Police Force. The Forest Police Force formed crews with its own personnel and volunteers that lived near the police stations in the country. The action was aimed solely at fire suppression, without the support of planning, detection systems, operational centers, records, etc.

CONAF has developed forest fire protection activities since 1972 with a constant increase in technology and equipment. At present the role of the Forest Police Force has changed, discontinuing the suppression action and focusing on the enforcement of law and investigation of the fire causes. The private forestry companies have developed forest fire protection activities since 1978 with a constant increase in technology and equipment aimed to protect their own lands. Table 1 shows the national forest fire control resources used in 1997/98 season in Chile. Other suppression forces are the City Fire Departments. Firemen of certain cities work quite efficiently and they are a useful support force in urban-wildland interface areas.

Special emphasis is given to fire suppression personnel safety through a Safety Program in each crew. Prior to the fire season this personnel is formally trained or receives refresher courses. However, special training is given to crew bosses. Accidents are an important problem: Since 1974 26 firefighters, 6 pilots and 1 air observers died in fire accidents.

Fire occurrence normally begins in November, reaches a peak in January and February and decreases in April. But in the last year El Niño had anticipating and active fire season in some regions. Nearly all the fires are caused by humans. Lightning or other natural causes are insignificant or not present. Average data of the last 10 fire seasons reveal that 10.9% of the wildfires are caused by the use of fire in forestry and agricultural activities, 31.2% by carelessness. Children playing with matches cause 9.9% of the total fire starts, reaching significant importance near some cities. Intentionally set fires (arson) represent 34.9% of fire causes while unknown causes account for 13.1%.

Tab.2. Wildfire occurrence and are burned in Chile 1964-1998

Season N°	Season (year)	Fires (#)	Burned Area (ha)	Average (ha/fire)
1	1963 - 1964	435	19.600	45.1
2	1964 - 1965	269	17.200	63.9
3	1965 - 1966	396	19.900	50.3
4	1966 - 1967	307	15.820	51.5
5	1967 - 1968	507	61.314	120.9
6	1968 - 1969	807	34.747	43.1
7	1969 - 1970	551	16.725	30.4
8	1970 - 1971	669	22.603	33.8
9	1971 - 1972	1.172	81.570	69.6
10	1972 - 1973	1.214	42.763	35.2
11	1973 - 1974	1.332	19.162	14.4
12	1974 - 1975	1.630	9.604	5.9
13	1975 - 1976	2.785	24.266	8.7
14	1976 - 1977	1.909	26.458	13.9
15	1977 - 1978	3.380	29.963	8.9
16	1978 - 1979	4.718	76.215	16.2
17	1979 - 1980	2.977	22.536	7.6
18	1980 - 1981	4.197	32.056	7.6
19	1981 - 1982	4.520	26.842	5.9
20	1982 - 1983	4.782	45.748	9.6
21	1983 - 1984	6.252	80.191	12.8
22	1984 - 1985	5.223	47.572	9.1
23	1985 - 1986	5.429	62.754	11.6
24	1986 - 1987	5.144	90.011	17.5
25	1987 - 1988	5.207	68.735	13.2
26	1988 - 1989	5.241	88.062	16.8
27	1989 - 1990	4.114	25.545	6.2
28	1990 - 1991	5.193	50.274	9.7
29	1991 - 1992	4.786	24.224	5.1
30	1992 - 1993	6.114	49.981	8.2
31	1993 - 1994	6.210	65.606	10.6
32	1994 - 1995	5.354	26.174	4.9
33	1995 - 1996	5.886	40.082	6.8
34	1996 - 1997	5.457	43.595	8.0
35	1997 - 1998	5.329	90.888	17.1
Total		119,496	1,498,786	12.5
Average		3,414	42,822	12.5

The problem of forest fires has been increasingly worsened by the economic and social transformation faced by our country in the last decades. Industrialization, increase of tourism and the mobility of citizens have excessively increased the risk of fire. Fire statistics for the period 1965-1998 are given in Table 2. The data reveal an increase in the number of forest fires in the mid 1980s and a stabilizing trend in the mid 1990s. This development may reflect the impacts of a national fire prevention program of CONAF using TV, newspapers, posters, and road signs, especially in rural areas.



Tab.1. Forest fire control resources in Chile

Organization	Fire Suppression Resources (number of units)					Lookout Towers		Motorcycle Prevention Personnel	Professional Staff	Air Resources	
	Crews	Helitack	Engines	Total Firefighters	No.	Labourers			Helicopters	Air Tankers	
National Forestry Corporation	73	6		1.007	55	135		32	261	7	4
Private Forestry Companies	78	8	19	912	154	379		155	100	13	10
Total	152	14	19	1.919	209	514		187	361	20	14

For the use of fire in forest and agricultural work, CONAF has established by law a special regulation for using fire under a controlled burning method (burning permit system), with heavy fines for violators. The development of the burned area is very irregular. This is attributed primarily to the unfavourable weather conditions, prolonged absence of rain, that prevailed especially in the south of the country.

The 1997/98 (November to April) fire season in Chile will reflect a 88.4% increase in burned areas over 10 average, but the fire will be in the top worst 10 years. This large consumption of forest land in part reflects the intensity of the fire activity and evidence of an abnormally weather pattern developing. Chile is currently suffering the worst dry seasons in the last 60 years. Table 3 shows the 1997/98 data in comparison with the 10 years average

**Tab.3.** Wildfire statistics of Chile 1987-98 in comparison with the decade 1988-98

Parameters	Average 1988 to 1997	%	Season 1997/98	%
N° of fires (< 5 ha)	4.783	89.3	4.830	90.6
N° of fires (> 5 ha)	552	10.3	467	8.8
N° of large fires (> 400 ha)	21	0.4	32	0.6
Burned surfaces (ha)	48.227		90.888	
Native forest	14.682	30.4	64.373	70.8
Brush and grassland	25.793	53.5	23.549	25.9
Forest plantation	7.752	16.0	2.966	3.3
Average ha/fire	9.0		17.1	

**Note:** Season November to April

In the south of country, X Region (Lake Region) and XI Región (Patagonian Region) during second week of February 1998 over 35 forest fires were reported. The hot weather pattern, the prolonged absence of rain, the influence of the local 'Puelche' type winds, and the remote and wildland area escalated the severity of the situation. A state of emergency was declared in this region, called military personal to help and firefighters of CONAF and fireline equipment had been mobilized from across the country. The situation across this region was critical. The control this forest fire during in average 20 days and 65,787 ha of native forest and brushland was consumed. This area represented 72.4% of the national damage in this season. In this season one fatality was reported: A PZL-18 Dromader air tanker crashed during fire operations in the V Region, the pilot died. Hot and windy often adversely flight performance.

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**COTE d'IVOIRE      *Management and Prevention of Forest Fires in Côte d'Ivoire***  
***SODEFOR's Forest Fire Protection Programme***

**The Forests of Côte d'Ivoire**

The Republic of Côte d'Ivoire is located between 4°20'N and 10°50'N and 8°W and 2°W in the central part of the Upper Guinea forest block. Three main tropical climate zones can be distinguished:

- \* Southern climatic zone or forest region with four seasons (two dry seasons and two rainy seasons) and annual rainfall ranges from 1600 to 2200 mm. Average temperature: ca. 28°C
- \* Central climatic zone or intermediate vegetation zone with three seasons (one very short interseason)
- \* Northern climatic zone or savanna region with only two seasons and average annual rainfall between 1100 and 1500 mm. A fourth climatic zone in the Western mountainous district is characterized by a higher rainfall as compared to the surrounding areas

The country is covered by different types of vegetation in relation with the climate: forest (South and West), Woodland (central) and Savanna (North). The forests of Côte d'Ivoire can be classified according to its two main ecological zones: the tropical rainforest in the humid south; and the savanna forest in the northern part of the country. Specifically there are:

- \* Southwest and Southeast regions: moist evergreen forest
- \* Northern regions: open savanna woodland and scattered pockets of dry forest
- \* Going towards the northern direction, one meets successively the moist semi-deciduous forest zone and the dry semi-deciduous forest with patches of savanna vegetation

Each type of forest contains various types of species characterizing all tropical forest. These different types of forest are exceptionally rich in endemic plant and animal species representing a very high biodiversity. There are some original biotopes in the lagoon district (wetland and mangroves), in the forest-savanna and arid savanna lands.

The south-western part of the country still has major forest reserves estimated about one million ha including the TAI National Park (348.000 ha) which is the only extensive primary rain forest area remaining in West Africa.

It is difficult to obtain accurate and up-to-date information on the total forest area. The only certain fact is the regular decrease of the forest area due to the pressure of agriculture (encroachments) and fires.

**The evolution of the closed forest zone**

Although the forest zone area itself did not change at all (16 millions hectares), the structure of the forest has been changed due to anarchic agricultural encroachment and intensive forest exploitation. It has been estimated that the original forest cover was ca. 16 million ha of rainforest. The forest area decreased successively to 12 million ha in 1960, 9 million ha in 1969, and 6 million ha in 1973. Today the dense forest area in both zones is not known with precision. However, it is estimated that ca. 3.5 million ha represent the total gazetted forests, national park, and other residual forest area.

The tropical closed forest of Côte d'Ivoire has been exploited for its timber, and mainly cleared to create some important plantations of cash crops such as coffee, cocoa, rubber tree, palm oil, or subsistence farming, by a mainly rural population.

The use of traditional method of shifting cultivation has been practised. More than 60 % of the total closed forest area has been degraded by this method of cultivation, and the remaining forested area is understocked. The total area occupied by the bush fallow is estimated about 8 million ha

In spite of the relative success in agriculture, many aspects of land use are not successful. The rate of deforestation is quite high and the clearing conditions are spreading as a consequence of defective land use.



The forestry domain is divided into two main zones: The Permanent Forest Domain of the State (3.5 million ha), and the Rural Forest Domain (12.5 million ha) destined to the agricultural land in the forest zone.

Slash-and-burn agriculture activities cover about 5 million ha and is practised by the rural population. Some 150,000 to 300,000 ha of forest and bush fallow are cleared annually for shifting cultivation.

Actually the rural forest area is a succession of wood land, bush, bush fallow scattered by regenerative growth crop plantations.

The Permanent State Forest Domain includes classified forests and national parks and reserves. This zone is also occupied nearly 25 % by illegal encroachment of farmers. The lack of reliable data to find out the exact area, vegetational structure of each zone shows up the complexity of the situation. Forest lands are diminishing in area or have been degraded through overuse as result of increasing populations.

### **Forest Plantations**

Because of the intensive degradation of the closed forest in terms of area and productivity it has been decided early in 1930 to establish artificial forest plantations in order to supply timber production in the future and to rehabilitate the degraded zones.

**Industrial plantations:** Industrial plantations were established to supply timber production in addition to that of natural forest. Before 1966, only 8500 ha of plantations were established mostly in the savanna zone for building materials and fuelwood.

Reforestation efforts have been intensified since 1966 when a State Reforestation Service (SODEFOR) was created to pursue large scale industrial plantation programs. Up to 1976, 22.400 ha have been reforested under a forest cover with some indigenous (local) species, and on cleared lands with various species (mostly teak).

From 1976 plantations were mainly established on clear-felled lands after removal of all remaining timber. Most species used attaining high production in short rotations such as *Terminalia* spp., *Cedrela odorata*, *Gmelina* and teak (*Tectona grandis*).

Some 44,000 ha were planted in the period 1977-1988 and about 45,000 ha since 1988.

Today, SODEFOR manages about 120,000 ha of industrial forest plantations in proportion of 45 % Teak, 40 % local species and 15 % other exotic species (*Gmelina*, *Cedrela*, *Pinus*, *Eucalyptus* spp. etc.).

**Rural Reforestation:** Some 15,000 ha of small plantation stands had been planted by the rural communities and individuals under the technical assistance of the forest services mainly in 1988 declared «Ivorian's Forest Year» by the government of Côte d'Ivoire, to produce mostly building materials and fuel wood.

### **Forest Fires**

In the rural land area of the central and northern part of the country every year bush fires are set by the rural populations for hunting or preparation of grazing resources within the forest. Even in the southern forested zone, fire was used to prepare croplands.

The fact of this large scale of deforestation in the closed forest area, and the man made desert process in the open savanna (Northern part of the country) there has been an influence on the closed moist forest zone climate. It has considerably changed and the dry seasons have become longer.

The process of clearing and burning provides conditions for forest fires in the evergreen and semi-deciduous forest zones. The consequences of these situations have been the outcoming in 1982 of the forest fire phenomena.

**Tab.1.** Assessment of land and forest fires in Côte d'Ivoire from 1983 to 1998 distributed over 20 gazetted forests managed by SODEFOR

	Total		
Year	Number of Fires <sup>1</sup>	Area burned (ha) <sup>2</sup>	Damages (ha) <sup>3</sup>
1983	n.d.	12000	3517
1984	n.d.	754	0
1985	n.d.	65	0
1986	23	76	0
1987	19	1384	56
1988	15	162	32
1989	31	245	0
1990	44	621	38
1991	14	430	47
1992	26	2485	165
1993	24	191	0
1994	12	528	0
1995	23	431	0
1996	30	3871	314
1997	26	860	91
1998	33	8521	576
<b>Total</b>	<b>320</b>	<b>32,624</b>	<b>4,836</b>

<sup>1</sup> Number of fires fought

<sup>2</sup> Total area affected by fires including natural and artificial forests

<sup>3</sup> Total forest plantations area

n.d. not determined

During the years 1982-1983, from December to March, vast forest fires occurred in closed forest zones (evergreen, and semi-deciduous forests). The country had been surprised, traumatized and upset by the fullness of disaster with the following damages:

- \* About 1.7 million ha of forest, bush fallow, and tree crops had been affected by the fires
- \* 45,000 ha of forest destroyed
- \* More than 100,000 ha of cash crops (coffee, cocoa, rubber tree, palm oil. etc.) were burned
- \* 4000 ha of subsistence crops were destroyed
- \* 21 people were killed

The fires went through 12,000 ha of industrial forest plantations and about 3000 ha had been partially or completely destroyed. The losses were very important for the country whose economic development is based on timber export and agricultural expansion. The losses have not been evaluated in detail, but the impact on the population was great. However, an estimation of the loss of 3000 ha of forest plantations on the basis of the establishment costs, was close to \$US 40 million.

Since then, in every year the forests of Côte d'Ivoire experience forest fires with the degree depending on the severity of the dry season. However, the rate of disaster is less than the one of the year 1983.



### Management and Prevention of Forest Fires since 1983

After 1983 management structures of this new phenomena have been created. The Ministry of Environment and forestry created the "National Committee for Forest Defense and Fight against Bush Fires", with relays on the field (regional and department levels). At the level of SODEFOR a department of the management and prevention of forest fire was instituted. In order to implement the fire protection office, and to start the management and prevention activities, a Canadian expert had been appointed by an FAO Technical Cooperation Project. This project was intended to initiate practical steps, to increase SODEFOR's capability to plan, support, and manage forest fires.



**Fig.1.** Villagers combatting a savanna fire approaching a forest edge in Côte d'Ivoire. Photo: J.G.Goldammer (GFMC)



**Fig.2.** Experimental fire Côte d'Ivoire conducted in the frame of FOS/DECAFE in 1991 (see references at the end of the contribution)



## **SODEFOR's Forest Fire Protection Programme**

SODEFOR is a State company created in 1966 to build up plantations of exotic and indigenous species for industrial wood production. It has achieved by systematically establishing and managing over the last 30 years 120,000 ha of forest plantations. Most of these plantations are standing in the semi-deciduous forest zone, where the risk of forest fires is very high. The previous forest fires had caused great damages to the plantations. Since 1990, there have been few changes in the purposes of SODEFOR, which becomes also responsible for the management of the natural forest, and mainly the gazetted forests of the State Forest Domain. The total area of the gazetted forests is estimated about 4 million ha, out of which ca. 2.5 million ha are in the rainforest zone and 1.5 million ha in the savanna region.

**Objectives of the Forest Fire Protection Programme:** At the beginning of the forest fire protection operations in 1983-84, only 10 forest zones where forest plantations have been established were concerned by the system. Minimizing the risk of building material and biodiversity lost in the situation of forest fires, the programme has been extended over the 2.5 million ha of forest. The main activities of the programme are:

- \* Constitution of committees for prevention and fighting of fires by classified forest area
- \* Training of field assistance, supervisors and committee members
- \* Equipment of the fighting committee members
- \* Preparation of fire prevention and fighting plans
- \* Analysis of results and evaluation of the actions.

**Action Plans:** With the increase in forest fire events and their impacts on the forest areas (natural and artificial) that are under its control, it has become necessary for SODEFOR to implement a full service to deal with this new phenomena. This service manages the aspects of forest fire event all the year by analysis and evaluation of the activities and actions before, during and after the fire period. The practical preparation of each campaign of forest fire prevention is scheduled into different steps by the field assistance for each forest area (classified forest). These dispositions are:

- \* List of field assistance and committee members
- \* Checking out of the existing equipments and needs
- \* Establishment of maps of patrols, roads, water stations, and high risk sites...
- \* Awareness campaigns
- \* Materialization and wedding of fire-breaks

## **Organization of a Forest Fire Campaign**

**Human organization:** The forest fire is an important problem for SODEFOR. A chief fire manager is appointed at headquarters, and on the field there are fire protection assistant for each forest. The field fire protection assistant organizes and supervises the activities of prevention and suppression of forest fires for each gazetted forest area, with fighting committees. A committee is composed by 20 members and a perimeter of surveillance and protection. For each campaign of forest fire protection from December to March, SODEFOR mobilises about 1800 firemen organized in 90 committees, constituted by the people of the villages in the vicinity of the gazetted forests. Every year a workshop for building programmes and training is organized. Training is required for committee members in practical aspects of surveillance (patrols) and fire suppression.

**Measures of fire prevention and sensibilization:** The prevention guidelines are:

- \* Sensibilization of rural populations living around classified forests about forest fires hazard. Some meetings are organized before and during the critical forest fire period of the dry season, and also radio messages on local languages
- \* Establishment and control of related infrastructures (roads) and equipments. The most important equipments are bulldozers, tractors, vehicles, tanks and pump units. There are also some materials like hoses, smoke masks, and hand tools
- \* Establishment and weeding of fire-breaks around forest plantations (50 to 100 m) and at the boundaries of natural forest (gazetted forest) zones

- \* Elimination of fuel loads which easily ignite and increase the intensity of fire. Any action inside the forest land (natural or artificial forest) which can have a direct effect on the degree of inflammability must be avoided. Then, combustible materials such as unused timber from thinning operations are disposed outside the parcel.

**Detection and effective fire fighting:** The planning action begins by the determination of protection zones, the perimeter of surveillance; and the patrols mapping.

**Perimeter of protection:** A protection zone is determined for each committee and its area is about 1000 to 1500 ha for forest plantations and 5000 ha in average for natural forest block. Each committee has entire responsibility to keep a constant close watch over the entire block through regular patrols. The committee has also to execute all operations of prevention and to extinguish any fire occurred in their block.

**Detection and surveillance:** The assessment of a system of fire danger warning depends on the season (weather conditions: temperature, humidity) and the fuel loads. Fire detection is carried out through ground patrols and fixed stations (towers in some cases) by the committee members or special teams. Some of them are equipped with a radio system, motorcycles and bicycles. The detection occurs from 6:00 a.m. to 7:00 p.m. every day during the period of two to three critical months.

**Fire suppression:** When a fire is detected the members of the concerned committee are informed and have to take appropriate dispositions of fight to extinguish the fire. The necessary equipment and the water tankers are made available for the operations.

**Suppression report:** A report is made for any forest fire detected and fought with the following information:

- \* Source of ignition
- \* Origin of fire
- \* Time of detection
- \* Size of the area affected
- \* Intensity of fire and damages
- \* Total area covered by fire

### **Principles of action**

As we know, forest fires are caused accidentally or intentionally by humans, we decided to increase the responsibility of all rural communities around each gazetted forest area. Contracts are established and concluded with them through fire committees in order to participate to the forest protection measures. The contracts are remunerated monthly (during the four months of the dry season). The remuneration is inversely proportional to the size of the area affected by fire. The basis of payment are:

- \* 500,000 F CFA (\$US 1000)/month by committee for 0 ha burned
- \* 400,000 F CFA (\$US 800)/month for less than 5 ha
- \* 200,000 F CFA (\$US 500)/month for less than 10 ha
- \* 50,000 F CFA (\$US 100)/month for less than 20 ha

The average cost of surveillance is about 3000 F CFA (\$US 7)/ha/year for forest plantations and 1000 F CFA (\$US 2)/ha/year for natural vegetation.

### **The Evaluation of the SODEFOR's FFMP Programme**

The average annual cost of the forest fire management and prevention is estimated about \$US 1 million, including payment of the fire fighting committees, equipment, infrastructures, training and previous measures of prevention. Early in 1992, SODEFOR decided to undertake an in depth evaluation of its experience in the

management and prevention of forest fires. The key to the success of its forest fire management and prevention strategy has been the nature of the relationship that is set up between the rural population living around gazetted forest and the foresters (SODEFOR's agents).

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#### **Additional Information on Fire in Côte d'Ivoire from the IFFN/GFMC Archive**

Côte d'Ivoire hosted a major fire research programme in 1991: The project "Fire of Savannas" (FOS/DECAFE) was part of the project DECAFE (Dynamique et Chimie Atmosphérique en Forêt Equatoriale). The overall aim of FOS/DECAFE was to investigate the contribution of gaseous and particle emissions from savanna fires to the regional and global emission budgets, and to clarify the role of fire emissions on tropospheric ozone formation. The interested reader will find the most important results of FOS/DECAFE in the two following publications:

Lacaux, J. P., J. M. Brustet, R. Delmas, J. C. Menaut, L. Abbadie, B. Bonsang, H. Cachier, J. Baudet, M.O.Andreae, and G.Helas. 1995. Biomass burning in the tropical savannas of Ivory Coast: An overview of the field experiment Fire Of Savannas (FOS/DECAFE '91). *J. Atmos. Chem.* 22, 195-216.

Lacaux, J.-P., H.Cachier, and R.Delmas. 1993. Biomass burning in Africa: An overview of its impact on atmospheric chemistry. In: *Fire in the Environment: The Ecological, Atmospheric, and Climatic Importance of Vegetation Fires* (P.J.Crutzen, and J.G.Goldammer, eds.), 159-191. J. Wiley & Sons, Chichester, England.



The IGBP International Global Atmospheric Chemistry (IGAC) Project  
 Focus Impact of Biomass Burning on the Atmosphere and Biosphere  
 "Biomass Burning Experiment" [BIBEX]



**GREECE*****The 1998 Fire Season***

The summer of 1998 was for Greece a season of average forest fires. We had experienced high precipitation during Spring. The result was an increasing growth of herbs. In most regions of the country there was no rain at all between end of May and end of August. Moreover, in the middle of Summer we had three to four times scorching hot weather exceeding 38°C. So the plants were dried up. Furthermore, during the first fifteen days of August the wind was blowing extremely hard, usually between 5 to 6 Beaufort.

As a result of these weather conditions we had an increasing occurrence of wildland fires. Between 1 June and 31 August 1998 we had a total of 8748 fires which burned a total area of about 95,571 ha. The average fire size was ca. 11 ha. From the above burned area about 78,192 ha are wildlands while the rest are agricultural and urban areas etc.

Concerning the destruction of forests and other wildlands by fire we consider the year 1998 to be an average year. We have to take into account that in a year with favourable weather conditions Greece experiences a low number of wildland fires with an average burned area of somehow more than 20,000 ha. In years with bad weather conditions the burned area is approaching 150,000 ha.

This Summer in Greece for the first time the responsibility of wildland fire fighting was with the Fire Service. During the previous years the fire fighting was duty of Forest Service. The former firefighting personnel of the Forest Service was transferred with the proper equipment to the Fire Service.

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***The 1998 Forest Fire Season in Greece: A Forest Fire Expert's Account***

The 1998 forest fire season in Greece has been far from usual and certainly most controversial. What made it so different was a decision by the Greek government to transfer the responsibility of forest firefighting from the Forest Service to the Fire Service. The decision was taken at the end of 1997 and it was mainly a political one. It was prompted by what was considered poor results of the Forest Service in the previous years and did not really consider in depth all the parameters of the undertaking. Actually, it lacked any serious scientific justification or planning.

During winter and spring of 1998 there were many voices that warned about an oncoming disaster. They included a number of politicians, the representatives of Forest Service personnel of all levels, the Department of Forestry and Natural Environment of the University of Thessaloniki, and the few forest fire experts in the country who had not been given any opportunity to offer their input.

The law about the transfer of responsibility to the Fire Service finally took effect on 25 May 1998. That left very little time to the Fire Service to seriously prepare itself for the challenge. At the same time, it had become evident that no provision had been made for cooperation between the personnel of the Forest and the Fire Services at all levels. The Fire Service officers, who had been contributing in the past to forest firefighting, mainly close to urban areas and most often from paved roads, never having command on forest fire incidents, believed they knew all they needed. The significant difference between wildfires and the other types of fires they had been trained for (industrial, structural and ship fires etc.) was not obvious to them.

June was relatively moist and hence quiet, with no significant fires, facilitating the transfer of the Forest Service fire trucks and other equipment to the Fire Service. It also provided the necessary time for the Fire Service to hire seasonal firefighters in addition to its permanent personnel. Many lower rank employees of the Forest Service, mainly firefighters, reaching approximately 20% of all its personnel, were also transferred to the Fire Service.

The problems started on 4 July, early in the afternoon, with the passage of a dry cold front that was accompanied by very strong winds (7 Beaufort scale) and the typical in such cases wind shift. The front followed four days of lull, low humidity and extremely high temperatures which had reached 44 degrees Celsius in many parts of the country including Athens. To the surprise of the Fire Service, which did not have a fire danger prediction capability in place, more than 100 fires erupted within an hour in various parts of the country. About 20% of these fires started from burning garbage dumps, most of them illegal, close to forest lands. The wind picked up burning embers which found easily ignitable fuels where they landed. Simultaneously fires that had been burning slowly for days took off. Attica, the area around Athens, was hit the worst. All Fire Service units in Attica practically got engaged in forest firefighting and did the best they could. Unfortunately, the extreme conditions on one hand and the inadequate preparation of the Fire Service (e.g. lack of significant forest firefighting training and experience, lack of knowledge of the forest road network and fuels distribution, poor understanding of the correct use of aerial firefighting means, lack of well trained and equipped crews with hand tools), resulted in a large number of fires escaping initial attack, becoming large, and in many cases reaching urban-wildland interface areas.

The wind lasted at its peak for only a few hours, so by the end of the next day all fires were controlled. However, the problems had already become evident. By that time more than 10,000 ha had burned. Two civilians had been caught by the fires at different locations and perished and a third one died due to respiratory problems. Approximately 50 houses were destroyed in six different areas. One fire truck was destroyed but the crew, fortunately, managed to escape. What followed was a preview of the rest of the fire season. Fire Service officers quickly established a belief that all fires were part of a plan against them and against the new law. Forestry people, on the other hand, insisted publicly that the Fire Service was clearly inadequate. The mass media presented and often over-emphasized this disagreement. Relations became very tense and good cooperation between Forest and Fire Service personnel was rarely the case. Even at that moment no corrective measures were taken.

A fifteen day period with average fire activity followed. Many fires erupted and were contained at relatively small sizes but few of them exceeded 2000 ha in size. One more fire truck was destroyed and at least two firefighters suffered injuries. During this time, it became evident that too much firefighting was carried out using the 15 Canadair CL-215 waterbombers of the country, and too many controlled fires were not moped-up and guarded properly so they started again with the onset of winds or as humidity decreased in the middle of the day. This latter phenomenon increased the belief of the Fire Service that arsonists "were starting again the fires they had just put out". This statement could, of course, not be disputed with any proof, but it could not be supported either, as there was no experience on forest fire investigation in the Fire Service.

Then, as is common in the summer in Greece, the first serious "*meltemi*" type winds (seasonal 7-8 Beaufort scale northeastern winds that last for 3-4 days) came. Arriving on 22 July 1998, they caused a new round of large wildfires. This time the destruction was much larger as the winds persisted for many days and they were combined with low relative humidity. One of these fires, that erupted among houses on 22 July on mount Ymettos next to Athens, destroyed a number of houses, burned a few private cars and tragically killed three firefighters and one volunteer firefighter. Their fire truck, which they had abandoned, remained practically intact at a short distance from the point where their bodies were found. It was full of water and it is quite clear that if they had stayed in the truck they would have survived. The results of the Fire Service investigation on the incident have not been publicly announced.

In the first days of August the situation became even worse, mainly in central and southern Greece, with many fires becoming large and burning for many days. Ilia, a prefecture in western Peloponnese where ancient Olympia is, was hit the worst. Most of the forests there burned, reaching a total of more than 20,000 ha within that prefecture. Fortunately, ancient Olympia and its surrounding forest was saved. Another long lasting fire burned most of the *Pinus nigra* forest on mount Taygetos near Sparta in Peloponnese, an area of great ecological importance. Close to that, in Messinia, another large fire claimed two more citizen lives on 5

August, while a less intense but hard-to-fight fire on the steep slopes of mount Olympos in Macedonia kept burning for more than 18 days. However, most attention was caught by a disastrous fire at the outskirts of Athens. The fire started at 22:00 on 2 August at the village of Stamata northeast of Athens under calm conditions. It was not attacked effectively through the night, so next morning, when winds picked up, it accelerated, crowned in Aleppo pine (*Pinus halepensis*) forest and started spotting. It continued for four days, burning more than 7500 ha, causing unbelievable disaster and practically entering some suburbs of Athens. This fire destroyed the forest that had remained on the mountain of Penteli after the 6200 ha fire there in 1995, and reburned most of the previously burned area diminishing the probability for natural regeneration of Aleppo pine there due to lack of seed. Hundreds of houses and other buildings (hospitals, restaurants, factories, a school, etc.) were destroyed or suffered significant damage. A 67-year old man who lived in the village of Penteli at the base of Penteli mountain was caught by the fire and died as he was fleeing his home.

The inadequacy of the firefighting forces to cope with the blazes became so evident by 5 August 1998 that the government requested international help. Initial help in the form of Canadair CL-415 waterbombers came from Italy and France during the crisis and stayed in Greece for a few days. Four German military helicopters (CH-53) arrived later as well as a Russian Ilyushin jet plane that can deliver 40 tons of water per flight. Furthermore, four Canadair CL-215 planes were rented from Canada. The government also took special prevention measures such as forbidding visits to the forests in the fire stricken areas and organizing army-supported patrols in sensitive areas.

After 10 August 1998 weather conditions started changing. Air relative humidity gradually increased, winds generally subsided and some rain fell in various parts of the country. Fire activity decreased and only few fires became relatively large after that.

Official fire statistics, in contrast to previous years, had not been available through the fire season. By the end of August estimates from foresters brought the total burned area to approximately 120,000 or even 150,000 ha. At the end of fall, the Fire Service announced that a total of 95,571 ha had burned. Only 78,192 ha were wildlands while the rest was mainly rural and urban-wildland interface areas. These figures were questioned by forestry people. The data presented in Figure 1 show the total burned area per year in Greece for the 1980-1998 period; the 1998 figures of the total burned area are based on the (non-final) Fire Service estimates.

The number of fires, according to the Fire Service, reached 8748 in 1998, bringing the mean burned area per fire to approximately 11 ha. However, the fire recording system of the Fire Service is not compatible with the previously used one. As a result the number of recorded fires is more than double of the figure for any previous year as illustrated in Figure 2.

In conclusion, the mistakes made before and during the fire season resulted in a clearly foreseeable disaster. These mistakes should not be repeated. It is very important for the country to take advantage of the remaining time before the next fire season and to organize the best possible system for forest fire protection. Such a system should:

- \* Recognize the need for well planned overall fire management, and not only the need for effective fire suppression
- \* Give an emphasis on fire prevention
- \* Incorporate within a well planned and organized framework all existing forces, avoiding turf battles
- \* Take advantage of all the expertise and technology available in the country in order to make the system and the available forces work in the best possible way.

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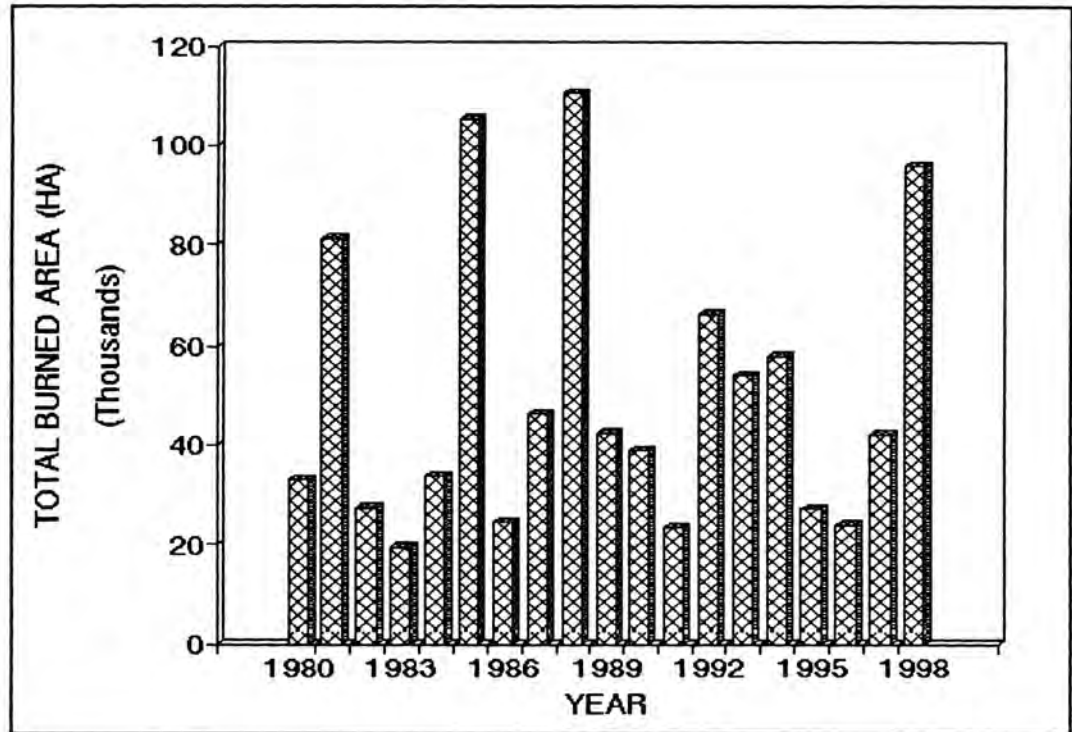


Fig.1. Total area burned per year in Greece in the period 1980-1998

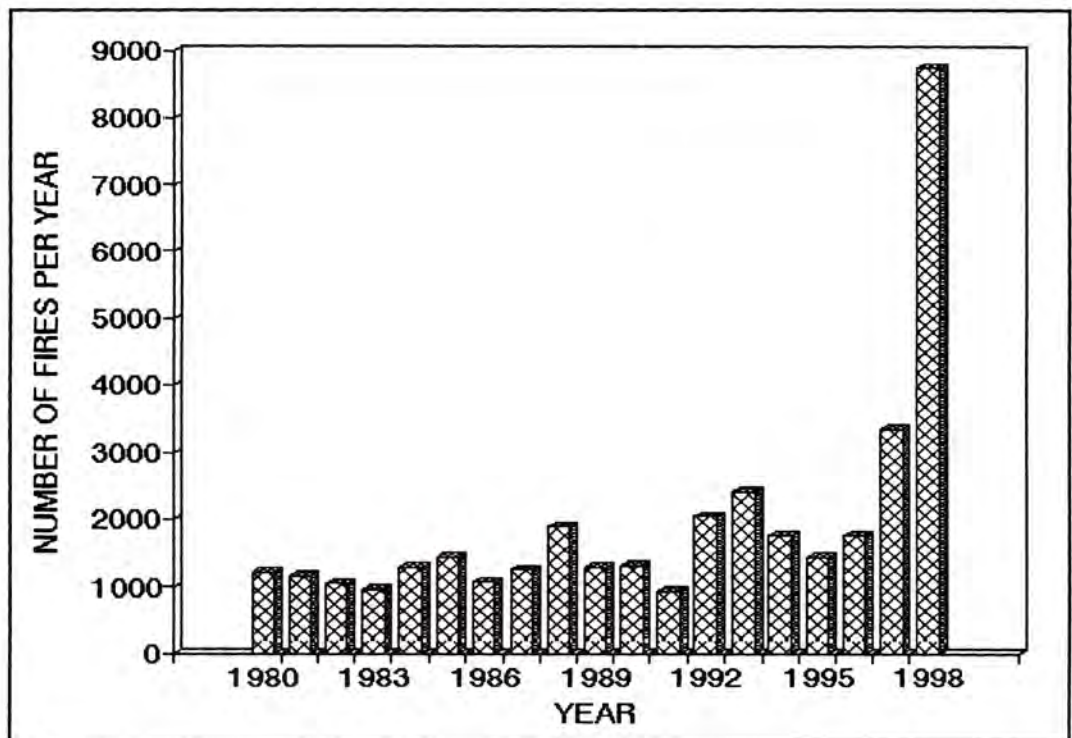


Fig.2. Number of forest fires in Greece in the period 1980-1998

## MEXICO

*Mexican Fires of 1998*

In 1998 Mexico suffered its worst fire season on record. Caught in the oscillations of an unusually heavy ENSO, the fires began early and continued late (Fig.1). Hurricanes twice slammed into the Pacific side of the southern states, encouraging fuels; then seasonal rains failed to arrive, either from the south (Pacific) or later from the north (Gulf of Mexico). Drought, temperatures, and winds reached historic proportions in many regions. Traditional burning - fundamental to Mexican agriculture and pastoralism - soon escalated out of control. Complicating factors included drug traffickers in some areas and rebellion in Chiapas.

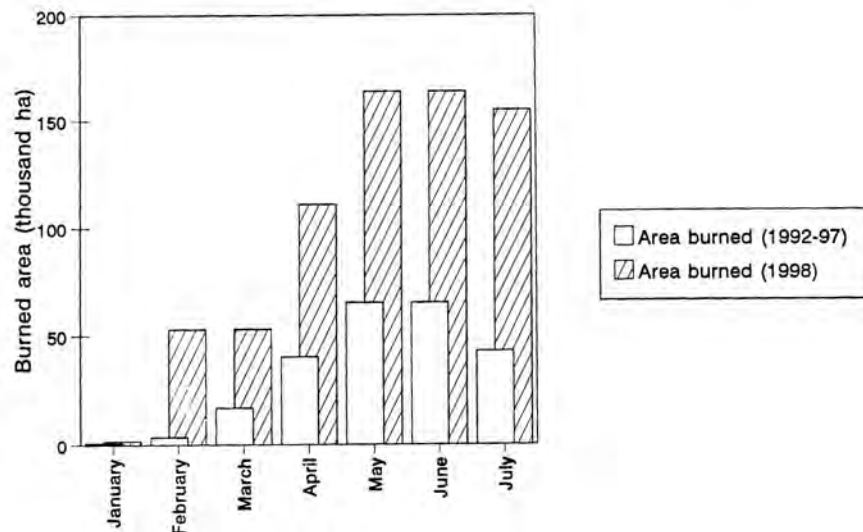
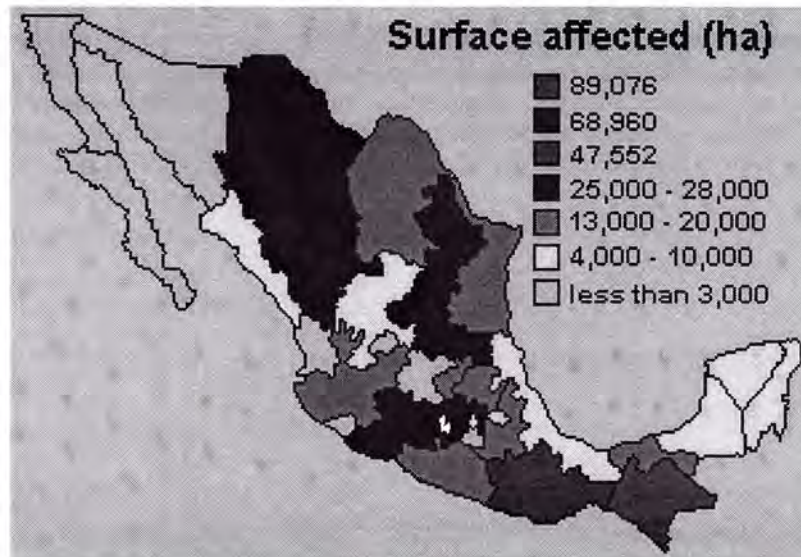


Fig.1. Comparative burned area, Mexico, by years (period 1992-97 vs. 1998)

While all the Mexican states experienced wildfire, the heaviest zones were along the Sierra Madre Occidental, the central Highlands, and the tropical mountains of Oaxaca and Chiapas (Fig.2). Officially, 14,302 fires covered over 583,664 ha. The area burned was roughly twice the average. An estimated 26% of the burned landscapes were forested, 32% were grasslands, and 42% brushlands. Some 97% of the fires had human origins.

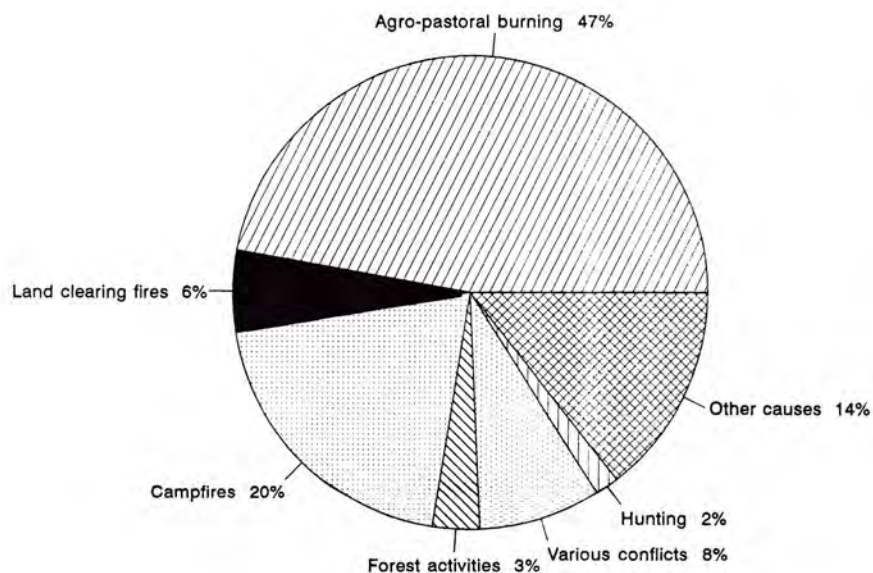
Environmental damage was extensive. Apart from the often severe burns, following drought, a number of national parks and nature reserves suffered, resulting in a declaration of environmental emergency in Oaxaca and Chiapas. Grave concerns centered especially on the fires that threatened Los Chimalapas, a preserve of spectacular biodiversity in a cloud forest for which natural fire is rare. Thousands of rural Mexicans had to evacuate their homes. Subsequent heavy rains have further worsened the aftereffects, particularly in the Federal District and Chiapas. Smoke caused a major deterioration of air quality in Mexico City and submerged many cities, from Villahermosa to Veracruz, in chronic haze. Then the pall spiraled into the southern United States,

causing a pronounced decay in air quality in Texas and Louisiana, in particular. Recent research also implicates the smoke in a higher proportion of positive lightning in those regions (see Lyons et al [1998]).



**Fig.2.** Map of burned area by Mexican states (1 January - 15 July 1998)

Control costs were high. Mexico mounted a massive response, moving beyond the normal inter-institutional group headed by the **Secretaria de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP)** and creating an emergency inter-secretarial group at the federal level. An estimated 823,971 person-hours of firefighting - national and state employees, army personnel, *campesinos*, volunteers - all supported the suppression effort. A total of 60 firefighters died. Aircraft involvement provides a useful index of this extraordinary year. For 1995-97, SEMARNAP deployed three planes and six helicopters. During the 1998 season it fielded 57 planes, 25 helicopters, three Skycranes, and a CL-415. The United States assisted with over 50 advisors, firefighting materiel, and an infrared-mapping aircraft. Expenses raced ahead of the 40 million pesos (US\$4 million) budgeted to exceed 290 million pesos (US\$29 million).



**Fig.3.** Fire causes in Mexico during the 1998 fire season



The response to the fires within Mexico has been immediate and widespread, a gamut of political alarm that has extended from villages to the presidency. The press offered unprecedented, daily coverage. Scientists, institutes, and universities are all committing research to understand the particular consequences of these fires, and what might be done to ameliorate their damages, but also the larger question of Mexico's fire ecology.

Accordingly, a review of the national fire protection system is underway. SEMARNAP has outlined a massive restoration program aimed primarily at timber salvage, soil stabilization, and reforestation. The **Comision Nacional Para el Conocimiento y Uso de la Biodiversidad (CONABIO)** has reviewed the consequences of the fires relative to Mexico's efforts at nature conservation, especially their impact on biodiversity. The United States is extending assistance through its Forest Service (Office of Foreign Disaster Assistance) and Agency for International Development for training, personnel exchanges, and advice on landscape restoration.

The relevant Mexican agencies have posted an excellent statistical summary of the season and their response on several internet sites. Consult:

<http://www.semarnap.gob.mx/naturaleza/emergencias/incendios>

Programme for reforestation of areas burned in 1998:

<http://www.semarnap.gob.mx/ssrn/conaf/restaura.htm>

Fires in Mexico 1998: An analysis of threats to biodiversity

<http://www.conabio.gob.mx/incendios/incendios.pl?numero=1>

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## NICARAGUA

*A Survey of Three Successive Recent Fire Seasons***Background**

There has been a long term trend of conversion of forest to agricultural land through the use of fire in Nicaragua. Fire is thus a major risk to forest resources since it is itself a cause of deforestation. It is also a prime indicator of human-induced land use changes, particularly land conversion from forest to agriculture. Monitoring of forest conditions and fire activity in particular is essential for the sound management of Nicaragua's important areas of forest resource and for the rational allocation of limited resources to meet fire threats and outbreaks.

Nevertheless, until recently, the available information on the occurrence, extent and impact of fires (and changes to the national forest estate generally) was limited in quality, quantity and timeliness. This presented a major handicap to forest management. While comprehensive analysis of fire data can improve understanding of fire activity and enable better management decisions to be made, such an approach may be a real challenge for a budget constrained government.

**Fire monitoring through NOAA satellite data reception in Nicaragua**

The UK Department For International Development (DFID) supported a joint environmental monitoring project between the Nicaraguan *Ministerio del Ambiente y los Recursos Naturales* (MARENA) and the Natural Resources Institute (NRI). MARENA is the government agency charged with responsibility for a sustainable management of renewable natural resources in forestry, and in other areas of environmental damage.

The overall purpose of the Nicaragua Land Resources (Fire) Monitoring Project was to encourage more integrated and sustainable environment monitoring methods in Nicaragua towards improved management of natural resources, particularly forests. The particular objective was to assist with appropriate and cost effective forest fire and environmental monitoring through utilisation of real-time local reception of data from environmental satellites and to evaluate their relevance and sustainability in the context of Nicaraguan institutions. The project ran from June 1995 to June 1998.

The project installed a PC-based NOAA satellite receiving ground station at MARENA headquarters in Managua to enable daily observation of active fires occurring in Nicaragua. This is used to assist forest protection, fire control and natural resource management activities in Nicaragua. Information products are generated on a routine basis and supplied to a number of Nicaraguan institutions at local, provincial and national level. Regional level information can also be generated and this is attracting a wider base of end users. The information on fire activity is delivered to departmental authorities in charge of fire control in the form of lists of co-ordinates with references to the 1:50,000 topographic map index and to observation towers where appropriate. At a local scale, this provides an early-warning tool for fire fighting.

At a national scale, the data are analyzed in their context (land cover, forest type, administrative divisions) by using GIS, to provide thematic information which can be used for example to locate possible deforestation fronts, helping to raise political awareness, or to direct extension programmes to promote adequate strategies, such as alternative land use.

**Results**

In Nicaragua, most fire activity occurs during the dry season, which stretches from the end of December up to the end of May. Three successive seasons were monitored by the project (1996 to 1998). Table 1 presents a synthesis of the number of fires (i.e. hot pixels) that were detected in Nicaragua over these three seasons.

Figure 1 illustrates the typical West-to-East movement of fire activity in Nicaragua. The earliest fires (in January and even December some years) are generally observed only in the pacific region (the driest, most densely populated and most farmed region of the country). Two months later, the central mountain region begins to suffer outbreaks of fire activity. Toward April, fire activity invades the rest of the country and especially increases in the Atlantic region, although this has the lowest population density and the wettest climate.

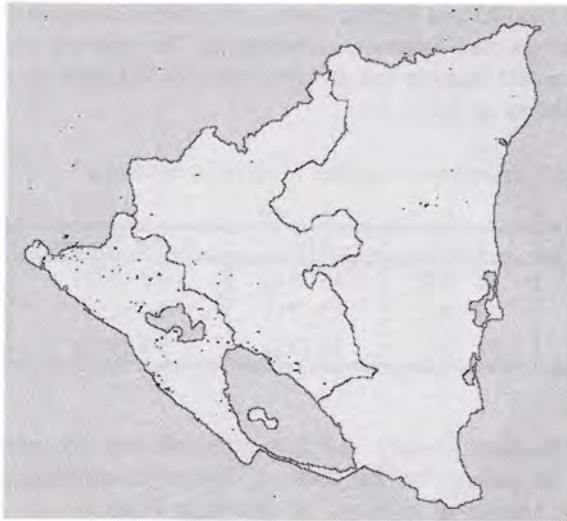


**Fig. 1 :** Monthly hot pixel maps for the **1997** fire season in Nicaragua. The inside boundaries represent the main geographical regions: Pacific Coast, Central Mountains, Atlantic Coast.

Nicaragua Land Resources (Fire) Monitoring Project.  
 MARENA – Ministerio del Ambiente y los Recursos Naturales  
 NRI – Natural Resources Institute  
 DFID – Department For International Development



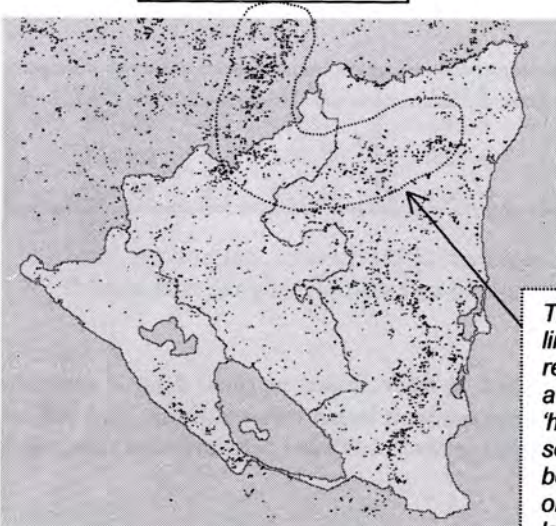
January 1997



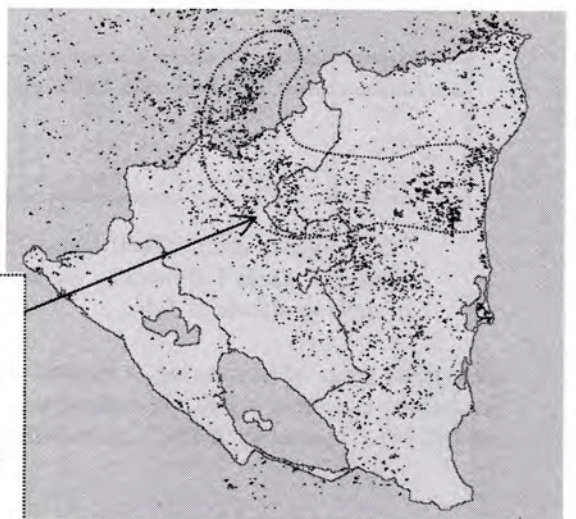
February 1997



March 1997



April 1997



May 1997

The dotted line represents a likely 'human settlement belt' around one of the last large extensions of primary rainforest in Central America.



**Tab.1.** Number of detected hot pixels on Nicaraguan territory over three dry seasons

Year	January	February	March	April	May	Total Fire Season
1996	279	496	1,729	5,996	251	8,751
1997	88	174	575	4,359	4,334	9,530
1998	151	395	1,601	14,024	1,987	18,158

### Analysis

#### Data weighting

For various reasons, it was not possible to ensure an uninterrupted coverage of the respective periods. The rate of valid data captured varied slightly over the respective months and between years. In order to compare data from different seasons, the monthly and seasonal hot pixel number figures were weighted. The numbers of hot spots were divided by the respective numbers of days of actual data capture and multiplied by the total number of days in every month or in the whole fire season, as shown in Table 2.

**Tab.2.** Number of days of actual captures every month (maximum number of days in brackets)

Year	January	February	March	April	May	Total Season
1996	17 (31)	18 (29)	24 (31)	22 (30)	18 (31)	99 (152)
1997	13 (31)	13 (28)	23 (31)	19 (30)	19 (31)	87 (151)
1998	16 (31)	17 (28)	17 (31)	25 (30)	18 (31)	93 (151)

In this correction, we assumed that fire occurrence increases linearly and that acquired data are evenly distributed within every month, which may be close to the reality. On this basis, all the tables and diagrams shown below are produced from the figures weighted by number of captures. As shown in Table 3.

**Tab.3.** Weighted numbers of detected hot pixels

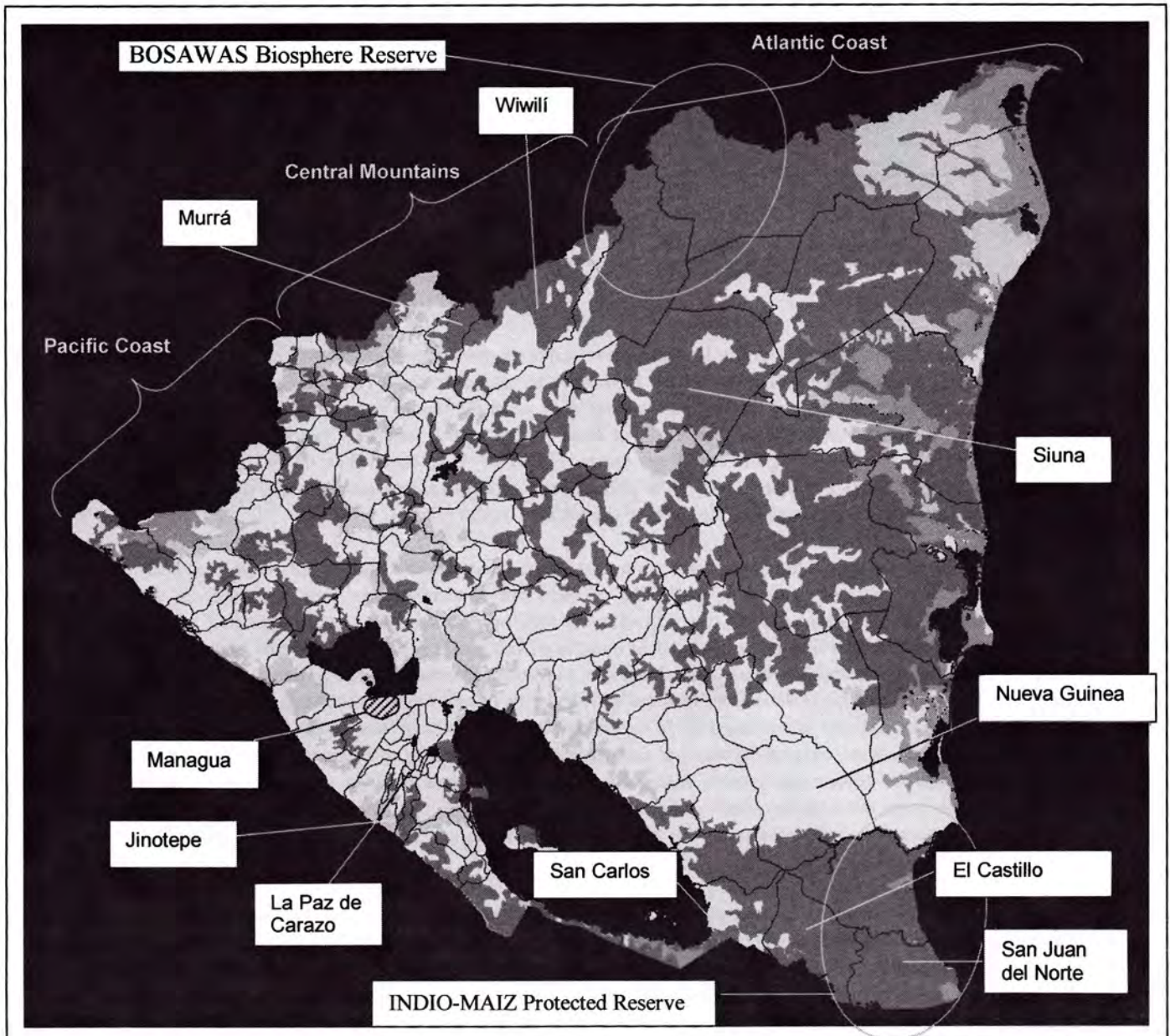
Year	January	February	March	April	May	Total Season*
1996	509	799	2,233	8,176	432	13,436
1997	210	375	775	6,883	7,071	16,541
1998	293	651	2,919	16,829	3,422	29,482

\* The figures under 'Total Season' are not the sums of all the months, but are the 'raw' figures of Table 1 divided by the total number of captures and multiplied by the total number of days as shown in Table 2.

After three years of monitoring, a number of observations can be made, based on these data. It appears that fire activity can show a different pattern in each season. For example, it began rather early in 1996 and rather late in 1997. Unusually, in 1997, most of fire activity occurred in May. 1998 has been the most dramatic year

**Fig.2 :** Land use and municipality map of Nicaragua. For clarity, the 11 original land use categories have been gathered into 4 new classes, which are:

- Dark grey : broadleaf evergreen forests (>20m, 12-20 m) and forestal fallows
- Middle grey : mangroves, swamps and wet lands
- Light grey : pine forests and tropical deciduous dry forests
- White : crops and pastures, incl. Perennial crops, and other marginal categories and areas outside the studied area.



#### *Fire occurrence in its context*

As indicated above, it is critical to analyze fires in their context. As a first approach, we compared the detected fires (i.e. hot pixels) with available geographical information on (a) administrative boundaries (140 municipalities, 17 departments, 3 main regions) (MARENA, 1995); (b) land use; dividing the country into 11 categories, including gross forest types, according to inventories dating from 1988 to 1992 (see Fig.2)



(MARENA 1995); and (c) population and rural poverty rate in each municipality (Lacayo 1998). Tables 4 and 5 show the fire occurrence distribution according to the geographical regions, and to the gross land use categories, respectively.

**Tab.4.** Numbers of hot pixels in each geographical region, over three seasons (weighted figures)

Year	Pacific Coast	Central	Atlantic Coast	Total
1996	1,550	3,548	8,318	13,436
1997	1,920	3,891	10,730	16,541
1998	1,287	6,103	22,092	29,482
Ancillary information				
Area (km <sup>2</sup> )	18,702.61	36,136.42	66,594.04	121,433.0
% forested	41,58 %	43,06 %	74,16 %	59,90 %
Population	2,467,742	1,354,246	535,111	4,357,099

Absolute figures draw attention to the lowland broadleaf evergreen forest areas, where the highest number of fires occurs. If those numbers are considered in relative terms however, it can be seen that the percentage of fires in those forests with regard to the total number of fires in the whole country is not significantly different from the proportion of territory they occupy, at least as far as the two first years are concerned. But the increase observed in 1998 is significant (from around 35 to 37 % to more than 44 %). Both tables 4 and 5 make clear that the drought caused by *El Niño* phenomenon and the consequent increase of fire activity mostly affected the evergreen rainforest that lies across the wide Atlantic plain.

The density of 'fires' (hot pixels) was also investigated. In this way, the size of the respective areas is taken into account, since it is obvious that, whilst the greatest fire occurrence has been registered in the Atlantic Coast region (Tab.4), this one also covers the largest territory, representing more than half of the country. Observing fire occurrence density, expressed in number of hot pixels per 10km<sup>2</sup>, reveals that forest fallows as well as swamps and inundable lands have been the two most affected zones by fire activity over the three monitored seasons. Hot pixel density in swamps and wetlands nearly doubled between 1997 and 1998 (Tab.5). This is likely to be a direct effect of an *El Niño*-related drought, making those areas more prone to be burned than usual. This observation might mean that burning activity is exerting an increasing pressure particularly on wetlands. These are essentially located along the Atlantic coast and play an evident ecological role in the balance of the large catchments which drain the eastern half of the country. Most of these aquatic or semi-aquatic ecosystems are included among the highest priority areas in terms of biodiversity value (World Bank 1997).

Forest fallows are assumed to correspond to land parcels temporarily left to forest recolonization inside complex forest-crop-pasture mosaics, at the margins of larger forest areas. The high fire activity observed there implies an acceleration of the traditional migrant agriculture cycle and then an increased reconversion to crop or pasture, which dramatically increases the fragility of soils that were already considered as marginally or not suitable for agriculture (Herrera 1995).

Intuitively, but also according to the results in Tables 4 and 5, features such as a high proportion of forest, and a fairly low population density but with a high proportion of rural poor, would seem to be a typical combination to observe a high fire occurrence density. But fire activity is so complex a phenomenon that studying it on a case-by-case basis is likely to result in more relevant information than trying to find correlations between variables over the whole set of data. For example, the five municipalities which had the highest observed hot pixel density for every season were selected. These were examined with respect to the other recorded features (% forested area, population density, % poverty rate) corresponding to each municipality. This is shown in Table 6.



			Hot Pixel Occurrence 1996			Hot Pixel Occurrence 1997			Hot Pixel Occurrence 1998		
Forest types	Area (ha)	%	Absolute Number	Proportion in the country	Density No./10 km <sup>2</sup>	Absolute Number	Proportion in the country	Density No./10 km <sup>2</sup>	Absolute Number	Proportion in the country	Density No./10 km <sup>2</sup>
Broadleaf evergreen forest > 20m	4,358,121.44	36.56	4,699	34.97%	1.06	6,226	37.64%	1.41	13,106	44.45%	2.91
Broadleaf evergreen forest 12-20 m	1,195,853.58	10.03	1,452	10.80%	1.20	1,627	9.84%	1.34	2,460	8.34%	1.99
Broadleaf deciduous forest 4-12 m	487,653.25	4.09	459	3.42%	0.93	556	3.36%	1.12	726	2.46%	1.44
Pine forest	595,901.94	5.00	501	3.73%	0.83	809	4.89%	1.34	772	2.62%	1.25
Mangrove	145,987.90	1.22	121	0.90%	0.82	244	1.47%	1.64	245	0.83%	1.62
Crop or pasture land	4,335,413.31	36.37	5,169	38.47%	1.18	5,522	33.39%	1.25	9,496	32.21%	2.12
Perennial crop (e.g. coffee)	221,342.10	1.86	180	1.34%	0.80	177	1.07%	0.78	250	0.85%	1.09
Swamp and wetland	496,050.79	4.16	745	5.55%	1.48	1,254	7.58%	2.49	2,119	7.19%	4.13
Small islands	11,850.96	0.10	0	0.00%	0.00	2	0.01%	0.15	5	0.02%	0.41
Forest fallow	59,130.57	0.50	105	0.79%	1.77	115	0.69%	1.91	298	1.01%	4.89
Rocky outcrop	11,677.04	0.10	5	0.03%	0.39	9	0.05%	0.74	5	0.02%	0.42
Total	11,918,982.88	100	13,436	100.00%	1.11	16,541	100.00%	1.37	29,482	100.00%	2.39

Tab.5. Number of hot pixels by type of land cover in Nicaragua (weighted figures)

**Tab.6.** Features of the municipalities with the five highest fire occurrence densities per season.

Year	Municipality	Region	Fire	% Forest	% Forest	Pop.density/	%
1996	Murrá	Central	3.60	73.31%	67.45%	23	80.24
	San José de	Central	3.48	57.91%	37.04%	74	66.40
	Nueva Guinea	Atlantic Coast	2.30	7.73%	7.73%	28	37.54
	El Rama	Atlantic Coast	2.20	45.36%	43.99%	13	58.41
	San Miguelito	Atlantic Coast	2.13	76.05%	76.05%	12	72.66
1997	La Paz de	Pacific Coast	3.87	0.00%	0.00%	223	41.61
	Jinotepe	Pacific Coast	3.86	56.14%	56.14%	194	29.52
	Murrá	Central	3.41	73.31%	67.45%	23	80.24
	Prinzapolka	Atlantic Coast	2.81	92.55%	69.86%	1	63.91
	Wiwilí	Central	2.68	55.35%	55.35%	18	70.20
1998	Siuna	Atlantic Coast	5.91	80.15%	80.15%	12	76.97
	Nueva Guinea	Atlantic Coast	5.38	7.73%	7.73%	28	37.54
	El Castillo	Atlantic Coast	5.24	96.85%	96.85%	6	77.76
	Cruz del Rio	Atlantic Coast	5.03	75.21%	74.04%	2	47.25
	San Carlos	Atlantic Coast	4.73	47.04%	34.98%	19	54.72
Average Three	Murrá	Central	3.65	73.31%	67.45%	23	80.24
	Siuna	Atlantic Coast	3.32	80.15%	80.15%	12	76.97
	Nueva Guinea	Atlantic Coast	3.19	7.73%	7.73%	28	37.54
	Cruz del Rio	Atlantic Coast	3.14	75.21%	74.04%	2	47.25
	Wiwilí	Central	2.90	55.35%	55.35%	18	70.20

Table 6 shows that in 1997, the most affected municipalities are two densely populated ones in the Pacific Coast region, with a fairly low proportion of rural poor population. One of them has even no forest coverage at all. This is clearly in opposition to the expected combination as mentioned above.

The case of the municipality of Nueva Guinea (south-east of Nicaragua) is one of particular interest. In average over the three monitored fire seasons, it is third in terms of hot pixel density (3.19/10 km<sup>2</sup>), although its forest coverage rate is fairly low (7.73 %). This broad municipality has undergone a strong expansion of settlement and land clearing for a long while, since it has been particularly devoted to developing livestock production. Focused field studies might confirm that fire activity there is essentially aimed at refreshing pasture for cattle. Moreover, its forest coverage was particularly struck by Hurricane Joan which devastated the south-eastern coast of Nicaragua in 1988 and created an open 'track' within the original broadleaf evergreen forest (Ciesla 1997).

Siuna, which also lies on the Atlantic coast region of Nicaragua but in the north-east, is very different. It also had a high average fire density over the three seasons but still has a high forest cover proportion. As this municipality is at the junction of the two highways linking the west to the east of the country, it is subject to increasing pressure from both sides of those roads. In addition, the main traditional economic activity there used to be mining, which is not as space consuming as livestock rearing or migrant agriculture. With the recent decline of this 'industry', lots of small miners lost their jobs and remained without resources (Stührenberg 1996). A more intensive settlement process then began, invading the primary forest gradually. Hot pixels maps clearly show a 'settlement belt' around those large forest extensions, which include the Bosawas Biosphere Reserve.

Both Murrá, the most fire affected municipality on average over the three seasons, and Wiwilí, which has the fifth highest hot pixel density over the same period (Tab.6) are in the Central Mountains region. Although the same consideration about land clearance pressure can be made (it is actually the 'western' settlement front of the same large forest area), another factor might influence fire activity. That part of Nicaragua is arguably the region most affected by the 'desarmados' problem that appeared at the end of the civil war in 1990. Indeed,

when peace was signed, several thousands of ex-soldiers from both sides were given a little land in order to facilitate their return to a civil life after several years fighting. But most of them knew nothing of agriculture and in most cases they were left alone, with fire as their only clearance tool.

Another interesting fact is observed when comparing two neighbouring municipalities, in the extreme south-east of Nicaragua, along the San Juan River which makes the boundary with Costa Rica: El Castillo and San Juan del Norte. According to the land cover map, those territories have 97 % and 96 % covered by broadleaf evergreen primary forest respectively. But the difference between them in terms of hot pixel density is significant (see Tab.7).

**Tab.7.** Comparison between two neighbouring municipalities

Municipality	Region	% Forests	% Broadleaf	Population	% Rural Poor
San Juan del Norte	Atlantic Coast	99.66 %	95.85 %	0.16	9.59
El Castillo	Atlantic Coast	96.85 %	96.85 %	5.85	77.76
Hot Pixel Density (No./ 10 km <sup>2</sup> )					
		1996	1997	1998	Average
San Juan del Norte	Atlantic Coast	0.00	0.00	0.12	0.04
El Castillo	Atlantic Coast				

An explanation can be found in the fact that San Juan del Norte is almost completely situated within the protected Indio-Maiz natural reserve, while El Castillo is mostly crossed by its buffer zone, which is subject to a high migrant agriculture pressure (Valerio 1998). Population figures clearly show that in the latter, the population is generally rural and poor, thus dispersed throughout a large part of its territory. In the former, although the population is perhaps as poor, it is concentrated in the municipal capital, just on the Caribbean littoral. Along with Bosawas Reserve, Indio-Maiz Reserve, which is the core zone of the 'Si-a-Paz' protection area, is the last primary tropical rainforest area of relevant extension that still remains intact in Nicaragua. But despite all, fire activity also increased notably there in 1998.

## Conclusions

Results from three complete seasons clearly indicate fire incidence, severity and variation over time and between different regions. The availability of this time series information enables inter-year comparisons, initial studies of fire distribution within the country and analysis of seasonal trends.

Our interpretation demonstrates the potential of such data to increase understanding on extent and type of fire. It is critical to be able to discriminate detected fires between 'good' and 'bad' fires according to their impact on the environment, by including them in the ecological, social and economical contexts. This study also emphasises the importance of accurate and updated ancillary data to enhance appropriate interpretation of the information provided by the satellite imagery.

What was achieved throughout this Project is very encouraging. There is now a greater appreciation and knowledge, within MARENA and on the part of forest managers and a number of local authorities, of the relevance, importance and use of NOAA/AVHRR data to assist monitoring and evaluating forest fires. A small scale remote sensing unit is now established and managed on a routine basis. In parallel, GIS capacity there has also experienced a recent and spectacular development, either in different divisions of MARENA or in other government agencies.

Up to now, Nicaragua has had no means to monitor the situation effectively and thus make informed decisions on natural resource pressures, effectiveness of policies, and areas to prioritise. Within the context of existing forest fire and natural resources management, Nicaragua now has a cost-effective mechanism to demonstrate the scale and nature of the problem and to adapt its policies accordingly. Nicaragua will also be able to use the same tool as a verifiable indicator to monitor the effectiveness of protection measures.



It is in this way that this low-cost and decentralised technology transfer may manage to bear fruit: by contributing to a better allocation of human and logistical resources, and improving forest fire prevention and control strategies.

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**SOUTH AFRICA*****1998: A Year of Destructive Wildfires***

In 1998 year more wildfires occurred in South Africa than in decades, in all corners of the country. At least fourteen people lost their lives directly as a result of the fires, while more than twenty people lost their lives in road accidents caused by the smoke from grassland fires. Hundreds of thousands of hectares of agricultural land, nature reserves and timber plantations were lost in the process, while numerous houses, farms and even factories were destroyed by the runaway fires experienced.

Unfortunately no suitable records were kept of all the wildfires that occurred during 1998, but a summary of the major wildfires, their causes, damage created and impact, will be provided in this report. As a result of the wide contrasts in climate, altitude, vegetation cover and other fuel and land-use characteristics between the different regions in South Africa, the information about the wildfires experienced will be discussed by biome.

**The Fynbos Biome**

**Biome characteristics:** This biome comprises evergreen sclerophyllous heathlands and shrublands. Trees and evergreen succulent shrubs are rare, while grasses form an insignificant part of the biomass (Huntley 1984). Fynbos normally takes about 4 to 6 years before sufficient biomass has developed to carry a fire, and optimum burning rotations range from 12 to 18 years.

**Locality:** Fynbos covers approx. 5.3% of South Africa, and is almost exclusively occupying the coastal areas of the Western Cape and Eastern Cape Provinces, as far as (just) east of Port Elizabeth. Most of it occurs along the southern mountain ranges, but coastal communities are also present, in an area where rainfall ranges from 200 to 3000 mm per year.

Bordering the natural fynbos areas we also find some industrial pine plantations (particularly on the S foothills and plateau of the Outeniqua and Tsitsikamma mountain ranges). Although their total area is restricted to approx. 110,000 ha, they contribute significantly to the local industrial output of the Cape regions.

**Wildfires experienced and causes:** Dry *Bergwind* conditions contributed mostly to the extremely hazardous conditions experienced, and during two such periods - not lasting longer than a few days - most of the destructive fires occurred. During both periods people had to be evacuated from certain communities, and the lives of six people was lost during one of the Tsitsikamma fires that raged right through the Tsitsikamma mountain range, through about 4000 ha of plantations, and in the process destroying a whole rural settlement.

The extremely dry conditions and absence of rainfall during the period preceding the wildfires contributed significantly to the fires, which were mainly caused by human beings, by allowing prescribed burns to become uncontrolled, and through arson. However, during the last spell of fires experienced in the Tsitsikamma during August, dry thunderstorms caused most of the fires in the mountains.

A steady decrease in prescribed burning application in the mountains also had created areas with abnormal fuel loading in some of the mountain fynbos areas, which contributed significantly to the high fire intensities (and even fire storms) experienced. In the plantations a lack of weed control and proper fuel management indirectly left the stands affected with no chance of survival.

**Recommendations:** Burned areas in the mountains should be mapped, together with the mapping of remaining areas, by average vegetation age. Special care should be taken for the urban interface of these areas, and to identify "blowup situations" well in time. There should be concerted efforts by the provincial authorities for a more intensive fuel management programme by means of more regular prescribed burning. The "natural fire occurrence policy" can still be applied in areas suitable for this purpose provided they are recognized as "least disturbed" by man, but elsewhere the creation of old fynbos land, with abnormal fuel loadings, should be avoided by means of a proper fuel management programme.

Timber growers should now change their fire protection plans to a more flexible system, starting by mapping burned areas, and rating fire hazard by plantation unit on a compartment level. Thereafter proper prescribed



burning programmes should be put in place as part of an effective fuel management and weed control regime on a regional scale, particularly in the Tsitsikamma (de Ronde 1990).



**Fig. 1. and 2.** Prescribed burning operations in Fynbos shrubland (upper) and pine plantation (lower) in the Western Cape Province. Photos: J.G.Goldammer



### **Grassland Biome: Higher Rainfall Area**

**Biome characteristics:** Although 24.1 % of South Africa is covered by this biome (Huntley, op. cit.), less than 10% of this area falls in the higher than 800 mm per year rainfall margin. These grasslands are dynamic, with most of the biomass being "cured" during the dry winter season. Most of these grasslands can burn after one winter (curing) season, providing dangerous fuels if fire is not allowed in controlled form within 2 to 3 years if left unburned. However, the rate of biomass production is also significantly influenced by seasonal parameters, particularly rainfall occurrence.

**Locality:** Mostly situated in the Drakensberg mountain area, from the NE Cape (southern slopes of the Drakensberg, S of Lesotho) to the Drakensberg escarpment in the N, in the Mpumalanga Province. Most of the area is used for agricultural purposes (particularly grazing) but industrial timber plantations are also found there in abundance, covering more than 1 million ha

**Wildfires experienced and causes:** Although the area covered by this biome experienced more fires than usual, the occurrence did not exceed normal patterns as much as in the fynbos and grassland falling within the lower rainfall margins (see next paragraphs). However, the summer rainfall stopped very early (during April already, compared to during June/July during normal seasons) and this caused early grassland curing, and a subsequent early start of the fire season.

In the absence of a proper fuel moisture and grass curing monitoring system coupled to Fire Danger Index, foresters, farmers and nature conservators - used to burning each year during June and July - were not aware of the dangerous situation that had developed, and as a result most wildfires in this area originated from controlled prescribed burning.

The most serious case of mortality occurred during an arson-caused grassland fire in the Mpumalanga Highveld area, near Badplaas, when four people were killed when attempting to drive through a grassland fire front in a van without a protective canopy. Some serious plantation fires were also experienced in the NE Cape, in Mpumalanga, and in Swaziland, and in the worst cases more than 1000 ha of plantation was lost at a time.

**Recommendations:** Fortunately selective use of prescribed burning is mostly used by farmers and foresters, but the sequence of burning needs improvement to arrive at a regional, integrated burning plan with pre-determined priorities, concentrating on regional buffer zoning (de Ronde 1997). The burning season should also be more flexible, but (most important) starting and ending dates should be determined scientifically after a monitoring programme, and determined in such a way that it can give foresters and farmers early warning when unusual seasonal changes are recorded that can affect the safety of fire application.

Upgrading of the existing fire danger rating system - to include regional characteristics, land use, grass curing patterns, fuel build up and moisture - is recommended to provide safer prescribed burning conditions, and subsequent less problems with situations where controlled prescribed fires turn uncontrolled (de Ronde 1998).

### **Grassland Biome: Marginal Rainfall Area**

**Biome characteristics:** The most important characteristic of this part of the grassland biome, is that it falls in the marginal (600 - 800 mm per year) rainfall area. The grassland is as dynamic as in the higher rainfall area, but produces on average less biomass per year, and thus the optimum fire need will be approximately 5 to 6 years. However, this can range within the region from 2 to 8 years depending on soil type, locality in the landscape and microclimate. Most important is that seasonal rainfall can fluctuate more than in the higher rainfall regions, and thus contribute significantly variation in yearly biomass production. This might be as low as 500 kg/ha/year during dry seasons, and as much as 2500 kg/ha/year during seasons with above-average rainfall. This aspect in particular determines the extent of fire hazard during a specific fire season. Most of this grassland is utilized for agricultural purposes, and where grassland is maintained, for it is mostly used for grazing purposes. A relatively small area within this biome is utilized for nature conservation purposes, particularly in the Eastern Free State.

**Locality:** Situated mostly in the SW of the Mpumalanga Highveld, the E Free State and Gauteng Province, this biome forms a very important part of the agricultural sector, with vast areas covered by the grassland, although covering less than 3% of South Africa. Prescribed burning is here less commonly used by farmers compared to the frequent use of fire in the higher rainfall area, but the use of fire is not uncommon in farming communities.

**Wildfires experienced and causes:** The biome has experienced some very serious wildfires this season, mostly caused by arson. In the Vrede area (SE Mpumalanga) and near Warden (E Free State) 30,000 to 40,000 ha of farmland were wiped out by single fires, also burning down farm homesteads and equipment worth millions of Dollars. In Gauteng Province, one Nature Reserve was burned to the extent that animals had to be transported to other reserves to save them, while the most serious road accidents, caused this year by smoke from grassland fires, were recorded in Gauteng, killing at least 20 people indirectly. Most of the latter were caused by smoke from prescribed as well as from uncontrolled burns.

One of the main indirect causes of the wildfires experienced in this region was that farmers were unaware that the last 3 to 4 years of above-average rainfall had caused an very high grass biomass production pattern to develop, and no steps were taken before the 1998 winter to counteract this problem by means of increased prescribed burning programmes or the creation of proper fire belt systems and buffer zones. In Gauteng - as elsewhere - the traffic authorities were also not taking the necessary action to safeguard roads exposed to fire and smoke from grassland fires. Where sections of public roads are exposed to serious smoke from fires, these must be closed for traffic immediately, and should remain closed until the smoke has lifted.

**Recommendations:** Region-specific grassland fuel buildup and grassland curing patterns should be monitored as part of an improved fire danger rating system, so that guidelines for prescribed burning intensity can be supplied well in time to the farming communities for them to take timely action. A regional approach should also be followed to fire protection and fuel management measures, so that regional buffer zones can be constructed along strategic lines, and to move away from the individual prescribed burning measures at present being applied.

Traffic authorities should also be advised of any wildfires occurring in particularly areas, and well in advance be told about any prescribed burn that might cause problems along public road sections.

#### **Grassland Biome: Lower Rainfall Area**

**Biome characteristics:** Although this grassland is also dynamic, the grass is more sparsely spaced, and only slowly and systematically adds biomass above ground level. Typical yearly biomass addition is 400 to 600 kg/ha/year, and it takes mostly approx. 12 years before such a community can carry a fire, and then only on steep slopes, and/or if some dominant prevailing wind can move the fire front. The low rainfall is the main reason for this (400 to 600 mm per year average). However, good rainfall years can increase biomass dramatically, creating a fire hazard in regions where for years there was none. Most of this grassland is utilized by farmers for low intensity grazing.

**Locality:** This grassland biome covers most of the central Free State, as well as the North West Province. It is estimated that approx. 10% of South Africa is covered by this grassland type, but a high percentage of this has been taken up by cultivated land, particularly in the NW Province.

**Wildfires experienced and causes:** Wildfires have been relatively unknown in these areas, or are normally restricted to small controllable fires. However, for quite a few years above-average rainfall was experienced, and the higher-than-normal biomass production had created a situation where a wind-driven fire could run completely out of control. Quite a few fires of this nature were recorded in the Free State area, although none of them caused serious damage to men and property. However, one such fire in the NW Province burned down a range of farms, damaging homesteads, while in another one (near Schweizer Reynecke) two policemen were killed. Most of the fires occurred during strong windy conditions, and almost all of them were caused by arson.

**Recommendations:** Although no daily fire danger rating forecast is necessary for this area, some form of biomass addition monitoring is recommended to warn farming communities when a fire hazard situation is

reached, with a strategic fire protection plan for the region, that can be used prior to such a season. Simple rainfall pattern monitoring and quarterly grassland biomass observations can then provide a fuel build up index that can set fire protection measures in motion in time.

### Moist Savanna Biome

Covering about 10% of South Africa, this biome is mostly situated on the plateau, 500 to 1000 m above sea level. The vegetation cover is a combination of woodland and grassland, and some industrial timber plantations are also found there (approx. 300 000 ha). A high percentage of the area is utilised as nature reserves or game farming, and also other for agricultural purposes.

Although some wildfires were experienced in the Mpumalanga Lowveld and Zululand, there was no deviation from normal patterns in this area.

### Conclusions

Although weather conditions in the Fynbos and Grassland regions were drier than normal, with a longer period of rain absence, it was in most cases the lack of proper fuel management and integrated fire protection that contributed significantly to the seriousness of the 1998 wildfires. There is also a clear indication that the existing fire danger rating system should be adjusted to include fuel moisture and fuel buildup indexes, as well as a grassland curing monitoring system, to provide specific regions with early fire hazard warning provision over and above the daily, weather-based, fire danger rating used at present.

A regional early warning system should also be backed-up by a more appropriate fuel management and regional fire protection system, that is created well in advance of the fire season. In other areas, such as in higher rainfall areas of the Highveld, fire protection measures should be better co-ordinated on a regional scale, to move away from the existing ad hoc individual measures presently being applied.

If the above recommendations are applied at a national level, a repeat of the scale of damage to property and loss of life experienced during 1998, can be avoided in the future.

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**SPAIN***Forest Fires in 1998 - An Average Year***Fire Risk**

The year 1998 can be classified like an average year, according to the forest fire risk. In the month of March a dry period at the Northwest increased the risk, giving opportunity to many grass and bush fires which in some cases developed into forest fires. After a rainy spring, the month of July was rather hot, showing a sudden increase of fire danger in Northern Catalonia, where the largest fire of the year started on 18 July 1998. In August the danger shifted again to the Northwest. Consequently a reinforcement the suppression resources was necessary. Several air tankers and BRIFs (hot-shot brigades) were sent from other regions. By the end of the summer a rainy period reduced the danger along the whole country. However the drought started again, lasting nearly until the end of the autumn with many grass and bush burnings and fires again at the Northwest.

**Fire effects**

Table 1 shows the 1998 data in comparison with the preceding year. The most important fires are listed in the Table 2.

**Tab.1.** Wildfire statistics for Spain 1994-1998

Date	Average 1994-97	1998
No. of Fires (< 1 ha)	12,722	14,352
No. of Fires (> 1 ha)	8,026	7,089
No. of Large Fires (> 500 ha)	34	19
Burned Surfaces (ha)		
Forested	80,976.3	41,235.9
Brushland and Grassland	102,630.6	80,258.1
Total	183,606.9	121,494.0
Burned Surface as a % of the National Woodland Area	0.72	0.47

**Tab.2.** Wildfire Statistics by location and area burned in 1998

Date	Place	Woodland Surface Burned (ha)
13-16 March	Villayón (Asturias)	2,207 ha
26-30 April	El Paso (Isla de la Palma)	1,450 ha
	El Solsonés (Cataluña)	
18-22 July	Cíjara (Ciudad Real)	19,979 ha
30-31 July	Las Hurdes (Cáceres-Salamanca)	678 ha
8-12 August	Vilaflor (Isla de Tenerife)	1,721 ha
	Xurés (Orense)	
23-26 August	Luyego (León)	1,649 ha
	Sanabria (Zamora)	
22-28 August		2,097 ha
13-15 September		3,321 ha
29-30 November		3,000 ha

Four victims were registered:

- \* A farmer when setting a brush burning at Castrocontrigo (León)
- \* Two firemen in a coordination helicopter, crashed in Gerona
- \* A forest firefighter of a municipal crew in Xurés (Orense)

### Fire Management

The resources available during 1998 have been rather similar to those during 1997 (see IFFN January 1998, p.84-85). This year the amphibious aircrafts CL-215 T of the Ministry of Environment performed two missions abroad:

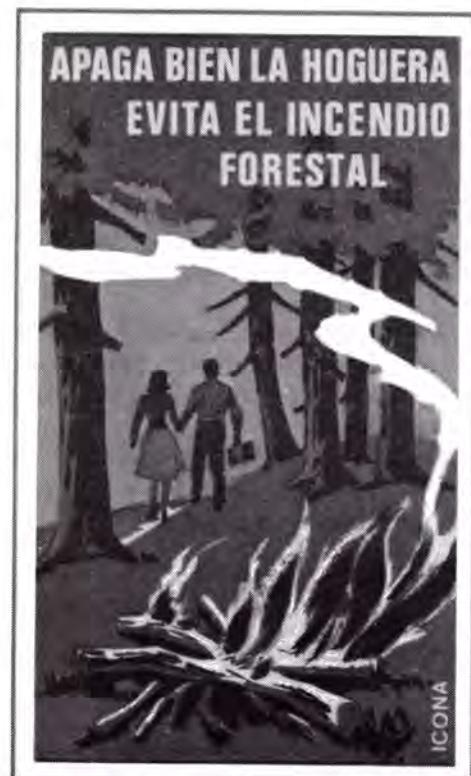
- \* The first one in the month of April at the Monte Gurugú (Morocco), by the Spanish town of Melilla. The fire started from several bonfires lighted by people hidden in the forest awaiting for an opportunity to enter illegally in Melilla and from there to Europe
- \* The second one in the month of August, at Santarem (Portugal), during three days

The Ministry of Environment is preparing the new Spanish Forest Strategy, which will include a section on forest fires, according to the Red Books on Prevention and Coordination approved in 1997.

Like a conclusion this year again the Severity Index of Spain (burned surface as a percentage of the national woodland area) is the lowest among the European Union Mediterranean countries.

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## NEWS FROM INTERNATIONAL ORGANIZATIONS

### ECE/FAO

The UN Economic Commission for Europe (ECE) Trade Division, Timber Section, periodically collects and publishes fire statistics of the ECE member states (all Western and Eastern European countries, countries of the former Soviet Union, the U.S.A. and Canada). The last data set covers the period 1995-97 and is available as a UN publication:

**ECE/FAO 1998. Forest fire statistics 1995-1997. Timber Bulletin, Vol.LI (1998), No.4. ECE/TIM/BULL/51/4, New York, Geneva, 19 p.**

The statistics can also be downloaded from the Internet:

< <http://www.unece.org/trade/timber/ff-stats.html> >

For additional global statistical data: see files of the Global Fire Monitoring Center (GFMC):

< <http://www.uni-freiburg.de/fireglobe> >



**Food and Agricultural Organization of the United Nations (FAO)**

### *Final Report of the FAO Consultation "Public Policies Affecting Forest Fires"*

Seventy-one participants from thirty three countries and thirteen international organisations, drawn from many different sectors including the private sector and NGOs, and representing a wide range of land use and other disciplines, met at FAO Headquarters from 28 to 30 October 1998 to:

- \* identify, analyze and discuss the public policies which contribute to forest fires
- \* collate information from institutions dealing with forest fires
- \* produce recommendations on planning and policies for fire prevention, control, mitigation, rehabilitation measures
- \* provide a strong message to member countries through FAO (as neutral forum) on policy issues related to fire
- \* suggest actions to be taken by countries through a statement to the forestry ministers who will meet in Rome in March 1999.

This report is based on the outputs of the meeting.



## **I Preamble**

Nearly all countries, in every stage of economic development, and in every eco-region, are suffering the environmental, social and economic consequences of forest fires. These consequences have broader implications beyond the forest itself and beyond national boundaries, including tragic impacts on human health and lives. The recent occurrences of drought associated with the El Niño phenomenon have brought the effects of forest fires to the world's attention.

But the effects of fires are not all negative. Fire is a natural process that influences and is integral to many ecosystems which have evolved in response to the effects of fire. Traditional knowledge of fire as a tool is deeply embedded in the cultures of developing and developed countries alike. Fire is still essential for land clearing to meet the food requirements of most developing countries and as part of their development process, while in other countries fire is used to achieve a wide variety of resource management objectives.

Reconciling the positive roles of fire as a servant of humankind and the negative effects if fire becomes the master are among the important challenges to policy makers in sustainable forest and land use management.

## **II Present situation**

The present situation of national policy development in response to wildfires is often of *ad hoc* reaction to a situation that has already developed, rather than proactive mitigation before the emergency arises. Frequently policy development does not consider the underlying causes of fire incidence and spread which may lie outside the forest sector, such as rural poverty and deprivation, or the effects of other public policies related to land use and incentives. Sometimes forest fire incidence and spread may be caused by ill-conceived forest management policies, in particular policies of total fire exclusion that have led to fuel accumulation and catastrophic fire outbreaks.

In general, land-use policy development is seldom based on reliable data or information on the implications of forest fire extent or causes, nor has it involved consultative or participatory processes with those most closely involved and affected. Even where policies linked to reducing the incidence and damage of forest fires are in place, there may be institutional weaknesses that do not allow them to be enforced, arising from shortage of public funding due to political instability or economic weaknesses.

## **III Preliminary action needed to develop public policies related to fire management and sustainable land use practices**

There is a need for reliable and up to date systems for national, regional and global fire reporting, analysis and storage of data. Such data, and information on fire causes and socio-economic and environmental effects, are required as a sound basis for policy making. Linked to these is the requirement for international agreement on terms and definitions as a basis for information-sharing and communication.

Information on resource management alternatives and their consequences is essential for involvement of all stakeholders in policy formulation and development.

## **IV Conclusions and recommendations to member countries regarding the principles for policies for sustainable land or forest use related to the reduction, mitigation and control of wildfires and the use of prescribed fires**

No single formula can cover the wide range of ecological, socio-economic, and cultural conditions that exist between and within regions, nor the different objectives that different societies will decide. But there exist certain broad principles common to all situations and objectives, which include the following:

- \* The formulation of national and regional policies specifically addressing forest fires, as an integral component of land-use policies, where they previously did not exist.

- \* Flexibility in policy implementation, and the capability to review and revise fire-related policies
- \* Clear and measurable policy objectives and implementation strategies are needed to minimise the many adverse effects of uncontrolled fires and to maximise the benefits from fire prevention, or from the controlled use of fire. Such objectives and implementation strategies would provide for sustainable land use practices, compatible inter-sectoral policies, joint fire management responsibilities at the community level, and the participation of the private sector and NGOs.
- \* Involvement of all stakeholders in policy development, especially through devolved or community forestry approaches. Recognition by decision-makers that sustainable land management may in many instances only be attained through devolution of control of forest resources and the involvement of the communities adjacent to or within forest in all aspects of management and fire protection. Such devolved approaches will require the revision of existing policies and laws and introduction of appropriate land-tenure arrangements to provide incentives for equitable local/community based participation in forest management and fire protection and control.
- \* A favourable policy environment must be created for all aspects of systematic fire management (prevention, detection, suppression, prescribed fire, post-fire rehabilitation etc.) and for an appropriate balance between prevention, suppression and prescribed fire use, based on local conditions. Such an environment should attempt to quantify the monetary and non-market values in order to emphasise the costs and benefits to society and to decision-makers.
- \* Policies are required for other forms of land-use, in particular credit policies should encourage land-use options that do not further contribute to deforestation.
- \* Policies that tend to increase forest fires must consider public health effects. Policies concerned with maintaining the health of ecosystems that are fire-adapted may have to balance public health and forest health issues.
- \* Land-use policies may have to consider the need for appropriate incentives and subsidies to promote fire prevention.

Some technical aspects may support policy formulation and implementation. They include:

#### **Systematic or Integrated Fire Management**

- \* devote more human and financial resources on fire prevention than at present in order to reduce the subsequent need and expense for fire suppression;
- \* policies should promote and regulate prescribed fire for a variety of land management purposes, including the reduction of hazardous fuels, and should promote public understanding of the purposes of prescribed burning<sup>1</sup>;
- \* policies should define the process whereby fire management plans are developed to achieve the resource management objectives of conservation units;
- \* develop educational, extension, and public awareness programmes on fire in general and on policy-related matters in particular, appropriate to the needs of various stakeholders;
- \* vigorous training programmes in all aspects of fire management and at all levels including volunteer community fire-fighting brigades and the training of farmers in safe fire use;
- \* integration of fire management planning with inter-sectoral resource planning;
- \* encourage silvicultural practices that sustain healthy ecosystems which in turn reduce the impacts of fires;
- \* develop policies for a fire command structure that clearly delineates authorities and responsibilities of the various agencies involved;
- \* considering the threat from fires burning in radioactively contaminated vegetation a special fire management programme must be developed for the radioactively contaminated regions in Russia, Ukraine and Belarus with high priority. This would include also careful recording of data and experience for any future similar emergency.

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<sup>1</sup> The perverse effect of provisions of the Kyoto Protocol of the Framework Convention on Climate Change regarding carbon emissions arising from prescribed burning in Annex 1 countries was noted. Prescribed fires are caused by humans and thus count as emissions against a country's carbon balance, while a disastrous fire that arises naturally because of a failure to reduce fuel loads does not.

### **Institutional Co-operation**

- \* encourage fire management cost-sharing among all relevant stakeholders at all levels;
- \* develop inter-sectoral co-operation at national and local levels;
- \* develop international agreements that facilitate the exchange of expertise;
- \* develop capacity building in fire management.

### **Restoration / Rehabilitation**

- \* salvage useable resources following fires;
- \* encourage natural recovery through protection whenever possible for the purpose of maintaining genetic integrity;
- \* undertake re-stocking where necessary;
- \* restore the infrastructure and rehabilitate local communities.

### **Technology / Research / Information**

New technologies offer the means to introduce new and more environmentally and socially acceptable land use management policies; particular attention is drawn to "zero-burning" land clearing techniques.

Fire research at national and regional levels needs to be strengthened in order to support development of fire policies and fire management capabilities, especially related to investigations into socio-economic and cultural aspects of fire outbreaks. Fire research is needed into a number of topics:

- \* the development of new dedicated space-borne remote sensing technologies for improving decision support in fire management including sensor technologies for fire detection and early warning of fire.
- \* post-fire recovery techniques and fire effects and ecosystem recovery processes.
- \* the impact of climate change on fire regimes and fire severity.

Existing accumulated experience should not be neglected, and local indigenous knowledge should be acquired on traditional fire related cultures and customs as a guide for fire management practices and policies.

Evaluation systems should be developed to assess fire damage and benefits and to draw attention to the true costs and benefits of fires.

Policies and techniques that aim to increase agricultural productivity, while providing and enforcing disincentives for reckless programmes, will slow forest conversion for unsustainable agriculture and will thus reduce forest fire damage.

## **V Conclusions and recommendations to FAO and international organisations**

There are many international organisations, including FAO, other UN-agencies and NGOs, involved in forest fire-related activities at global and regional levels. Continued and improved collaboration and co-ordination are urged.

Transboundary or regional agreements for collaboration in fire management need to be developed, with the technical and financial support of international organisations.

International organisations are further urged to support the design and implementation of a global fire inventory or reporting system, in close collaboration with the fire science community and end-users. An internationally harmonised fire management terminology is required to support such global or regional fire reporting systems.

A global fire information system is needed to provide immediate access to real-time data and information on current fires, archived information, and other sources which are needed by countries to develop fire management programmes, increase preparedness and respond to outbreaks at national, regional and global levels.



FAO and other international organisations should play a catalytic role in the establishment of networks, to promote the sharing of information and knowledge and technical co-operation between developing countries. Sufficient resources should be allocated for these purposes.

Guidelines and codes of practice for fire prevention and control are also required, not only in the forest sector but in any sector that could impact on forest fires (e.g. road alignments, power lines).

Technical assistance, from FAO or other international organisations, is still required, particularly in institutional support and capacity-building.

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### **FAO Ministerial Meeting on Forestry on "Sustainability Issues in Forestry, the National and International Challenges"**

The FAO convened the Ministerial Meeting on Forestry on "Sustainability Issues in Forestry, the National and International Challenges", Rome, 8-9 March 1999. On 9 March 1999 the Forest Ministers released the "Rome Declaration on Forestry". The statements regarding forest fires are based on the resumé "Global Action to Address Forest Fires" which was a summary of the recommendations of the Expert Meeting on Public Policies Affecting Forest Fires (FAO, Rome, October 1998). The Ministerial Meeting, among other, welcomed the recommendations the Fourteenth Session of the Committee on Forestry (COFO) (Rome, 2 March 1999) and encouraged their endorsement by the FAO Council with a view to facilitating their early implementation.

### **Rome Declaration on Forestry of 9 March 1999**

We, the ministers responsible for forests or their representatives who met at FAO Headquarters in Rome, Italy on 8 and 9 March 1999 at the second Ministerial Meeting on Forestry under the sponsorship of the FAO, to consider "Sustainability Issues in Forestry, the National and International Challenges,"

- \* emphasizing the critical importance of forests to the welfare, livelihood and food security of all people and future generations and to the life support system of the entire planet, as set forth in the 1995 Rome Statement on Forestry and in the 1996 World Food Summit Plan of Action,
- \* deeply concerned with the important challenges associated with forest loss and degradation in many regions and stressing the need to maintain the integrity of forests as ecosystems by promoting sustainable forest management worldwide,
- \* noting that this Ministerial Meeting was convened by the Director-General of FAO to highlight the critical need to make national and international progress toward the sustainable management of the world's forests, and to consider international instruments to support sustainable forest management, global action to address forest fires, and the Strategic Framework for FAO 2000 – 2015,
- \* welcoming the progress made to date on sustainable forest management, including FAO's role in the assessment of forest resources, and the significant achievements at national, regional and international levels, including the development and implementation of criteria and indicators for sustainable forest management and of national forest programmes,
- \* noting that the Intergovernmental Forum on Forests (IFF), which was established under the auspices of the United Nations Commission on Sustainable Development with a time-limited mandate, is considering issues related to sustainable forest management, including international arrangements and mechanisms,
- \* also noting a range of options for international arrangements and mechanisms to support sustainable forest management, including voluntary, incentive-based approaches; private sector initiatives; regional agreements and initiatives; and global legally binding and non-legally binding instruments,

- \* further noting that a number of international arrangements and mechanisms already exist which address and have implications for the environmental, social and economic aspects of sustainable forest management, and that the need for and nature of future international arrangements and mechanisms should be considered in more depth by the UN Commission on Sustainable Development at its eighth session in the year 2000 as a matter of priority,
- \* recognize that this Ministerial Meeting provides an opportunity to exchange views on international arrangements and mechanisms and provide high level political support to the ongoing discussions at the Intergovernmental Forum on Forests,
- \* call on FAO to facilitate and give support to national, regional and international processes related to forests, especially enhancing the implementation of national forest programmes and criteria and indicators for sustainable forest management,
- \* noting that the causes of forest fires are many and complex and recognizing the need to harness efforts to prevent forest fires as well as to address the multiple causes and consequences of fires around the globe,
- \* welcome the meeting on Public Policies Affecting Forest Fires hosted by FAO in October 1998 and encourage FAO to take action to implement the recommendations directed to it,
- \* call on FAO and other international organizations, donor agencies and interested countries to work together to address the underlying causes of forest fires, to improve the coordination of their efforts to prevent and combat forest fires and to rehabilitate affected areas with a view to providing assistance requested by governments,
- \* noting the draft Strategic Framework for FAO 2000 – 2015 that will be considered by the FAO Conference in November 1999 highlights the critical need for countries to implement integrated approaches to sustainable development, including combatting desertification and drought, which recognize the importance of the sustainable management of forests and their ecosystems in achieving sustainable agriculture and food security,
- \* also noting that forests can be adversely affected by policies outside the forest sector, including agriculture and trade policies, and recognize the need for integrated land use and mutually supportive trade and environment policies in support of sustainable forest management,
- \* underscore the importance of inter-disciplinary and cross-sectoral approaches to forest management, participatory decision making in development taking into account gender balance, and increased cooperation, including through partnerships, between the public and private sectors to achieve sustainable forest management and sustainable development,
- \* encourage national, regional and international efforts to increase public awareness of the importance of forests and strengthen education, research, extension and the dissemination of knowledge and information to improve forest management,
- \* call on all interested parties to give greater priority to sustainable forest management; reaffirm the proposals for action agreed by the Intergovernmental Panel on Forests regarding international co-operation in financial assistance and technology transfer; recognize the need to build capacity for sustainable forest management in public and private sectors at local, national and international levels; and urge FAO to allocate adequate financial resources to forestry,
- \* welcome the recommendations the Fourteenth Session of the Committee on Forestry (COFO) and encouraged their endorsement by the FAO Council with a view to facilitating their early implementation.

We pledge our political will to bear on improving forest management in our respective countries and to promote effective international cooperation to achieve sustainable forest management worldwide.

We further pledge

- \* to work together towards a constructive and forward looking outcome on future arrangements for the global forest policy dialogue at the eighth session of the United Nations Commission on Sustainable Development;
- \* to better co-ordinate and strengthen our efforts to prevent, manage, monitor and suppress forest fires especially in anticipation of the next El Niño/La Niña events and, in the longer term, to address the underlying causes of forest fires;
- \* to work closely with our counterparts in other ministries in our countries to promote cross-sectoral policies and activities that support sustainable forest management.

Rome, 9 March 1999



In preparation of the expert meeting in Rome a current global state-of-the knowledge summary on "Public Policies Affecting Fire" was prepared by the FAO. Five regional reports which cover (1) Europe and temperate-boreal Asia, (2) the Mediterranean region, (3) Africa, (4) Asia-Pacific, and (5) the Americas will be published as conference proceedings. They will be ready by May 1999. The official contact address for the proceedings is:

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**International Decade for Natural Disaster Reduction (IDNDR)**



**IDNDR**  
**1990 - 2000**  
Building a Culture of Prevention

***Natural Disaster Reduction in Asia***

Organized by the IDNDR, in collaboration with the UN Economic and Social Commission for Asia and the Pacific (ESCAP) and the Asian Disaster Preparedness Center (ADPC), the IDNDR-ESCAP Regional Meeting on Natural Disaster Reduction in Asia took place between 23 and 26 February 1999, in Bangkok, Thailand. It was opened by the Deputy Foreign Minister of Thailand, Mr. Sukhumbhand Paribatra. About 200 representatives of governments and organizations from 24 Asian countries attended the Regional Meeting. The Meeting reviewed the accomplishments in the region during the Decade and formulated recommendations for future efforts to ensure continued commitment to disaster prevention throughout Asia during the next millennium. Discussions were held on the economic aspects of water hazards; the urban and environmental aspects of geological hazards; and on fire and transboundary atmospheric hazards. The Bangkok Declaration, adopted at the end of the meeting, underscored the need to integrate mitigation and prevention practices into national development and planning processes. This is expected to enhance community resilience and promote political and socio-economic stability in the event of such disasters. The Declaration also encouraged sustained efforts to harness the considerable traditional knowledge and approaches for dealing with hazards and building up community capabilities and promoting private-public partnerships. Looking beyond the Decade, the Regional Meeting emphasized the need for effective coordination mechanisms within the UN System, as well as within individual countries, to promote disaster reduction and risk management during the 21st century as an integral part of sustainable development.

**Bangkok Declaration of the IDNDR-ESCAP Regional Meeting for Asia, 26 February 1999, Bangkok, Thailand**

The IDNDR-ESCAP Regional Meeting for Asia: Risk Reduction and Society in the 21st Century was convened at the United Nations Conference Center in Bangkok, Thailand, from 23-26 February 1999, in which more than 150 representatives of national governments, United Nations and other international organizations, technical and scientific programmes, non-governmental and community-based organizations from 24 ESCAP countries participated. The Meeting reviewed the accomplishments in the region during IDNDR and formulated recommendations for future efforts to ensure continued commitment to disaster prevention throughout Asia during the next millennium.



Following the Yokohama Strategy and Plan of Action for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation adopted at the World Conference on Natural Disaster Reduction in 1994, several regional and national initiatives have been taken in Asia. The Regional Meeting noted the active involvement and growing participation in disaster reduction activities within the UN system, and by international organizations, national governments, professional and non-governmental organizations, community bodies, private commercial interests and other stakeholders in civil society. The role of the Asian Disaster Preparedness Center in capacity-building and awareness-raising in the region was notable during the Decade. The establishment of the Asian Disaster Reduction Center was also a significant development during the Decade.

Reflecting the views of the IDNDR Scientific and Technical Committee, the meeting underlined the importance of sustained commitments to disaster prevention by government authorities and others in order to consolidate and further the accomplishments of the Decade relating to national development in the 21st century.

Participants acknowledged that different hazards associated with tropical cyclones, water, geological conditions, wildfire, and severe climatic conditions will continue to threaten all Asian countries. The population pressure and ecological fragility of habitats in the region will aggravate the adverse impact of these hazards. In this context, the Meeting highlighted the need for drawing upon different national experiences, knowledge and professional abilities to prevent disasters. A multi-disciplinary, coordinated approach and greater awareness of policy-makers and communities will help realize appropriate, adequate and sustained allocations of human, technical and material resources for disaster prevention.

The Regional Meeting welcomed the emergence and increasing adoption of policies and practices at international, regional, national and local levels of responsibility for reducing the impact of natural disasters, rather than merely responding to them. Adoption of structured approaches to risk assessment, integration of mitigation and prevention practices into national development and planning processes, including greater commitment to land-use planning measures, and improved early warning systems will not only substantially reduce human suffering and property losses but will enhance community resilience and promote political and socio-economic stability.

The Meeting emphasized the necessity of developing new and effective ways to engage more people dedicated to disaster prevention activities in the course of their on-going work and consistent with their livelihoods throughout Asia. Sustained efforts would have to be taken for harnessing the considerable traditional knowledge and approaches for dealing with hazards and building up community capabilities and promoting private-public partnerships. Regional arrangements should be rendered more effective by ensuring exchanges of information and experience throughout the region. The Meeting recognized the assistance that has already been forthcoming from financial institutions and donors and called upon their continued support to promote the culture of prevention by supporting national disaster reduction plans on a pro-active basis to advance disaster prevention as a public value.

The Regional Meeting welcomed the convening of the IDNDR International Programme Forum and ECOSOC session, in July 1999, in bringing the Decade to a successful conclusion and in evolving recommendations for sustained disaster prevention in the future. The Meeting recognized the Programme Forum as a unique international opportunity for countries, institutions, and organizations to inform the world of the diversity and success of disaster prevention programmes in the region.

Looking beyond the Decade, the Meeting emphasized the need for effective coordination mechanisms within the United Nations system, including at the regional and sub-regional levels, as well as within individual countries, to promote disaster reduction and risk management during the 21st century as integral parts of sustainable development, including responses to global change. These should function in directing efforts to prevent and mitigate disasters due to natural, technological and environmental hazards. In particular, the Meeting urged the Secretary General of the United Nations to set up an appropriate mechanism for bringing about concerted global action. The Meeting also emphasized the importance of continuation of the functioning of the existing regional institutions and frameworks beyond the Decade.

The participants of the IDNDR-ESCAP Regional Meeting for Asia express their recognition of disaster prevention as an integral component of sustainable development in Asia. By this declaration, the Meeting calls

for a holistic and integrated effort by all member countries to promote disaster prevention as a public value; to improve integrated risk management through the involvement of an increasing range of professional, technical and scientific disciplines; to strengthen and further regional and sub-regional professional and institutional frameworks; to realize meaningful participation of local communities in reducing the vulnerability of people, the environment, social and economic resources; and to enhance disaster management capabilities.

### United Nations Environment Programme (UNEP)



The United Nations Environment Programme (UNEP) Global Resource Information Database (GRID) in February 1999 has published "Wildfires and the Environment: A Global Synthesis". This document can be found on the UNEP-GRID website:

<http://grid2.cr.usgs.gov/pubs/wildfire.pdf>

The website version is rather large (2.9 MB) and Adobe Acrobat reader is required. Printed versions of this comprehensive report can be obtained by:

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### United Nations Educational, Scientific, and Cultural Organization (UNESCO)



*First International Scientific Conference on  
"Fires in Mediterranean Forests: Prevention, Suppression - Soil Erosion - Reforestation"  
Athens, Greece, 3-6 February 1999*

The conference was organized by the Hellenic National Commission for UNESCO, on behalf of the Hellenic Government and under the auspices of the General Director of UNESCO, in Paris, and of the United Nations Development Programme (UNDP).

The aims of the conference were to

- \* give the opportunity to various research groups of the Mediterranean countries and to countries of other regions, to meet and exchange points of view concerning their research and scientific achievements;
- \* foster reinforcement of co-operation and to examine the probable existing similarities or differences, so as to avoid double research efforts;
- \* examine sectors that present a need for further research; and
- \* strengthen better co-ordination between research and application.

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The major topics of the conference were

- \* The global problem of forest fires
- \* Prevention and protection against forest fires
- \* Forest fires and soil erosion
- \* Post-fire handling of burnt areas in the Mediterranean region

The conference took place at the Hellenic Ministry of Foreign Affairs, Athens. For further information and details on conference proceedings please contact:

Secretariat of the Hellenic Commission for UNESCO  
3 Acadimias Ave.  
GR-Athens 10027

Fax: + +30-1-3630603  
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### Conference Conclusions

The protection of natural forest ecosystems reflects the cultural level of a people and of a country and it should, therefore, be a first priority issue for the Mediterranean countries.

Forest fires and Mediterranean forest ecosystems have co-existed for millennia and they will continue to do so. There is, however, a continuous change in the balance between them and with a tendency for an increase in forest fires and a reduction in forests. This is mainly the result of human activities. Mediterranean forests are restored nearly completely after a fire if they are protected from human activities. Consequently, forest protection is not accomplished just by putting out the fire.

During recent decades, there has been a dramatic increase in both the number of fires and the area burnt. This is one of the main reasons for the initiative of UNESCO to organize this Conference.

The conclusions of the Conference are the following:

- \* In the last decades the objective of forest resource management, especially in Mediterranean countries, has shifted from production of material products to production of non-material goods and services from the forest, with an emphasis on environmental protection and ecological balance.
- \* The scientific reports presented at this conference have underlined the importance of fire prevention. They have made obvious also, that the individuals who are in charge of decision-making do not fully appreciate the ecological role of fire in the Mediterranean forest. Consequently, any relevant decisions emphasize only the suppression of fires and the acquisition of the means to achieve it. As a result, funds are allocated accordingly.
- \* The presentations made evident the need for a shift towards an integrated management of the presence of fire in Mediterranean forest ecosystems, instead of continually concentrating on the partial concepts of forest fire prevention and suppression. This objective requires cooperation of many scientific disciplines and utilization of research findings. The use of prescribed burning, especially in range- land management, can be an important tool in this direction.
- \* The forest fire phenomenon is managed differently from one Mediterranean country to another. In most countries the responsibility for prevention and suppression belongs to the Forest or Environmental Services, but in a few countries or regions of countries fire suppression responsibility belongs to the Fire Brigade. (Source: Report of the European Union forest fire experts, Brussels, July 16-17, 1997). The effectiveness of the governmental choices involved was discussed during the Conference. It became evident that fire management schemes controlled and coordinated by one integrated organization are relatively more efficient. However, it is necessary to distinguish and identify the responsibilities and functions of all organizations and Services involved, aiming to achieve the best possible cooperation and to avoid contradictions and "turf battles", thus securing effective coordination, as well.

- \* Education about fire risk-danger and self-protection of structures and human activities within forest lands in the Mediterranean region, especially in the urban-wildland interface, must be a basic element of every fire protection policy.
- \* At the Conference many informatics systems for support of forest fire management were presented, based on modern technology (GIS, remote sensing, Decision support systems, fire danger prediction systems and technology, etc.); many of them were the outcome of research in Mediterranean countries of the European Union. It was concluded that some of these systems have reached operational status while others are still at research level. It is then necessary to support their application and to evaluate and study their feasibility in relation to the improvement of function and increase in effectiveness of the organizations that their employment may have. Cooperation between countries and scientists that use such technology already at operational level with countries that have not reached this stage may prove very useful and should be supported by the responsible organizations.
- \* From the papers presented at the Conference the importance of post-fire soil erosion, especially due to high intensity fires, became evident. Forest fire management must seriously consider the need for taking measures (e.g. fuel reduction, prescribed burning) aimed at reducing fire intensity and, consequently, the negative effects of wildfires. Similarly, after the fire the potential for disaster should be evaluated and appropriate measures for rehabilitation and protection of the area must be taken (timber salvage, erosion prevention measures, natural regeneration protection, etc.).
- \* Regarding post-fire management practices in Mediterranean forest ecosystems the experts stressed that these ecosystems are well adapted to fire. After a fire intervention should be limited and carefully planned. Enforcement of measures preventing changes in land use of burned forest areas is the most important requirement for their protection.
- \* An effective communication policy, highlighting the problem and educating citizens about the danger of causing forest fires, as well as on forest ecology issues, must be an integral part of forest protection policies.
- \* The support of International Organizations towards Mediterranean countries should be aimed at reinforcing cooperation in the Mediterranean region, in managing the problem of forest fires through organized Conferences or meetings of scientists, managers and politicians must continue. Also a system should be established in order to utilize better the conclusions and suggestions of these Conferences, so that they will be seriously taken into consideration and will be incorporated in future political decisions on the forest fire problem in Mediterranean countries.

**The participants of the Conference also agreed on and accepted the following special declarations:**

- \* The Conference expresses its sympathy for the extensive destruction of the Greek forests, due to the large wildfires during the summer of 1998. The losses of human lives, and the environmental and socioeconomic disaster have deeply concerned the international community and, especially, Mediterranean countries. As a result, the responsible authorities of Mediterranean countries are called to take, as soon as possible, all the appropriate political and organizational measures that will ensure the utilization of all the existing long-term experience in forest fire control of all the organizations and Services involved, in order to avoid similar biblical disasters of the Mediterranean forest wealth in the future.
- \* The Global Fire Monitoring Center (GFMC) was established in 1998 and is currently co-sponsored, among others, by UNESCO, the IDNDR and several international fire research programmes, and cooperates with UN-ECE/FAO and FAO Silva Mediterranea. The overall goal of the GFMC is to facilitate information exchange and decision support at an international level by providing near real-time fire monitoring, archive data and other relevant information. Mediterranean countries are urged to actively contribute to continuously improve the information and data flow to the GFMC in order to create a most complete fire information system, to share expertise and to contribute to common international action programmes in fire management and policy development.

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## WORLD BANK

**World Bank Workshop**  
**"Fire Hazards, Transboundary Haze and Sustainable Forestry in East Asia and the Pacific"**  
**Surabaya, Indonesia, 9-12 December 1998**

The workshop was organized by the Environment and Natural Resources Division of the Economic Development Institute of the World Bank (EDIEN) in collaboration with IC-SEA, CIFOR, ICRAF, WWF, IUCN and the ADB, and co-financed by AUSAID and the Government of the Netherlands. The main objectives of this workshop were:

- \* an analysis of the basic, structural sources of the problem of land use, forest burning and land degradation;
- \* a better understanding of the long-term impacts of fires on resource degradation including forests, biodiversity and water;
- \* the provision of information to assist key decision-makers and opinion leaders to better recognize and respond to the need for national policy and institutional reforms to address long-term forest sector problems;
- \* to go beyond Indonesia to the regional dimensions of the problem with a view to fostering regional cooperation on environmental security;
- \* to develop a network of policy makers and researchers--a community of practice--to enable the sharing of international experiences on policy and technological options for forest fire management and to foster collaborative research on these issues; and
- \* to identify the scope for regional follow up based on the workshop discussions.

As was envisaged at the time of designing the agenda, the deliberations of the workshop went beyond the issue of forest fires into the various aspects of sustainable forestry in Indonesia and in the East Asia region. Top-notch resource persons coupled with knowledgeable and enthusiastic participants ensured very high level discussions that translated into concrete policy recommendations. The recommendations of the discussion groups were the following:

#### **Social Issues**

The group examining the social issues related to sustainable forestry identified several constraints to successful forest management. An indicative list is — (a) lack of clarity of tenure; (b) lack of integrated land use planning; (c) inequitable distribution of costs and benefits and lack of proper incentives; (d) lack of community participation in critical decision-making; (e) failure to use traditional knowledge; (f) lack of an enabling legal framework; (g) corruption and lack of transparency; and (h) lack of political will.

The key recommendations of the group are as follows:

- \* collection organization and dissemination of reliable data;
- \* integration of data into a comprehensive land-use strategy;
- \* develop mediation and negotiation skills to involve different stakeholders in forest management;
- \* use mass media to promote awareness and public consultations;
- \* capacity building at the local community level and greater role for the community; and
- \* designation of a lead agency for forest management and clarification of the roles and responsibilities of other agencies.

#### **Technical and Ecological Issues**

The group examining the technical and ecological issues related to sustainable forestry identified the following four constraints to sustainable forest management: (i) inadequate / inappropriate land use planning, (ii) inadequate forest resource management plans and their enforcement, (iii) inadequacy or lack of information exchange, awareness and education, and (iv) inadequate environmental monitoring. The key recommendations of the group are as follows:

- \* development of land use plans based on land capability determined through scientific assessments in consultation with stakeholders;
- \* development and implementation of management plans for all categories of forests, internal and external monitoring of forest management based on standard and acceptable sustainability criteria;
- \* development of fire risk assessments and early warning systems;
- \* enabling policies and legislation to ensure institutionalized free flow of information and data within various agencies in the sector, between related sector within the country, among countries of the region and international institutions;
- \* development and institutionalized implementation of comprehensive education and awareness programs pertaining to fire and haze, transboundary atmospheric pollution, soil erosion, water pollution, etc.;
- \* removing institutional inadequacies in the issuance of business activity permits without due considerations of environmental impact assessment;
- \* remove conflicting policies and implement enabling legislation;
- \* reform forestry bureaucracy and define clear responsibilities;
- \* promote transparency and public consultation;
- \* promote donor coordination, collaboration and cooperation; and
- \* foster the political will and the commitment to make hard choices.

### Economic Issues

The group examining the economic issues related to sustainable forestry identified the following three main constraints to sustainable forest management: (a) policy distortions in the forestry sector; (b) policy distortions outside the sector but exerting a strong influence in forestry; and (c) lack of regional coordination among forest-rich countries. The main recommendations proposed by the group were:

- \* formulation of clearly articulated national land use policies specifically demarcating the areas of production, conservation and conversion forests;
- \* formulation of a national forest management strategy/plan incorporating technical and policy aspects related to forest harvesting, timber pricing, forest charges, timber trade, ecolabeling, and certification;
- \* environmental impact assessment must be mandatory and comprehensive for all projects;
- \* identification of the national and regional policy gaps by sharing information and experiences across countries in the region; and
- \* ensure that the impacts of policies outside the forestry sector (exchange rate, industrialization, agriculture expansion, etc.) do not have undesirable repercussions in forestry.

The detailed report is available on the World Bank file on the Global fire Monitoring Center (GFMC) website (<http://www.uni-freiburg.de/fireglobe>). For further details please contact either:

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## NEWS FROM FIRE RESEARCH

*Prometheus s.v. Fire Experiment in Switzerland (S. Antonino, 28 March 1998)*

### Background

In the frame of the EU-project Prometheus s.v. the branch station South of the Alps of the Swiss Federal Institute for Forest, Snow and Landscape Research organised a small fire experiment in a sweet chestnut stand in Southern Switzerland (S. Antonino, Canton Ticino). Due to the fire regime conditions in this part of Switzerland (winter forest fire season in the deciduous forest belt, surface fires) the fire experiment took place on 28 March 1998.

Altogether 16 research groups participated in this fire experiment. These groups were mainly from the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) and his branch station (FNP SdA), the Swiss Federal Institute of Technology in Zurich (ETHZ), the Swiss Federal Laboratories for Materials Testing and Research in Dübendorf (EMPA), the Departments of Geography of the Universities of Basle and Bern and the Fire Ecology Research Group of the Max Planck Institute for Chemistry at the University of Freiburg (Germany).

The different groups of the WSL studied fire propagation and temperature development during the fire, post-fire runoff and soil erosion, effects of the fire to fauna, vegetation and chestnut blight, fine root and mycorrhiza regeneration after the fire and the influence of the fire to soil chemical properties and the soil water. The Institute for Geophysics of the ETHZ took soil samples for rock-magnetic investigations. The EMPA measured the fire temperatures with a mobile IR-camera. The Department of Geography of Bern did splash erosion measurement as well as infiltration and soil aggregate stability measurements and the Department of Geography of the University of Basle did soil respiration and soil microbial biomass measurements. Last but not least the Max Planck Institute for Chemistry (Germany) took emission samples. The arrangements of all test plots and the location of the point measurements can be seen in the general map (Fig.1).

Other groups, who participated in the fire experiment were from the Swiss Army and the local fire brigades. The Army took IR-pictures with a video camera from a helicopter and was responsible for setting the fire in a line and the local fire brigades were responsible for making a fire break and to control the fire.

### Design of the Fire Experiment

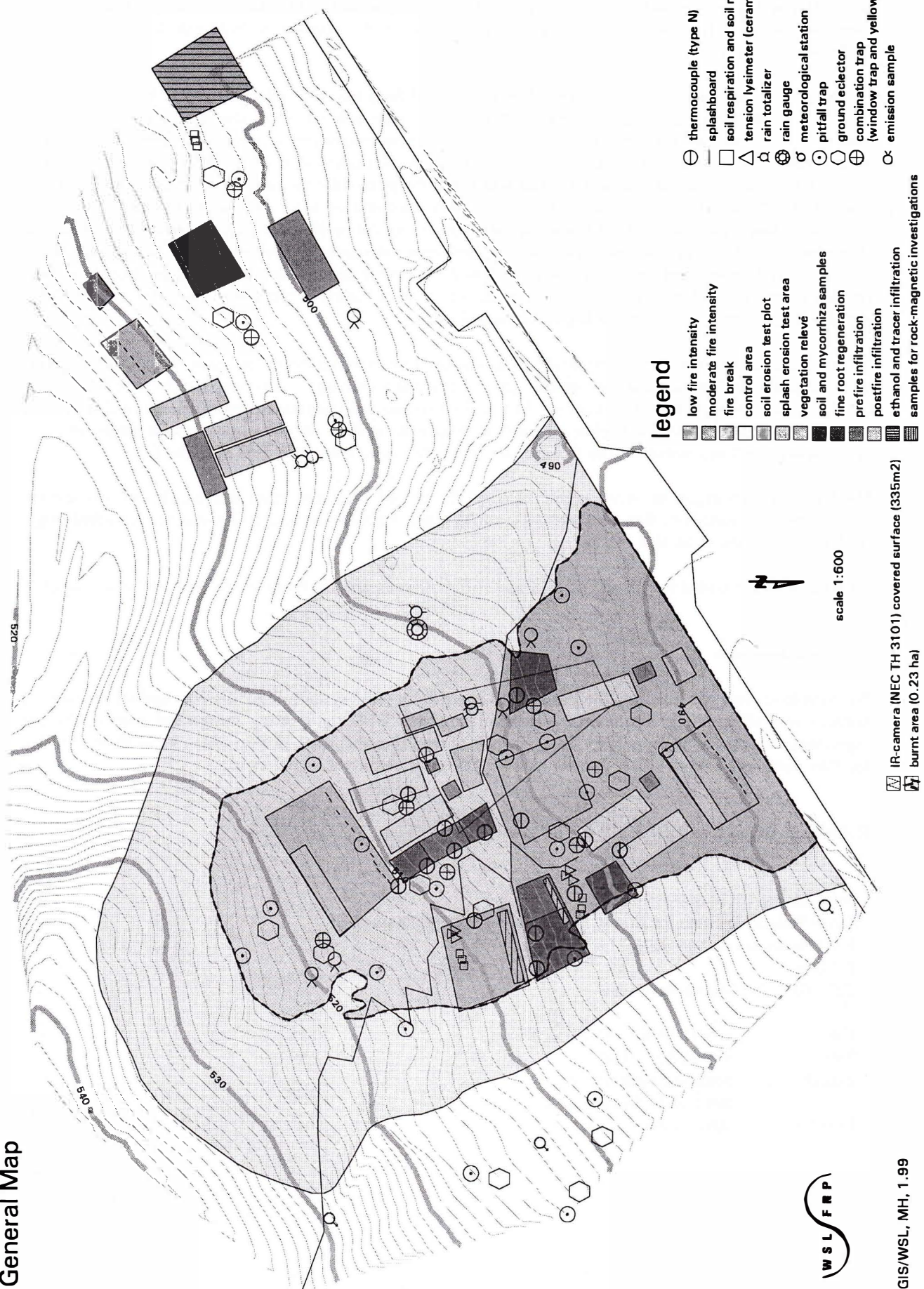
The fire experiment was carried out on a north facing slope with a medium inclination of 30 degrees. The size of the experimental site (inclusive control area) was about 1 ha. The total burnt size was 0.23 ha. One main intentions of the fire experiment was to simulate two different fire intensities and to study ecological effects of a forest fire in relation to fire intensity. Therefore the upper part of the fire experiment test area was left untreated (fuel load was about 1 kg dry material / m<sup>2</sup>). and in the lower part we put about one more kilo of chestnut litter per square meter.

Already more than half a year before the fire experiment the first research groups started with taking samples and monitoring the fire experiment test site. Tension lysimeters (ceramic cups) were placed at three different soil levels (20-25 cm; 50-55 cm; 75-80 cm) on the upper and lower part of the fire experiment test site. Every two weeks samples of the soil water were taken and analyzed in the laboratory. In every water sample pH, water conductivity and the amount of total organic compounds (TOC) as well as anion and cation concentration were measured. At the same time the first vegetation studies on the fire experiment test site, based on *relevés*, were conducted as plant sociological surveys over 100 m<sup>2</sup> plots using the combined scale after Braun-Blanquet (1964) for estimating frequency. Also pitfall traps, ground eclectors and combination traps (window trap and yellow pan) were installed for collecting insects, spiders and millipedes. The first soil respiration and infiltration measurements were carried out some days before the fire experiment and soil samples for chemical and physical analyses as well as for rock-magnetic investigations and mycorrhiza fungi studies were taken the days before the fire experiment. The day before the fire experiment soil samples with a cylindrical sampler of 1 dm<sup>3</sup> (0-10 cm) were taken to determine the pre-fire soil moisture content. Finally just before setting the fire, fuel samples (0.5 m x 0.5 m) were taken to determine fuel load and fuel moisture content.



**Fig.1 and 2.** Start of the fire experiment at the lower portion of the slope with relatively high fire intensity (upper) and calming down of fire intensity in the upper portion of the burning plot (lower). Photos: J.G.Goldammer







Three weather stations were installed some days before the fire to monitor the weather conditions during the fire experiment. Every minute a medium value of the air temperature, air humidity, wind direction and wind speed was stored with Skye-Instruments data loggers. Then, in the morning of 28 March, the fire was set at 09:30 by specialists of the Swiss Army.

For monitoring the fire spread 31 N-type thermocouples (fifteen thermocouples in the fuel bed at + 10 cm, eight in a depth of -2.5 cm and eight in a depth of -5 cm) were connected to a Campbell CR10X datalogger with an AM416 multiplexer and distributed to the fire experiment area (see general map). Every two seconds a temperature measurement was made. In addition a mobile IR camera (NEC TH 3101) with a resolution of 256 x 207 pixels was mounted on a tree about 8 m above the ground for monitoring a surface of about 335 m<sup>2</sup> and a FLIR 2000 system (Forward Looking Infra Red), mounted on a Alouette III helicopter of the Swiss army, was flying diagonal over the fire experiment and taking online IR-video pictures of the fire spread for about one hour. Last but not least there was a ground crew who noted the passage of the fire and the flame length at certain points and another group as well as the TV were taking video and photo pictures throughout the fire experiment. Also during the fire the group of the Max Planck Institute for Chemistry took emission samples in the control area and the fire experimental test site.

Shortly after the fire experiment the first groups started their investigations. The traps for collecting insects were reinstalled and at the same time another group was already looking for surviving insects. Soil samples for the different investigations were taken, the first infiltration and soil respiration measurements carried out and the runoff and soil erosion test plots, the splash boards as well as an automatically rain gauge and five precipitation totalizers installed. The first soil water samples were taken two days after the fire.

Most post-fire investigations were carried on until the end of 1998 and some like runoff and soil erosion measurements, vegetation, fine root and mycorrhiza fungi regeneration and soil water and chestnut blight studies will be carried on also in 1999.

First results are expected for the end of 1999 and will be discussed in the frame of the Prometheus s.v. project.

### Acknowledgements

We wish to express our thanks to the Prometheus coordinator (Algosystems S.A.; Greece) and all Prometheus partners as well as the group landscape inventories of the WSL for creating the general map of the fire experiment. The financial support for the Swiss part of the Prometheus s.v. project of the Swiss Federal Office for Education and Science (BBW-Project No. 97.0058) is gratefully acknowledged.

**Reference:** Braun-Blanquet, J. 1964: Pflanzensoziologie. Wien, Springer. 865 p.

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### *Workshop on Fire Disturbance in Dynamic Global Vegetation Models*

Under the frame of the International Geosphere-Biosphere Programme (IGBP) the "Core Projects" Global Change and Terrestrial Ecosystems (GCTE) Focus 2, the Biospheric Aspects of the Hydrological Cycle (BAHC) International Project Office in collaboration with the IGBP International Global Atmospheric Chemistry Projects (IGAC), Biomass Burning Experiment (BIBEX), held a workshop to develop a strategy to integrate ecosystem disturbance into dynamic global vegetation models. The workshop main thrust was on fire as disturbance, but included discussion of other disturbances, such as insect and disease outbreak, land use, and extreme weather events. The workshop, hosted by the Potsdam Institute of Climate Impact Research in Potsdam Germany was held 22-24 June 1998.

Disturbance plays a major role in shaping and maintaining many of the Earth's terrestrial ecosystems. In fact, many ecosystems depend on fire for their very existence. As example, the prairie's of North America would be wooded Savannah if it were not for grazing and fire. Global Change is expected to result in changed distribution of current ecosystems, changed composition of those ecosystems, and in creation of new ecosystems. The International Geosphere Biosphere Programme, through the Core Projects Biospheric Aspects of the Hydrological Cycle, International Global Atmospheric Chemistry, and Global Change and Terrestrial Ecosystems recognized that disturbance needed to be included in the modelling efforts of each project. Three main themes were recognize: impact of disturbance on carbon pools, vegetation change, and feedbacks to the atmosphere. This strategy was based on the fact that biomass burning influences atmospheric chemistry, that feedbacks of energy, water and trace gases to the atmosphere are influenced by vegetation, and that changes in the composition of ecosystems have direct impact on the carbon pool, on biodiversity, and health and productivity of the land. Disturbance includes fire, insect, disease, drought and flooding, land conversion, land use, air pollution, and introduction of exotic species. While it will be necessary to ultimately include all disturbances, the Potsdam workshop limited itself to fire. This strategy is based on the fact that there are no process driven models for all disturbances, and that fire has a number of reliable models with which to begin the process of introducing disturbance into dynamic global vegetation models. While this workshop limited itself to fire, a great deal of consideration was given to the fact that the model shell must be able to include other disturbances in the future. As a result, the strategy was to focus on a hazard function which would lead to effects of disturbance. The hazard function is basically a probability statement of risk of effects. This approach is equally valid for all forms of disturbance.

### **Workshop Recommendations and Challenges**

The inclusion of disturbance models within DGVMs creates a number of unique challenges for model development, calibration, and verification. These challenges include:

- \* Optimum model formulation for disturbances cannot be currently specified. Therefore, alternative model approaches must be systematically implemented, tested and compared. Criteria for comparison of disturbance modules should be based on the adequacy of their representation of the disturbance regime and subsequent effects of disturbances on vegetation.
- \* Model comparison is dependent upon the adequacy of data describing vegetation structure, land-use, and reconstruction of historical climate and fire history. Some of these data may never be available at a global scale. Therefore, construction of such data for different regions (e.g., boreal, tropical, savanna, etc.) should be developed as case studies for model comparison.
- \* Plant functional types (PFTs) used in DGVMs are not yet specifically designed to account for responses to disturbance. Detailed consideration must be given to the possible need to expand the definition of PFTs to include disturbance effects.
- \* Inclusion of fine-grained details of vegetation response to disturbances within coarse-grained DGVMs is difficult from both a practical and theoretical standpoint. Theory suggests that predictions across temporal and spatial scales is possible for single attributes (i.e., either mean, variance, or extreme disturbance events), but prediction in shifts of disturbance regimes are difficult to characterize by simple models alone.
- \* A general disturbance framework for inclusions within DGVMs should account for multiple disturbance agents. The present challenge is to consider both fire and insect disturbance (and the interaction between fire and insect effects) within different vegetation types.

- \* Because fire and insect effects are contagion processes, the simulation of coarse-grained dynamics of disturbance effects may benefit from fine-grained descriptions of the spatial heterogeneity of vegetation and land-use.
- \* The spatial scales associated with both data and models for development and testing of prediction of global change are arbitrary. Systematic investigation of aggregation errors and resulting prediction bias associated with inconsistencies in scales between models and data is a needed to insure the adequacy of current descriptions and future predictions.
- \* Plant ecophysiological responses to multiple disturbances are poorly understood, making the interaction between fire, insects and plant physiology difficult to simulate. Response functions that describe changes in DGVM ecophysiological parameters as a consequence of disturbance are needed to accurately simulate vegetation dynamics.
- \* Identification of disturbances which may act at global scales to affect patterns of growth and productivity of vegetation remains a significant challenge for DGVM models.

Specific research tasks need to be designed to address the above issues in order to insure that model projections adequately and reliably reflect changes in vegetation dynamics as a consequence of global climate change, land-use change and disturbance.

A detailed paper resulting from the workshop is entitled "Strategy for a fire module in global dynamic vegetation models" and will be published in one of the forthcoming issues of the International Journal of Wildland Fire.

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## RECENT PUBLICATIONS

### **Fire Management and Landscape Ecology - Proceedings of the 1997 Banyuls Conference**

This conference proceedings is a collection of papers by noted European scientists on the topics of:

- \* Fire effects on soil processes
- \* Plant community responses and dynamics
- \* Fire adaptive and survival traits of plants
- \* Fire responses of animal communities
- \* Burned areas and fire modelling

*Trabaud, L. (ed.) 1998. Fire Management and Landscape Ecology - Proceedings of the 1997 Banyuls Conference. Int. Association of Wildland Fire.*

This extraordinarily comprehensive volume is published by the International Association of Wildland Fire (IAWF). For order information please contact:

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## OTHER MEETING REPORTS

### 3<sup>rd</sup> International Conference on Forest Fire Research & 14<sup>th</sup> Conference on Fire and Forest Meteorology

During the 16 to 20 November 1998 the 3<sup>rd</sup>. International Conference on Forest Fire Research and the 14<sup>th</sup> Conference on Fire and Forest Meteorology took place in Luso, Portugal. The first of these Conferences has been sponsored by the University of Coimbra since 1990 every four years in Portugal. The Conference on Fire and Forest Meteorology is held every two years, usually in the USA or Canada. The last time it was held in 1996 in Lorne, Australia. Convening the 14<sup>th</sup> Conference on Fire and Forest Meteorology in Luso, was a first for Europe.

The Conferences had an attendance of 310 scientists and delegates from research and management institutions of 30 different countries from five continents. During the three and half days dedicated to formal sessions, around two hundred and fifty papers were presented in oral or poster form, including nine invited lectures on topics of general interest. As during the previous conferences the presentations were organised in the following five main sections and their respective subjects:

#### Section A - General and Institutional Aspects

- \* Institutional organisation of fire management agencies;
- \* Cooperation between research and operational institutions;
- \* Medical aspects

#### Section B - Fire Behaviour

- \* Physics
- \* Experiments
- \* Software

#### Section C - Fire Meteorology

- \* Fire danger
- \* Wind modelling
- \* Satellites

#### Section D - Fire Effects

- \* Air, water and soil
- \* Animals
- \* Plants
- \* Landscape

#### Section E - Fire Management

- \* Detection
- \* Fuel management
- \* Fire management systems

All papers presented during the Conferences are published on 2600 pages of a two proceedings volumes that were made available to the participants at the beginning of the meeting. The invited lectures were given in plenary sessions. The thematic papers were presented in three parallel sessions. Two half-day sessions were organised for the presentation and discussion of posters.

The opening lecture was presented by Michael Fosberg, Climate Impact Research Institute (Potsdam, Germany). It dealt with Global Change and Fire Risk. Two of the invited lectures were given by representatives of the World Meteorological Organisation, Yeves Ruiz, and of the World Health Organisation, Dietrich Schwela. Yeves Ruiz referred to the effort of WMO in establishing general directives to support the Meteo Services of the countries affected by forest fires and in providing the specific services required by the other services. D.Schwela spoke about the impacts of forest fires on human health, dealing in particular with potential diseases of the respiratory system. Based on the experience of the 1997 Indonesia fires, he mentioned

the great concern shared by the WHO on the consequences of forest fires to the populations living in the vicinity of large forest fires and to all those involved in fire suppression activities, because of their intense exposure to smoke and particles emitted by the fire.

Terry Clarke, National Center for Atmospheric Research (U.S.A.), gave an invited lecture on Coupled Atmosphere-Fire Dynamics. José M. Moreno, Universidade Complutense de Madrid, spoke about Scale Effects and Fire Ecology. Ricardo Velez, Nature Conservation Institute of Spain, presented the details of institutional cooperation between research and operational programmes in his country. Martin Alexander, Canadian Forest Service, introduced the International Crown Fire Modelling experiment. Michael Flannigan, also from the Canadian Forest Service, gave a lecture on the Past, Present and Future of Fire Weather Research. The closing invited lecture was given by Malcolm Gill, CSIRO (Australia), and it dealt with an Hierarchy of Fire Effects and their Effects on Landscapes.

This Conference was organised by a Commission presided over by the author and including around twenty scientists and representatives of operational institutions from various countries. The honorary commission included several Portuguese authorities and representatives of international institutions involved in the problem of forest fires worldwide.

On 19 and 20 November 1998 a study tour to the National Park of Montesinho, in the Northeast of Portugal took place. With the cooperation of the Directorate of the Park and of the National Institute for Nature Conservation, various projects related to fuel reduction and fire prevention were presented to the participants. A visit to some areas that burned during last summer was also included in the programme.

Benefitting from the presence in Portugal of some of the most renowned specialists in fire behaviour prediction, the third edition of the Short Course on Fire Behaviour Modelling was organised. This course took place on 21 and 22 November 1998 and was directed by Wendy Catchpole (University of New South Wales, Australia). Three other scientists participated in teaching various subjects to an audience of around sixty researchers: Patricia Andrews (USDA, Forest Service, Missoula), Martin Alexander (Canadian Forestry Service) and Michel Larini (University of Marseille, France), presented the state of the art of research in this field. Both theoretical and empirical approaches were described in detail by the lecturers during their presentations. The field experiments of crown fires, described by M. Alexander, were particularly impressive for the insight that they provided on the behaviour of this relatively unknown fire propagation regime. The shrubland fire research in Australia described by W. Catchpole is setting the standards for similar activities in other parts of the world. P. Andrews presented the latest developments of the Behave fire propagation system, now included in Firesite. M. Larini presented the results of the physical simulation of a two-dimensional fire propagating in a uniform fuelbed, requiring very few empirical parameters.

During this course the participants had the opportunity to visit the Laboratory of Studies on Forest Fires that is situated in Lousã. This Laboratory is administered by the University of Coimbra with the objective of supporting experimental research on physical aspects of forest fires. It contains a large combustion tunnel and a large combustion table that can be inclined at arbitrary angles. Both structures are currently used in the study of wind and slope effects on fire spread.

Also related to the Conference activities, a meeting of around 35 specialists on remote sensing applications to forest fires was held on 21 November 1998. This meeting of the European Association of Remote Sensing Laboratories (EARSeL) was promoted and coordinated by Emilio Chuvieco from the University of Alcalá de Henares, Spain.

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## MEETINGS PLANNED FOR 1999-2000

## POLAND

*IUFRO Conference on Remote Sensing and Forest Monitoring*  
*1-3 June, Rogów, Poland*

The IUFRO Conference on Remote Sensing and Forest Monitoring will be held at the Center of Ecological Education of the Warsaw Agricultural University, Rogów, Poland, 1-3 June 1999.

**Conference Objectives:**

- \* Review the state-of-the-art of remote sensing as a tool of forest monitoring and inventory and forest fire management
- \* Review the research and application problems of the use of remote sensing in forestry and forest fire management (from countrywide to global scale)
- \* Review the present and future remote sensing systems in relation to forestry oriented applications
- \* Discuss the recommendations concerning future activity of IUFRO remote sensing society in relation to IUFRO-2000 Congress.

**Contact address for the conference organization:**

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**Contact address for the Chair, IUFRO Subject Group 8.05.00 Forest Fire Research, and session moderator "Remote Sensing and Forest Fires":**

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**RUSSIAN FEDERATION**

***Third International Scientific Conference  
"Fires in the Forest and at the Enterprises of the Forest and Chemical Complex:  
Initiation, Suppression and Ecological Consequences"  
Krasnoyarsk, Russian Federation, 5-10 July 1999***

**Objectives of the Conference**

Discussion of the results of scientific investigations of forest fire problems and fires at the enterprises of forest and chemical complex and economical enterprises in the 20th century and new methods of prophylaxis and fighting them.

**Organizers**

- \* Federal Forest Service of the Russian Federation
- \* Tomsk State University
- \* Siberian Branch of the All-Russian Institute of Fire Prevention and Suppression, Ministry of Inner Affairs (Krasnoyarsk)
- \* Siberian Branch of the Council of Combustion, Russian Academy of Sciences (Novosibirsk)
- \* Fire Prevention Service of the Russian Federation, Krasnoyarsk State
- \* Krasnoyarsk Regional Forest Management
- \* Eastern-Siberian Institute of the Ministry of Inner Affairs of Russian Federation (Irkutsk)
- \* Institute of Atmosphere Optics of the Russian Academy of Sciences (Tomsk)
- \* Ministry of the Inner Affairs of Republic of Tyva of the Russian Federation
- \* Tomsk Society of Mechanical Scientists
- \* V.N. Sukachev Institute of Forest, Siberian Branch, Russian Academy of Sciences (Krasnoyarsk)

**Scientific Programme**

General physico-mathematical model of forest and steppe fires; physical experiments; data bases; mathematical models; mathematical and physical modelling of forest fires and fires at the enterprises of the forest and chemical complex; forest fire prophylaxis; fire safety; fire protection of timber stores and other units in the forest and forest chemical industries and economic enterprises; prediction of forest and steppe fire danger on the base of general mathematical models and aerospace monitoring; ignition of forest fuels and spread of surface, crown and mass forest fires; limiting conditions of forest fire spread and new methods of fighting them; strategy and tactics and technical means of fighting forest fires; ecological consequences of forest fires and their effects on carbon cycle; legal aspects of fighting forest fires.

It is planned to conduct a fire experiment in Lesosibirsk and to visit the experimental base of the Siberian Branch of the All-Russian Research Institute of Fire Prevention. Contact Address:

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**Workshop "Fire on Ice"****Khabarovsk, 14-15 August 1999**

***Jointly with the International Conference "The World's Natural Forests and Their Role in Global Processes"***  
***Khabarovsk, Russian Federation, 15-20 August 1999***

**Workshop Objectives**

The workshop intends to review the state of knowledge in the dynamic interactions between climate variability, fire regimes, and permafrost in boreal circumpolar ecosystems. Special attention will be given to the changing active layer and the release of radiatively active gases. The formulation of future joint research projects will be discussed which will address the consequences of climate change on fire regimes and permafrost thawing and its consequences on ecosystems, biogeochemical cycles and atmospheric chemistry. The workshop is a joint activity of the IGBP Northern Eurasia Study (IGBP-NES), the Biomass Burning Experiment (BIBEX of the IGBP Core Project International Global Atmospheric Chemistry (IGAC), the Fire Research Campaign Asia North (FIRESCAN), the International Boreal Forest Research Association (IBFRA) Fire Working Group, and the Global Fire Monitoring Center (Max Planck Institute for Chemistry, Biogeochemistry Department). Workshop participants will be fire and permafrost scientists actively involved in northern circumpolar research.

It is envisaged to produce an IGBP document with papers and research agenda. Registration and contact for FIRE ON ICE (for registration for overall conference logistics: see address at bottom)

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**Registration for the conference (logistics):**

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