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FAO Meeting on Public Policies Affecting Forest Fires

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FAO Meeting on Public Policies Affecting Forest Fires

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FOREWORD

Every year, large areas of savannah-type, mixed forest/grassland formations are affected by fires, particularly in the dry zones of Africa and South America. Forests in the humid tropics, although less prone to fire, are also affected by large fires, the most serious in recent times being in Indonesia in 1983 which burned 3.6 million ha in East Kalimantan, and the 1997-1998 fires. Coniferous forests in the humid tropics are often affected by fires: in the 1980s the area of pine forest in Honduras and Nicaragua burned annually amounted to some 3.5 percent of the total pine forest area of both countries, and large fires have burned natural and man-made tropical pine forests in Mexico and Indonesia (Northern Sumatra).

Fire is also a permanent threat to forests in the subtemperate and temperate zones of North Africa and South America while from 1950 to 1990 fires in China are reported to have affected annually an average of 890,000 ha, the most damaging having been the fire which burned some 1.85 million hectares in the north-eastern province of Heilinjiang on 6 May 1987. In the former USSR, the total area burned on forest and other land from 1991-1995 was more than 5 million hectares. In North America, notwithstanding extensive, highly sophisticated prevention and control efforts, more than 2.3 million hectares of forest land still burn each year.

Although some data on fires are available from some countries, most data are incomplete. Thus it is difficult to provide an overall estimate of the annual extent of fires in forests and other wooded lands. A crude estimate for the temperate/subtemperate and humid tropical zones of the developing world, leaving aside the extensive dry tropical zones, for which little reliable information exists, was of the order of 2 million hectares of forest and other wooded land per year during the 1980s. In the period 1983-1994, a total of 902,330 fires was recorded covering 20,059,346 hectares of forest land in the temperate forests of the Northern Hemisphere.

The large fires of 1997-1998 served to focus public and international attention on the need to address not only the emergency response but also those policies in both the forestry and non-forestry sector which, directly or indirectly, contribute to these fires.

For many years, FAO has provided information and technical assistance in the area of forest fire management, including data collection, production and dissemination of information, preparation of guidelines on forest fire management and status and reports on forest fires, and direct advice to member countries.

Special attention has recently been given to information and public awareness in related policy, legal and institutional issues. Following suggestions made at the XI World Forestry Congress and the result of the Information Meeting on Forest Fires held on 12 November 1997 during the 29th FAO Conference, in response to the recent media attention to forest fires, FAO held a Meeting on Public Policies Affecting Forest Fires from 28 to 30 October 1998.

The main objectives of the Meeting were to:

- identify, analyse 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 a neutral forum) on policy issues related to fire;
- suggest actions to be taken by countries through a statement to the ministers responsible for forestry who met in Rome in March 1999.

The Meeting brought together diverse participants among whom were key experts in land-use policies affecting forest fires from governments, the private sector, NGOs and international agencies.

The Meeting has clarified the main public policies that contribute to forest fires and has offered a better understanding on the solutions to reducing their incidence.

This publication is presented in two parts. Part I contains the regional papers analysing the main socio-political causes of forest fires and the measures/actions adopted to prevent and reduce their impacts; it provides the focus for the exchange of information and ideas among the participants and presents the main conclusions and recommendations of the meeting. Part II brings together the papers and contributions provided by the participants to the meeting.

M. Hosny El-Lakany
Assistant Director-General
Forestry Department

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PART I

EXECUTIVE SUMMARY

THE 1998 FIRE SITUATION

Wildfires significantly impacted people, property, and forests throughout the world during the widespread drought associated with the 1998 El Niño episode. These fires killed many people; caused severe health problems from air pollution in Indonesia, Malaysia, Central America, Mexico, and the United States; disrupted air and sea navigation; damaged rain forests in Brazil and Mexico; and caused the evacuation of thousands of people from their homes. Slash and burn agricultural practices, land clearing, severe drought, and unnatural accumulations of forest fuels all served to produce fires of disastrous proportions. Even countries possessing advanced fire management technologies were not able to cope with the severity of the situation until weather conditions moderated.

FAO FIRE CONFERENCE CONVENED ON PUBLIC POLICIES

Recognizing that nearly all countries of the world, encompassing all stages of economic development, are suffering the environmental, social, and economic consequences of damaging wildfires, FAO convened a conference in Rome, Italy, on 28-30 October 1998 to identify, analyse, and discuss public policies that affect forest fires. Seventy-one participants from thirty-three countries and thirteen international organizations, including the private sector and NGOs, reviewed public policy implications that were presented in five regional fire papers. Following this review of the global fire situation, five regional working groups produced recommendations on planning and policies for fire prevention, fire suppression, fire use, mitigation, and rehabilitation measures. These recommendations and suggested actions to be taken by countries were presented to the forestry ministers when they met in Rome in March 1999.

The important challenge to policy makers in establishing sustainable forest and land use management practices lies in reconciling the positive roles of fire as a beneficial servant to humankind with the negative effects of fire when it becomes a bad master. Unfortunately, the present policy situation related to forest fires is generally a reactive one where governments respond to wildfires following a serious outbreak of problems. The more productive policy model would be a proactive one where governments provide a wide range of mitigation strategies before emergencies arise.

Policy makers and the general public need to understand that a strategy that only focuses on the emergency preparedness and response side will not be sufficient in the long run. Only when sustainable land use practices and emergency preparedness measures complement each other do long-term benefits accrue for society.

RECOMMENDATIONS TO MEMBER COUNTRIES REGARDING BROAD POLICY PRINCIPLES

No simple policy guidelines exist to cover the wide range of ecological, socio-economic, and cultural conditions that occur globally, but certain broad policy principles are common to most situations. Conference participants identified these rather universal principles for consideration by member countries:

- Formulate national and regional policies, linked to sustainable land use practices, where such policies do not presently exist.
- Establish flexibility in policy implementation, and review and revise policies periodically.
- Define clear and measurable policy objectives and implementation strategies.

- Involve all stakeholders in policy development, recognizing that community commitment and support are essential ingredients in obtaining sustainable land use practices.
- Create a policy environment that promotes a balanced and comprehensive programme of systematic fire management, where support is evenly distributed among the important elements of fire prevention, fire use, and fire suppression.
- Establish policies for other forms of land use that impinge on the fire environment. For example, incentives should encourage land use options that do not contribute further to de-forestation.
- Define polices for sustaining the health of fire-adapted ecosystems that will balance public health and forest health issues related to the use of prescribed fire.
- Establish land-use policies that include appropriate incentives and subsidies to encourage fire prevention practices among the various publics.

OTHER TECHNICAL ASPECTS OF POLICY FORMULATION AND IMPLEMENTATION

Conference participants identified several additional improvements needed to support the formulation and implementation of effective public policies related to forest fires:

- Develop the capacity to apply systematic fire management procedures.
- Provide for institutional cooperation among all stakeholders.
- Develop guidelines for the restoration and rehabilitation of burned areas.
- Strengthen the process for disseminating knowledge regarding appropriate technologies, research, and information.
- Improve the collaboration and coordination of efforts of international organizations, including FAO, other UN agencies, NGOs, and the private sector, involved in forest fire related activities at global and regional levels.

AGENDA

WEDNESDAY 28 OCTOBER 1998

Morning	IRAN ROOM (B-016)
08.30-09.30	Registration (Entrance of Building A)
09.30-10.00	Opening Session - Mr. David A. Harcharik, FAO Deputy Director-General - Mr. M. Hosny El-Lakany, Assistant Director-General, Forestry Department
10.15-10.30	Coffee Break
10.30-11.30	Presentation of Regional Paper on Asia and the Pacific: - Mr. J. Schweithelm Discussion
11.30-12.45	Presentation of Regional Study on the Mediterranean countries: - Mr. D. Alexandrian Discussion
Afternoon	GREEN ROOM (Building A, first floor)
14.00-14.10	Presentation by Mr. Jorge Illueca (UNEP)
14.15-15.30	Presentation of Regional Study on the Americas and the Caribbean: - Messrs. B. Mutch, B. Lee and J. Perkins Discussion
15.30-15.45	Coffee Break
15.45-16.45	Presentation of Regional Study on Europe and Boreal/Temperate Asia: - Mr. J. Goldammer Discussion
16.45-17.45	Presentation of Regional Study on Africa: - Mr. Abdoulaye Kane Discussion
18.00	Reception offered by the Forestry Department (Indonesia Room, 8th Floor)

THURSDAY 29 OCTOBER 1998

Morning	GREEN ROOM (Building A, first floor)
08.30-09.00	Presentation: Monitoring Fire Potential From NOAA POLAR Orbiting Satellites - Mr. Felix Kogan, National Oceanic and Atmospheric Administration, Washington, D.C.
09.00-10.00	Inter-regional Panel to complement issues presented/discussed in regional studies
10.00-10.45	General discussion
10.45-11.00	Coffee Break
11.00-11.30	Organization of Working Groups
11.30-12.30	GREEN ROOM (Building A, first floor), PHILIPPINE ROOM (C-277), NIGERIA ROOM (C-215), or ETHIOPIA ROOM (C-285) Working Group Discussions
Afternoon	GREEN ROOM (Building A, first floor), PHILIPPINE ROOM (C-277), NIGERIA ROOM (C-215), or ETHIOPIA ROOM (C-285)
14.00-15.30	Working Group Discussions (Cont.d)
15.30-15.45	Coffee Break
15.45-18.00	Working Group Discussions (Concluded)

FRIDAY 30 OCTOBER 1998

Morning	GREEN ROOM (Building A, first floor)
09.00-10.00	Presentation of the FAO Global Information and Early Warning System for Food and Agriculture (GIEWS) Discussion
10.00-10.45	Brief Presentation by Regional and International Organizations of main programmes/activities on forest fires prevention/fighting/impact assessment
10.45-11.00	Coffee Break
11.00-12.30	Brief Presentation by Regional and International Organizations of main programmes/activities on forest fires prevention/fighting/impact assessment (Concluded)

Afternoon	GREEN ROOM (Building A, first floor)
14.00-15.30	Presentation and discussion of conclusions and recommendations of the Working Groups
15.30-15.45	Coffee Break
15.45-17.00	Presentation and discussion of conclusions and recommendations of the Working Groups (Concluded)
17.00-17.30	Closure of the meeting

REPORT OF THE MEETING

Seventy one participants from thirty three countries and thirteen international organizations, 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, analyse 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 minimize the many adverse effects of uncontrolled fires and to maximize 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 emphasize 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[1];
  - 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 programmemes 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 programmeme 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.

- Institutional Cooperation
  - encourage fire management cost-sharing among all relevant stakeholders at all levels
  - develop inter-sectoral cooperation 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.

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[1] 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.

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 programmemes, will slow forest conversion for unsustainable agriculture and will thus reduce forest fire damage.

V CONCLUSIONS AND RECOMMENDATIONS TO FAO AND INTERNATIONAL ORGANIZATIONS

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

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

International organizations 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 harmonized 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 programmemes, increase preparedness and respond to outbreaks at national, regional and global levels.

FAO and other international organizations should play a catalytic role in the establishment of networks, to promote the sharing of information and knowledge and technical cooperation 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 organizations, is still required, particularly in institutional support and capacity-building.

PUBLIC POLICIES AFFECTING FOREST FIRES IN THE ASIA-PACIFIC REGION

James Schweithelm[2]

SUMMARY

This paper covers countries lying in the tropical and sub-tropical areas of Asia and the Pacific, while the temperate and boreal regions are covered in the paper prepared for this workshop by Dr. J.G. Goldammer.

Fire regime is the accepted analytical tool for characterizing the role of fire in various environments, and is discussed in Section 2.2.

The fuels of most concern are grasses and shrubs, vines, fallen branches and trees, leaf litter, and in the case of deep peat deposits, the substrate itself.

Temperature, humidity, and wind speed are also important variables in forest fires. Steep topography increases the speed with which fire spreads upslope, and the orientation of ridges and valleys with respect to wind direction affect the direction of fire spread. El Niño/Southern Oscillation -- the periodic disruption of atmospheric pressure and rainfall patterns over the Pacific linked to sea surface temperature anomalies. These gradients are well-illustrated by a diagram in Mueller-Dombois and Goldammer (1990).

Pre-industrial humans were an ecological disturbance factor and did change the species composition of intensively used areas. Recent examples are the Ash Wednesday fires of 1983 in Victoria and South Australia and the 1994 Sydney fires.

Economists calculated that the direct smog-related costs incurred by Indonesia, Malaysia, and Singapore in late 1997 (not including 1998) was approximately US$1.4 billion. A further as yet unsubstantiated cost of the 1997 fires is at least an additional US$3.0 billion from predicted losses in timber, non-timber forest products, hydrological and soil conservation services, and some biological diversity benefits as well as costs related to carbon release and fire-fighting (EEPSEA/WWF 1998).

Asian tropical rain forests are known to be resilient enough to recover from low frequency/intensity fires over periods of decades or centuries, but increases in the frequency, scale or spatial extent of fires causes serious, if not permanent, ecological changes to occur, especially if combined with other disturbance factors. Nutrients are lost during burning through volatilization and particulate convection, and afterwards by leaching of the ash and accelerated erosion of bare soils.

Impacts of the 1982/83 East Kalimantan (Indonesia) fires on forest-dwelling peoples were studied by Mayer (1989 and 1996) and Colfer (1993). The German-funded Integrated Forest Fire Management Project has been studying community interactions with fire in East Kalimantan since the mid-1990's (Abberger 1996 and 1997). A number of researchers and organizations are studying the direct human impacts of the 1997/98 Indonesia fires, including WWF Indonesia, CIFOR, ICRAF, WRI, WALHI, and Telapak (the latter two are Indonesian environmental NGOs).

Several organizations have begun the lengthy and complex task of interpreting satellite images to determine the total area burned by the 1997/98 fires including WWF Indonesia (Fuller and Fulk 1998), the Centre for Remote Sensing, Imaging and Processing - Singapore (Liew *et al.* 1998), the European Union-funded Forest Fire Prevention and Control Project (Ramon and Wall 1998), and the German-

[2] FAO Consultant, Hawaii, USA.

funded Integrated Forest Fire Management Project, and the European Commission's Joint Research Centre (Dwyer *et al.* 1998) among others.

The International Workshop on National Guidelines on the Protection of Forests Against Fire, held in Bogor, Indonesia 8-9 December 1997, sponsored by the Indonesian Ministry of Forestry, ITTO and the Faculty of Forestry Bogor Agricultural University; the meeting on Land-use Management and Transboundary Pollution from Fires, held in Bogor, Indonesia 18-19 August 1998; and a Science-Policy Working Group Meeting of the Impacts Centre for Southeast Asia and are some of the national events where forest fires in Indonesia have been analyzed and discussed.

Malaysia has just developed new provisions to regulate burning that are under review by the states and assisted Indonesia to fight the 1997/98 fires by providing both fire-fighters and equipment.

Combating forest fires also requires appropriate policy instruments which include laws, regulations, institutions, and allocation of resources to facilitate policy implementation. Its lack does not to diminish the urgency of developing fire management policy, but rather serve as a plea that fire policy recommendations for developing countries of the region be made with the understanding of the reality facing managers. ITTO has contributed to these needs by producing Guidelines on Fire Management in Tropical Forests (ITTO 1997).

In the prediction of forest fires, a Geographic Information System (GIS) with layers that include maps of vegetation, fuel loads, values to be protected, and topography can make it more precise. Ofren and Harvey (1998) provide an example from Thailand. Due to the great expense involved, the costs of satellite imagery acquisition and analysis can be shared among neighbouring countries as has been agreed on by ASEAN member governments. People living in remote areas can become part of a detection network.

The very fire-prone southern part of the Australian State of New South Wales has a well-developed fire management body called the Southern Regional Fire Association that coordinates among the member districts and various land management agencies (Anonymous 1995). Each district has its own coordination body as well.

A large part of Indonesia's inability to cope with the 1997/98 fires stems from its lack of effective fire management coordination at any level of government, especially a unified command system with the authority to direct fire suppression efforts. Hansen (1998) has proposed a comprehensive fire management communication system for Indonesia.

Fire suppression strategy, tactics, and management are complex fields requiring leaders with appropriate education and field experience. Appropriate education curricula and training courses must be available at the national or regional level.

The Department of Conservation and Land Management of Western Australia State uses a ten year Master Burning Plan to manage fuels. The Plan is updated every two to three years and is discussed with stakeholders prior to approval. The Plan is based on a Wildfire Threat Analysis (Sneeuwjagt 1992).

The FAO Asia-Pacific Forestry Commission recently completed a draft Code of Practice for Forest harvesting (Asia-Pacific Forestry Commission 1997) that broadly addresses fire management. Most countries in the region have their own harvesting codes as well.

Campaigns should be tailored to target audiences in terms of content, language, and communication medium. The community forestry programmes in India and the Philippines provide a good communication mechanism.

Prioritization is itself a complex area of policy analysis, requiring the development of criteria for ranking areas based on human and biological values at stake as well as the cost of protecting these values.

Indonesia's Minister of Environment referred to chaotic land ownership and uncontrolled fires in East Kalimantan province in 1998 as being like the "Wild West" (Reuters 14 April 1998). Lack of accurate land ownership maps forced Indonesian officials to go to great lengths to prove which plantation firms were guilty of illegal burning. They are both victims of wildfires and important actors in fire prevention and suppression.

Unfortunately, some countries start policy analysis with equipment selection, thereby narrowing their policy options. The outpouring of fire management technical assistance to Indonesia in 1997/98 may have confused government officials by the sheer volume of uncoordinated and at times incompatible advice. This plan demands integrated effort among partners, and could fail if such cooperation is not forthcoming. The current economic crisis in the region will be an added challenge.

1. INTRODUCTION

1.1 The Asia-Pacific Region

The Asia-Pacific Region is defined by most international organizations as stretching from Afghanistan and Pakistan in the west, eastwards through the Asian mainland, and crossing the Pacific and Indian Oceans to include insular Southeast Asia, Australia, New Zealand, and Oceania. This regional definition is useful for dividing the globe into major units for ease of communication, but the countries that comprise it share few, if any, common characteristics in terms of culture, socio-economic development, political system or natural resource endowment. Such diversity presents a major obstacle when attempting to analyze fire management or any other natural resource policy, but it does provide a wealth of fire regimes and policies for comparative study. There is scope for sharing fire policy among countries in relatively homogeneous sub-regions such as Southeast Asia in anticipation that some policies can be applied regionally or globally.

1.2 Vegetation fire terminology

Scientists, policy makers, and resource managers have developed a specialized vocabulary to describe vegetation fires and the context in which they occur. Some of these terms, defined below, will be used in this paper to explain fire occurrence in specific countries and to analyze fire policy.

Vegetation fires refer to fires in all vegetation types including forests, grasslands, scrublands, and agricultural lands. Vegetation fires are sometimes ignited by lightning or other natural phenomena, or may be ignited purposely or accidentally by humans. Fires started purposely to achieve specific objectives are called controlled burns while accidental fires or escaped controlled burns are called wildfires. The likelihood that a wildfire will start and spread depends on the levels of fire hazard and fire risk. Fire scientists can measure fire hazard in a given vegetation type at a specific time based on the volume, type, dryness and arrangement of fuel loads, atmospheric conditions, and local topography. Fire hazard determines the ease of ignition and the difficulty of suppression. Fire risk is the measure of the likelihood that a wildfire will be ignited naturally or through human action. Fire risk from natural causes is to some extent predictable, while the determination of human-related fire risk is highly subjective, depending on a complex mix of fire history, formal and informal rules and regulations, land use, attitudes, and motivations.

2. FIRE IN THE REGION

Fire policy should be designed to meet resource management objectives within the parameters of a specific fire regime. Policy makers are confronted with the reality that both resource management objectives and fire regimes are likely to change, sometimes quickly and dramatically, in response to changes in the natural environment or social, economic and political conditions. These variables impact on forest fire policies and policy makers should understand how they affect the fire regime and the policy environment in order to design policy instruments that are flexible enough to be effective in a wide range of circumstances.

2.1 The human context

The nations of the Asia-Pacific tropics and sub-tropics are, with a few exceptions, in the early to middle stages of economic development. While there is great variability in terms of culture, economy, political systems, and demography within developing tropical Asia and the Pacific, most nations share characteristics that make it technically difficult or politically unattractive for them to manage human influences on fire regimes, complicating the task of fire policy formulation. Perhaps most importantly, many countries have rapidly growing human populations, with a large percentage of poor people living in rural areas, heavily dependent on small scale agriculture and forest products for their livelihoods. In some countries, forested areas are resource frontiers for timber production, mining, and commercial agriculture as well as safety valves to relieve population pressure elsewhere. This has created a three-way conflict between logging and mining firms, agricultural settlers, and indigenous forest dwellers. Governments have frequently been ineffective at reducing the conflict over land and forest resources due to inappropriate or ineffective land use and land tenure policies, insufficient management resources, and often a lack of political will.

In recent decades the scenario described in the preceding paragraph has led to accelerating rates of deforestation, altering fire regimes relentlessly as deforestation and increased fire use have interacted. Poor harvesting practices have made forests more fire-prone, fire use is undisciplined, and fire is often the tool of choice for forest conversion to agriculture by large firms and small-holders alike. The changes in the fire regimes of the tropical rain forests has been most dramatic, but even the fire regimes in seasonally dry areas have changed as fires have become more frequent and intense. Fire policy must now be designed to stabilize fire regimes, a more complex task than managing fire in a relatively stable regime.

Australia provides a direct contrast to the scenario described above. Australia is a huge, sparsely-populated, and largely dry continent that is economically developed and much of whose biota is the product of natural and human-induced fire. Australia has a variety of fire regimes and fire management policies based on decades of fire science research and management experience. This knowledge coupled with effective policies, including established land use policies, plus sufficient resources, and low levels of subsistence dependence on forests and natural vegetation gives Australian policy makers a relatively stable fire context in which to work. The policy formulation process is open, allowing a wide range of stakeholders to participate. Fire policy, however, must still be flexible enough to respond to changes in climate, unexpected natural disturbances, and political sentiment.

2.2 The ecological context

Each vegetation formation has a characteristic fire regime shaped by climate, ecological factors, and human actions which determine the frequency, intensity, spatial extent, seasonality, and predictability of fire (Christensen 1993). Fire regimes determine how fires affect vegetation ecology and biogeochemical processes. Humans have altered the fire regimes of most areas of Asia and the Pacific through their use of fire and modification of vegetation. Fire regimes fluctuate naturally in response to long term climate change and shorter term climate oscillations. The flora of most seasonally dry areas have evolved with fire regimes in which wildfires are frequent, and many species depend on fire for regeneration. The flora of the wet tropics evolved in fire regimes in which fires were caused by severe droughts with long return periods (Goldammer and Seibert 1990). These fire regimes have been altered dramatically over the past century as humans have used fire and harvesting to modify rain forests at an accelerating rate, causing major shifts in vegetation structure and species composition, and increasing fire hazard and risk.

The climatic and ecological factors that shape fire regimes are generally thought to be relatively stable, but can change unpredictably and sometimes suddenly. The apparent increased severity of ENSO-related drought in the western Pacific in the last two decades is an example. This may be a short term anomaly or a long term trend caused by natural climate oscillations or human-induced climate change. Fire regimes can change very suddenly as the result of infrequent natural disasters such as major cyclones which can change forest structure and fuel conditions overnight.

The region has a number of distinct fire regimes, each with one or more associated vegetation formations. Fire regimes are best understood as existing along a gradient of ecological and human factors. The characteristics and important features of the major fire regimes are described briefly below. Australia's fire regimes are covered in a separate section which, for the sake of brevity, does not do justice to their variety and complexity. Unless otherwise noted, the descriptions are based on information from the references cited after the regime title.

Tropical Lowland Deciduous Forests (based on Stott *et al.* 1990 and Goldammer 1996): This regime includes both monsoon and savanna forests, the latter having less tree cover and more grass. These forests occur in areas of South and Southeast Asia where the dry season is three to seven months long, total annual rainfall is usually less than 2,000 mm, and the mean temperature in the coldest month is rarely less than 20 degrees centigrade. Monsoon teak (*Tectona grandis*) forests occur naturally in mainland Southeast Asia and have been planted elsewhere. Sal (*Shorea robusta*) forests occur in the northern part of the Indian Sub-continent. Dry dipterocarp savanna forests occur in mainland Southeast Asia, and open grasslands and thorn forests are spread in patches across drier parts of the region. The relatively dry Lesser Sunda Islands of eastern Indonesia contain monsoon and savanna forests with affinities to Australian flora.

These forests usually burn one or more times per year with low level litter and ground cover fires being the norm. Levels of fire adaptation vary among formations. Fires are typically ignited purposely or accidentally by humans, and increased frequency of burning is putting stress on these fire-adapted ecosystems. The primary objective of fire management is to control fuel loads through controlled burns, grazing, or cutting. Total fire exclusion is not practicable and prescriptions must be site specific.

Fire Climax Pine Forests (based on Goldammer and Penafiel 1990): Pine forests occur naturally on disturbed sites in the lower montane forests of tropical Asia, primarily in the Hmalayan foothills, the mountains of mainland South East Asia, Sumatra (Indonesia), and Luzon (Philippines). Human disturbance of forests at lower and higher elevations have caused the altitudinal range of fire climax pine forests to expand. Pine plantations have been established at lower elevations in many parts of the region. Tropical pine species have various levels of fire adaptation and are prone to burning due to the volume and flammability of their litter. These forests are productive if fire frequency and intensity are stable, but tend to become degraded if fired too frequently or fire is combined with other disturbance factors. Most fires are ignited by humans through carelessness or escaped swidden fires, but may be started purposely to improve grazing or facilitate hunting. Most pines will not regenerate if fired annually, so managers must try to reduce fire frequency to the period required for regeneration. Total fire exclusion usually results in broad-leaved species reclaiming the site.

Evergreen Equatorial Rain Forest (Whitmore 1998, Goldammer and Seibert 1990, Schweithelm 1998): Tropical rainforest is the natural vegetation over large areas of Southeast Asia and the tropical Pacific. These forests require abundant rainfall and high temperatures year round: drought conditions prevail when monthly rainfall drops below 100 mm. Insular Southeast Asia, New Guinea and the high islands of Melanesia were largely covered with species-rich forests until recent decades. Logging and agricultural expansion have now greatly decreased their quality and extent. Other than New Guinea and protected or remote parts of Southeast Asia, the lowland rain forests of the region are a mosaic of disturbed stands, fire climax grasslands, secondary vegetation, and commercial crop plantations. Within this climate type, special vegetation types have their own fire regimes. The fire climax *Imperata cylindrica* grasslands are fired by humans annually to prevent invasion by woody pioneer species, peat swamp forests are susceptible to continuous sub-surface burning during severe droughts, and heath and limestone forests are more fire-prone than other forest types due to the limited water-holding capacity of their soils.

Undisturbed lowland rainforest is very resistant to burning, but scientific evidence indicates that Borneo's forests (and by inference, those elsewhere) have burned periodically over tens of millennia during extreme droughts. Humans have used fires as they settled the forests over thousands of years to create swidden plots and facilitate hunting. Traditional use of fire is thought to have had little long term ecological effect on the forests, but increased human population density, shortened fallow periods, and cash cropping have made shifting cultivation a major agent of deforestation. Careless commercial timber harvesting has greatly increased fire hazard, and logging roads have provided agricultural settlers with access to remote forest areas, thereby increasing the risk that their land clearing activities will result in wildfires. Logged and otherwise disturbed forests are being cleared by "slash and burn" of waste wood in preparation for conversion to palm oil, pulp wood, or other tree plantations.

Severe ENSO-related droughts over the last two decades, combined with human disturbance of rain forests and indiscriminate use of fire have led to massive wildfires in Indonesia that have dramatically changed the fire regime, and threaten the existence of the lowland rain forest flora in many parts of Sumatra and Kalimantan. The rain forest fire regime has shifted to a much higher fire frequency, larger area burned, and greater fire intensity. Fire policy and fire management approaches for rain forests are at an early stage of development. Changes in land use policy and attitudes will certainly be required.

Australia: Australia is a large, sparsely-populated continent which contains a wide variety of climate types including tropical and sub-tropical wet-dry in the north, temperate wet and seasonally dry in the south and south-east, Mediterranean in the south-west, and huge arid areas in the centre of the continent. Australia has been called the fire continent (Pyne 1995) because its vegetation has been shaped by fire. Fire plays a major role in the ecology of most vegetation types, and humans have had to both live with and learn to manage fire. Most of Australia's vegetation formations are fire-adapted, and many are fire-dependent for regeneration. The leaves of many forest species, notably the diverse eucalypts, contain high levels of volatile oils, resins and waxes and produce large quantities of litter, creating heavy fuel loads and high levels of fire hazard (Shea *et al.* 1981). The majority of Australian wildfires are ignited accidentally or purposely by humans, although lightning is important, especially in remote areas.

The south-east quadrant of the continent, encompassing the State of Victoria, The Australian Capital Territory, and parts of the States of New South Wales, South Australia, and Tasmania are some of the most dangerous areas for wildfires in the world due to the prevalence of hot, dry winds in the summer months, highly inflammable vegetation, and relatively dense human populations (Pyne 1995). This combination creates a fire regime in which fire frequency and intensity are high. The region has periodically suffered wind-driven fire storms that have resulted in major loss of human life and property: The southern part of the State of Western Australia has a Mediterranean climate and its *Eucalyptus marginata*-dominated forests also have high frequency/intensity fire regimes (Underwood and Christensen 1981, Sneeuwjagt 1992). The vegetation of the tropical and sub-tropical north ranges from fire-sensitive mesic and xeric rain forest to various formations of seasonal forest, woodland, savanna, and grassland that are fire-adapted in various degrees (Gill *et al.* 1990). Fire plays important ecological and agricultural roles in the north, but is not a major threat to life and property. The north is subject to cyclones, which can severely damage forests, greatly increasing the level of fire hazard. Fire regimes in arid and semi-arid areas are mild due to slow fuel accumulation.

2.3 Benefits and costs of fire

Fire provided pre-industrial humans with the means to shape vegetation in ways that facilitated their survival, and continues to be an important tool for land clearance, crop residue disposal, and for improving grazing in the Asia-Pacific region. In seasonally dry areas, fire is an integral part of natural ecosystems and many agro-ecosystems. When used with knowledge and restraint the benefits of fire outweigh its costs.

The massive fires in various parts of the globe over the past few years, especially those that occurred in 1997/98, have convinced many people that the cost to society from uncontrolled fire use outweigh the benefits accrued by individuals and corporations. From a policy analytical viewpoint, the total cost resulting from individual fires or fires aggregated over a country or region depend very much on which impacts are included in the calculation. During the recent fire and smog episode in Indonesia, politicians and citizens of surrounding countries were most interested in the direct and indirect effects of the smog on human health and economic losses to tourism, transportation, and to the manufacturing sectors. Atmospheric scientists were interested about the impact of the release of greenhouse gases and other chemicals and particulates from the fires (Goldammer 1998, Heil 1998). Conservationists, ecologists, and foresters were concerned that the fires would destroy valuable timber and non-timber products, lead to local or total extinction of plant and animal species, and cause significant disruption of ecological processes (Yeager 1997, O'Brien *et al.* 1998). They were also concerned that the fires could accelerate the already high rates of deforestation and forest degradation in the rich lowland forests of Sumatra and Kalimantan, cause serious nutrient losses, and adversely affect the livelihoods of forest-dwelling peoples. Aquatic and marine scientists were concerned about the impacts of the fires on rivers, lakes, and the nearshore marine environment resulting from excessive sedimentation and nutrient-loading.

3. COUNTRY CASE STUDIES

3.1 Rationale for country selection

As discussed in Section 1.1, the Asia-Pacific Region, even when limited to the tropics, sub-tropics, Australia and New Zealand, is very diverse and includes many countries. It is, however, only possible to include a small representative sample of these countries in this paper, with selection criteria based on one or more of the following: 1) how well each country represents conditions in its subregion: 2) the extent to which fire management is a significant policy issue; 3) whether there are examples of positive or negative lessons to be learned from fire management policy; and 4) the availability of information. Fire management profiles of Indonesia, Australia, India, Thailand, the Philippines, and Malaysia are as follows:

Country profiles

Indonesia (Schweithelm 1998, Goldammer and Seibert 1990, Schindele *et al.* 1989): Indonesia is the world's largest archipelago, straddling the equator for 5,000 kilometres, and forming a biological bridge between Asia and Australia. Indonesia's climate is shaped by the annual cycle of east and west monsoons which affect rainfall and winds across the archipelago. The major islands and most smaller island groups are dominated by humid tropical climate and rain forest vegetation, although the Lesser Sunda Islands, eastern Java, and small parts of other islands have mildly to pronounced rainfall seasons. The fire regime for most of Indonesia is described under Evergreen Equatorial Rain Forest in Section 2.2 and the regime of the seasonal climates under Seasonal Lowland Deciduous Forests.

The Ministry of Forestry manages approximately 60 percent of Indonesia's 190 million hectare land area in a centralized, and largely top-down manner. Less than 100 million hectares remains forested, deforestation rates are between 0.6 and 1.2 million ha annually (Sunderlin and Resosudarmo 1996), and approximately 26 million ha of the forest estate are eligible to be converted to other uses. The Indonesian government has aggressively supported the use of such conversion forest for the development of tree crop and pulp wood plantations.

Indonesia has relied on its commercially and biologically valuable forests as a major source of development capital over the past three decades. Indonesia's forest policy and management has been widely criticized for being technically unsound, unnecessarily damaging to biological diversity and forest-dependent peoples, failing to capture the full economic revenue from commercial timber harvesting (Barber *et al.* 1994, World Bank 1995), and increasing the frequency and scale of fire (Schweithelm 1998). Massive ENSO drought-related fires burned approximately 3.5 million ha of forest and other vegetation in East Kalimantan in 1982/83 (Schindele *et al.* 1989) and were followed by other major fire episodes in 1987, 1991, and 1994, culminating in the fires of 1997/98 that burned millions of hectares of Sumatra and Kalimantan.

Historical records and scientific evidence indicate that Indonesia's rain forests have burned in the past, but not with this frequency nor covering such large areas. The dramatic shift in fire regime has been blamed directly on a number of factors including: 1) careless logging that killed trees unnecessarily, left too much waste wood in the forest, opened the closed canopy exposing the forest floor to drying sunlight and wind, and made the forest accessible to agricultural settlers; 2) increasing numbers of people clearing land in or near forests by burning; 3) conversion of large areas of forest to oil palm and pulp-wood plantations through uncontrolled use of fire, and 4) lack of enforcement of burning regulations. Underlying causes of Indonesia's new rain forest fire regime are: 1) weak land use policies, laws, and implementation; 2) lack of effective land use zoning; 3) lack of resources and political will to manage and protect forests; 4) land tenure policies that promote conflict between traditional users, settlers, and commercial users; and 5) the ability of politically powerful individuals and firms to circumvent laws and regulations.

Most objective observers have concluded that Indonesia has made little progress in developing effective policies, institutions, and procedures to manage fire since the disaster of 1982/83. Work is now under way to build the necessary fire management framework. A workshop was held in December 1997 to obtain input for national forest fire protection guidelines, and another meeting was held in August 1998 to discuss the relationship between land use management and transboundary pollution. The German Integrated Forest Fire Management Project has been working to develop community based fire management planning in East Kalimantan that involves awareness-raising, village institutional strengthening, training of village fire crews, developing incentives to manage fire, and building cooperation among government, villagers, and timber concession operators (Abberger, pers comm). The European Union and JICA have each sponsored a fire management project in Sumatra.

The accelerating use of fire for forest clearance briefly levelled off in 1995 in the wake of international complaints the year before about transboundary smog from fires in Indonesia. The accelerating use of fire resumed in 1996 and 1997, leading to the great fires of 1997/98. Indonesia is faced with the pressing tasks of creating policy, institutions, and capability to stabilize the tropical rain forest fire regime while also adjusting fundamental land use and resource management policies to facilitate fire management in the longer term. These same policies must also be adjusted to rationalize resource use, strengthen biological diversity conservation, control deforestation, and protect the rights of forest-dwellers. Indonesia's highly centralized governing and policy making structure could potentially facilitate policy reform, but also complicates the task of adjusting policy to the diverse conditions found in the country.

Indonesia has been receiving international fire management assistance since the 1982/83 fires, and the 1997/98 fires have initiated another round of projects from bi-lateral and multi-lateral donors, research organizations, and international NGOs. Some of this assistance is part of regional or global coordination and research initiatives. It is beyond the scope of this paper to discuss all of these efforts, but some are described briefly below. Dennis (1998) has comprehensively reviewed international fire assistance to Indonesia. There are currently four on-going, bi-lateral, fire-related assistance projects to Indonesia that were in existence prior to the 1997/98 fires. They are funded by the European Union, Germany, Japan, and the United Kingdom. In the wake of the 1997/98 fires the following organizations started projects to monitor the fires, study their impacts and causes, and to begin strengthening fire management policy and institutions: WWF Indonesia, the European Union, ADB, UNDP, ITTO, USAID, and CRISP (Singapore). SEAFIRE is a planned research programme under the International Geosphere-Biosphere Programme which intends to clarify the origin, mechanism of transport, and impacts of fire emissions on the regional and global atmosphere and link this with on-the-ground land use ecological research (Goldammer 1998).

The following new fire projects have been proposed: A consortium of CIFOR, ICRAF, and UNESCO to investigate the underlying causes and impacts of fires in Southeast Asia; and IUCN and WWF jointly to establish a global network for fire prevention and control.

India (Based on Mutch *et al.* 1995 and Saigal 1989 unless otherwise indicated): India, the world's second most populated country, covers a large portion of the Indian sub-continent and contains a wide variety of climate zones ranging from the tropical south, to the north-western deserts, to the Himalayan mountains, and the wet north-east. Forests, including moist deciduous, dry deciduous, thorn, and pine, are widely distributed in the country, although most are under high use pressure. Plantations and production forests are generally under-stocked and timber production is low by international standards. Estimates indicate that 50 to 60 million Indians living in rural areas rely on forests for their subsistence, and the forests provide 40 percent of the nation's energy needs as well as timber, non-timber forest products, fodder and grass (Pande 1995).

Forestry has a long history in India, with forest management starting under the British colonial government in the mid-nineteenth century (Pyne 1995). Almost 97 percent of Indian forests are publicly-owned, 85 percent of which are administered by state governments (Pande 1995). State Forest Departments have direct responsibility for managing and conserving most forests, while the national level Ministry of Forestry and Environment coordinates between the states and formulates national plans. General forest policy is articulated in the National Forest Policy of 1988 and expanded on in the National Forestry Action Plan (NFAP). In a major break with past practice, State Forest

Departments are adopting a Joint Forest Management (JFM) approach in which local communities are given a role in management and a share of the products of state-owned forests.

Fire use is very common in rural areas in the north-east for land preparation, agricultural waste disposal, swidden agriculture (shifting cultivation), to improve grass and forage production, and to facilitate the production and collection of some non-timber forest products. Managers sometimes use controlled burns in tree plantations, nature reserves, and national parks. Official fire statistics are unreliable, but it is estimated that at least 30 percent of the nation's forests are affected by fire annually (Mutch *et al.* 1995). Total government control over forests created a conflict situation between State Forest Department staff and forest-dwelling people. Joint Forest Management now provides an institutional mechanism for relieving tensions by giving forest communities a stake in forest management. The National Forest Policy uses JFM as the centrepiece of its fire protection strategy but this still currently only covers a small percentage of the forest area. Fire awareness campaigns directed at forest communities have resulted in some villages voluntarily instituting fire vigils in the forest during the fire season.

A UNDP/FAO forest fire control project implemented in two Indian states in the latter half of the 1980s developed fire detection and suppression procedures (FAO 1991), and a follow-on project was implemented in ten additional states. A 1995 FAO-funded technical assistance mission provided training in forest fire management planning (Mutch *et al.* 1995) and recommended several policy initiatives.

Thailand (based on Samran 1998 unless otherwise indicated): The major forest formations of Thailand are dry dipterocarp, mixed deciduous, plantations, pine, dry evergreen, and tropical rainforest. Ninety percent of the nation's land area was forested at the beginning of this century but this was reduced to 26 percent in 1993 (RFD 1994) including scrublands and bamboo. The rapid rate of deforestation has been, and continues to be, the result of agricultural conversion to accommodate the growing human population which has increased ten-fold since the beginning of the century. The Thai monarchy traditionally granted farmers the right to clear new farmlands in forests, a practice that is at odds with modern forest law. Teak was always the main focus of commercial forestry, but output fell as deforestation increased, leading to Thailand becoming a net timber importer in 1977, and finally to a total nation-wide harvesting ban in 1989 (Kashio 1997).

Fires occur annually in the dry season from December to May, typically in the form of ground fires in the drier forest formations, grasslands, and dryland agricultural areas, mostly in the north and north-eastern parts of the country. Virtually all fires are started by humans in order to facilitate gathering of non-timber forest products, to dispose of agricultural waste, to convert land to agriculture, to settle conflicts with forest officers, to facilitate hunting, or due to careless use of fire or disposal of cigarette butts. People generally believe that fire is not harmful to the forest. Fire data are not regularly collected for the entire country, but an aerial survey in 1984-86 indicated that 3.1 million ha of all vegetation types burned annually at that time, while a repeat survey in 1992 showed that the burned area was down to 2.0 million ha. A study conducted by the Faculty of Forestry of Kasetsart University in 1990 showed that total monetary fire losses in forests and tree plantations were approximately US$2.2 billion.

The National Forest Policy No. 18 (1985) mandates that a plan for slowing deforestation must include forest fire prevention and suppression. Other laws set penalties for lighting fires. Attempts at fire management began in 1971 with short term technical assistance by a Canadian government-funded consultant. This led to the training of some Thai forest officers abroad in forest fire control in the early 1970s, and then to the establishment of the Forest Fire Control Section in the Forest Management Division of the Royal Forest Department (RFD). This section was upgraded to a Subdivision in 1981, and to the Office of Forest Fire Control and Rescue in 1991. Due to limited budget, this Office is able to conduct fire suppression on only 12 percent of the total forest area (2 million ha). In addition to this, the RFD has taken the following actions to manage fire:

- established forest fire control units in fire-prone areas;
- cooperated with the Ministry of Interior to organize and train local government officials and volunteers in fire-fighting;
- organized a network of government agencies and commercial aviation firms to report fires;
- provided funds to purchase fire-fighting equipment;

- conducted a nation-wide fire prevention campaign;
- began collecting fire data and conducting research.

Further development of fire management capability in Thailand is constrained by budget and personnel limitations, the relatively low status of the fire control organization with respect to other government agencies with which it must coordinate, and the fact that fire statistics are confined to the relatively small area under active fire management.

Philippines (based on Vergara personal communication unless otherwise indicated): Like Indonesia, evergreen rain forest is the dominant natural vegetation formation in the Philippines, but deforestation has progressed to the point that very little intact lowland forest remains. Forest cover diminished from over 50 percent of the nation's land area in 1950 to 21 percent today. Population growth, commercial logging, and expanding commercial agriculture are major causes of deforestation. All fires are anthropogenic and often start from shifting cultivation. Forest fires occur in pure pine stands (*Pinus kesiya*) in the highlands of Northern Luzon, broad-leaved forests adjoining shifting cultivation fields, and in grasslands (thereby complicating attempts at reforestation). The archipelago's six million hectares of fire climax grassland are typically burned annually to enhance grazing. The pine forests are fire-prone as discussed in Section 2.2, and the broad-leaved forests are susceptible to burning during ENSO-related droughts.

Laws forbidding swiddening and forest burning were largely ineffective, resulting in a paradigm shift in the late 1980's toward Community-Based Forest Management (CBFM). Under this approach, forest communities are made partners in forest management, given exclusive privileges to harvest forest products, and given secure tenure over 1,000 to 10,000 ha (Dugan 1997). The Philippines 25-Year Forestry Master Plan established the goal of putting three million ha of forest and protected area under CBFM management. In communities where CBFM is already in effect, the incidence of fire has been reduced significantly because communities have an economic incentive to safeguard the forest. The pine forests of Luzon are a special case because they provide watershed protection for the reservoirs of important hydroelectric dams. Watershed management efforts address fire management, including providing alternative income sources for shifting cultivators.

Malaysia (Based on Nuruddin 1998 and Thang 1997 unless otherwise indicated): Malaysia includes 11 states in Peninsular Malaysia and the much larger states of Sarawak and Sabah in northern Borneo. Malaysia has a monsoon-driven humid tropical climate, and the predominant natural vegetation is rain forest. Much of Peninsular Malaysia's forests have been logged and converted to tree crop agriculture in recent decades, while the forests of the two Borneo states have been extensively logged, and some have been converted to tree crops, especially oil palm. Malaysia is the world's largest producer of palm oil, with Indonesia a close second. The management of forests and other lands are the responsibility of the state governments, although the federal government enforces some national laws and coordinates among states.

The occurrence of wildfire is low in Malaysia by comparison to Indonesia and other countries of the region, although extensive fires did break out in Sabah during the extreme drought conditions of early 1998. The pressure to convert forest for small-holder agriculture is not as great as in other countries, and the government has been active in regulating the use of fire for commercial land clearance. Malaysia has a legal and institutional framework to control burning, a system for monitoring air pollution, and relatively advanced fire-fighting capability. The Ministry of Science, Technology, and Environment has formulated a National Contingency Plan to Combat Forest and Plantation Fire in Malaysia. The Plan is executed by a National Forest and Plantation Fire Committee that is composed of various government agencies, with the mandate to develop guidelines and procedures to coordinate interagency fire response. The Fire and Rescue Services Department is the lead agency for fire suppression. Fire danger prediction is an area requiring research and policy development.

Malaysia has pioneered the use of zero-burning techniques for forest clearance (Hashim *et al.* 1993), and is using persuasion, technical advice, and penalties to encourage plantation firms to adopt these techniques. These zero-burning techniques may also be applicable to Indonesia (Wakker 1998). Many plantations have their own fire detection and suppression systems.

Australia: Australia's original human inhabitants are known to have used fire extensively to manage vegetation, and it is believed that much of the continent's vegetation was shaped by their use of fire over tens of millennia. Europeans began to settle Australia two centuries ago, and gradually spread out to displace the aboriginal peoples and their fire regimes. From the beginning, settlers used fire to clear land and enhance grazing (Gill 1981), but it was not until this century that foresters and other land managers began to understand the need to manage fire actively to reduce property damage, manage production forests, and avoid undesirable changes in natural ecosystems.

Australian fire science developed rapidly in the middle decades of this century, resulting in an aggressive approach to fire management that relied on prescribed burning to reduce fuel loads in fire-prone vegetation before it could accumulate to dangerous levels or to insure regeneration of desired species (Shea *et al.* 1981). Range managers also use prescribed burns to control tree and shrub growth, improve pastures, and release nutrients (Leigh and Noble 1981). McArthur (1962) articulated the rationale for prescribed burning and developed indices for predicting fire behaviour and intensity based on weather and fuel conditions (McArthur 1966 and 1967). Australian fire scientists have developed a wide range of principles and techniques for planning and implementing prescribed burning as a key component of fire management strategies tailored to specific ecological conditions, management objectives, and values to be protected. Land managers can now design fire regimes within the constraints imposed by local ecological conditions and public sentiment. There are considerable differences in the objectives and methods used in prescribed burning between States (Shea *et al.* 1981). Prescribed burning met with significant public opposition when it was first introduced, and while its value is now widely understood, its role remains controversial.

Australia's state and local governments, rather than national government, are responsible for land and fire policy and management, even within national parks. There is a mosaic of land ownership and management within each state, meaning that all aspects of fire management must be coordinated if it is to succeed. Institutions have been developed at the state and district levels to insure that the planning and implementation of fire management and suppression efforts are coordinated among various government land managers and private land owners. These coordination efforts, coupled with fuel management over the last three decades, have largely succeeded in regulating the frequency and intensity of fire regimes on actively-managed lands. Periodic severe fires have swept across parts of south-eastern Australia during extremely unfavourable weather conditions in ENSO years. Creeping urbanization and forest fragmentation has made fire management particularly difficult at the urban interface, creating a threat to lives and property (Gill and Williams 1996).

3.2 Country synopsis

The six country case studies provide a number of insights into the context of fire management policy that may be applicable regionally or globally:

- Among the six countries, Australia's fire management policy, institutions, and science are by far the most developed, while Malaysia and Thailand have made significant progress in developing policies and institutions. Improved fire management in India and the Philippines is closely linked to these countries' community forestry programmes. Indonesia is working to improve all aspects of fire management in response its inability to prevent and control the 1997/98 fires.
- Fire regimes are generally shifting towards larger and more frequent fires (except in Australia where fire regimes tend to be severe, but stable). These changes, like accelerating deforestation and forest fragmentation, are related to other trends such as increased small-holder settlement of forest areas, explosive growth in timber harvesting in recent decades, and expanding commercial agriculture.
- The destabilization of fire regimes in developing countries is caused by a number of underlying causes as well as the direct causes mentioned above. These include high rates of population growth, poor land use zoning, land tenure laws that lead to conflict, weak or inappropriate land management policies and institutions, lack of enforcement of regulations, and conflict between land managers and local people.
- The developing nations in the group are, to a greater or lesser extent, hindered in their fire management efforts by weaknesses in policy and institutions, and lack of trained manpower, equipment, scientific knowledge, and funding. Areas of pronounced weakness are fire detection, communications, coordination, training, and gathering and analyzing statistical data.
- The majority of fires are ignited purposely or accidentally by humans for a variety of reasons. Rural people in the developing countries have traditionally used fire as a tool and do not believe

that it damages ecosystems, regardless of the level of use. In Australia, the role of prescribed burning is controversial despite the fact that it has been adopted by many land management agencies to manage a variety of ecosystems. Human attitudes play a strong role in fire management.

- Policy formulation tends to occur in reaction to acute problems, rather than as an orderly process within a comprehensive fire management policy framework with the participation of a broad range of stakeholders.
- Community forest management appears to be a very promising framework within which forest communities are given the responsibility to manage both forests and fire.
- International cooperation is a promising, but largely untested way for countries to share fire-fighting expertise, manpower, and equipment.

4. FIRE POLICIES

4.1 The policy formulation environment

Policy analysts envision policy formulation as an ordered process that begins with information gathering from which broad policy questions are framed, followed by development of policy options through consultation with stakeholders, selection and articulation of specific policies, and finally design of policy instruments. In reality, the process is seldom this orderly because it may be stopped or deflected by conflicts with existing policy, pressure from political interest groups, lack of resources and time, or lack of political will. Policy making often becomes an *ad hoc* process in which incremental policy decisions are made based on what is politically possible and will attract necessary budgetary support. In this paper, it is suggested that governments of developing countries in the Asia-Pacific Region should develop fire management policy within a comprehensive framework, with the understanding that some *ad hoc* approaches are necessary or inevitable to deal quickly with urgent fire management needs within a complex land and forest management environment. Fire policy must also be flexible and frequently updated to keep abreast with advances in knowledge and technology, political sentiment, and changes in fires regimes.

Forestry and land use policy formulation in the region has frequently suffered from addressing symptoms of problems rather than causes. This has been one of the main criticisms of Indonesia's efforts to develop fire management policy in the wake of terrible fire episodes over the last two decades (Tomich *et al.* 1998). It is necessary to analyze the underlying causes of unwanted changes in fire regimes while at the same time looking more broadly at the effects of other issues and trends that affect the way forests and rural lands are managed. Forest policy makers and managers, many of whom have enjoyed wide authority and narrow management objectives in the past, are now forced to adapt to trends such as decentralization, devolution of authority, and economic liberalization while trying to achieve broader management goals such as sustainable forest management, biological diversity conservation, equitable allocation of forest resources, and management of fire within prescribed regimes. These added responsibilities and complexities must typically be borne within an environment of weak and sometimes conflicting policies and institutions, limited political support, and few resources.

The policy environment for natural resources management is increasingly being influenced by international economic and political forces as well as a broader range of domestic stakeholders demanding a voice in policy formulation. In some cases, the land management policies of transnational firms or resource industries are as important as those of governments. Consumer groups and NGOs are making stronger demands for sustainably-produced timber and agricultural products and are employing tools such as certification, boycotts, and media campaigns to influence government and industry policies. A good example is a proposed attempt by some European NGOs to affect plantation land clearance policies in Indonesia through campaigns aimed at consumers of palm oil-based products. This campaign was triggered by the prominent role of oil palm plantations management activities in the 1997/98 Indonesia fires. Finally, the international community and neighbouring countries are becoming more forceful in pressuring countries to reduce transboundary smoke and atmospheric gas emissions from vegetation fires.

4.2 Fire management process

Fire management encompasses all measures taken to maintain fire regimes within desired bounds in target land management units. Fire management is an integrated framework of policies, institutional arrangements, procedures, technology, and resources. This framework usually runs vertically through two or more layers of government, as well as horizontally among various land management agencies and private owners. Fire management policy objectives will not be effectively achieved if any of the pieces of the framework are missing or do not work well together. Therefore, nations cannot expect to choose various bits of policy, technology and procedures at random and hope that these can somehow be forged into an effective fire management framework. As is the case in building a large building, a blueprint is needed to guide the construction.

A fire management strategy encompasses three broad categories of effort: preparedness; prevention; and suppression, each with its own components described briefly below:

Preparedness: This includes all measures to ensure that fire hazard is monitored, fire outbreaks reported promptly, and sufficient resources to suppress fires are available. At a more fundamental level, this includes having an understanding of the direct and underlying causes of unwanted fires and having policies and procedures in place to address these causes. Being adequately prepared requires having the following capabilities:

Prediction: The ability to predict the level of fire hazard. This requires scientific knowledge to construct fire behaviour models, meteorologists to predict fire weather conditions, ability to monitor fuel loads, and a means of communication of this information to land managers.
Detection: This can include various levels of technology including satellites , aircraft, and ground spotters. Standard procedures and methods for reporting the location and characteristics of fires are essential.
Coordination and communication: This requires the development of an institutional structure to coordinate all aspects of fire management within a given area among the public and private land managers. Most importantly, leaders of this organization must have the authority and communications equipment to direct fire suppression efforts and allocate resources.
Fire suppression resources: This includes fire-fighting leaders, enough properly trained and equipped fire-fighters available on short notice, and access to adequate transport, water, and logistical support for extended field operations. Ability to access and properly employ water bombers or other aerial suppression equipment.
Monitoring: The ability to measure the effectiveness of preparedness, prevention, and suppression activities for meeting fire management objectives. This requires baseline data, a system for continuous data collection and analysis.

Prevention:

Hazard reduction: This involves managing fuels through forest harvesting codes or other land management guidelines, prescribed burns, or vegetation change.
Risk reduction: This includes awareness campaigns targeted at rural people, corporations, field workers, or government officials who can have a role in preventing fires.
Enforcement: which requires policies and rules regarding burning, including conditions under which the use of fire is legal. Effective enforcement requires a policing system and the political will to act.

Suppression:

Detection: Rapid detection and communication of information and instructions.
Prioritization: Decisions about which areas or types of fires should be prioritized for suppression activities .
Mobilization: The ability to quickly move adequate suppression resources to the fire.
Knowledge: Information and expertise to formulate and implement appropriate suppression measures.

4.3 Related issues to be considered

Fire regimes are shaped by a variety of factors not included in fire management per se, but which must also be addressed to manage fire successfully.

Cross-cutting issues:

Land classification: Wildfires can often be prevented or their spread minimized by classifying land so that compatible uses adjoin to prevent fire risk e.g. fire-prone pine plantations should not be adjacent to protected areas with high biological diversity values, or near human settlements.
Land tenure: One of the major factors that increases fire risk in some developing countries is the lack of a transparent and effective mechanism for assigning land rights that is accepted by all segments of society. This can lead to open access situations (Bromley 1992) in which no one feels responsible about fire control , or to conflicts that are sometimes settled by intentional burning of crops or forests. Even if tenure is clear, accurate land ownership maps are needed to enforce burning regulations.
Land management: Many land management agencies are neither effective nor efficient at fire management due to lack of authority, unclear land boundaries, lack of resources, vague or conflicting policies, and pressure from powerful business interests.
Skewed economic incentives: Some governments in the region inadvertently increase fire hazard and risk through policies that explicitly or implicitly encourage uncontrolled settlement and conversion of forests through economic or other incentives intended to accelerate development.
Attitudes: In most countries of the region fire has always been used as an agricultural tool for disposing of wastes and clearing land, and rural people are slow to recognize that the current scale of fire use threatens to degrade ecosystems and ecological processes upon which they are dependent.
Land use: Forestry and agricultural practices closely related to fire management must be reviewed and regulated if necessary.
Forestry: Review and enforce harvesting codes to minimize waste wood left in the forest, damage to the residual stand, invasion by grasses and vines, and access for agricultural settlers. Make fire management an important criterion in forest certification.
Plantation agriculture: Control the location and extent of forest conversion, and minimize the use of fire in land clearance.
Small-holder agriculture: Monitor the intensity of swidden agriculture and forest conversion by settlers. Regulate the season and location of fire use for waste disposal, land clearance, and soil fertility management.

4.4 Aspects to be considered in formulation of a fire management policy

As was discussed in Section 4.1, countries rarely follow idealized policy formulation processes, but it is useful to discuss the major steps and questions that should be addressed in developing fire management policy. Successful policy formulation is heavily dependent upon asking the right questions of the right groups of people. As is the case with most policy, the ultimate objective of fire management policy is to determine the what, how, where, when, and who. The major steps in this process are: asking and answering questions; formulating options; articulating policy; designing instruments and institutions, and selecting technology.

Questions: Following is an indicative list of the types of questions that should be asked to start the policy dialogue. Most of these questions are simply a starting point for exploring other, related questions. An important part of this stage is determining which stakeholders should be asked to participate in the process of formulating and answering the questions. Forest-dwelling peoples living in remote areas are important stakeholders, and consulting them requires logistical effort and special tools such as Participatory Rural Appraisal.

- What were fire regimes like previously, how have they changed, and how would we prefer them to be?

- What are the legitimate uses of fire?
- Which groups of people are responsible for using fire inappropriately, and how could/should their behaviour be modified?
- What current policies affect fire regimes directly or indirectly, and should they be revised?
- What are the appropriate boundaries of fire policy in terms of sectors, land uses, and impact types?
- Which level of government should be primarily responsible for each component of the fire management framework, and how should they be connected through intersectoral linkages and vertical coordination?
- What scientific knowledge is lacking in formulation and implementation of policy?
- What resources are available to manage fire?

Options: Following are some of the possible steps in selecting and narrowing policy options.

- Develop policy selection criteria based on values to be protected, effects on other areas of policy, political sentiment, and cost-effectiveness.
- Conduct economic analysis of policy options to determine the costs and benefits of proposed options to the government and various sectors of society.
- Analyze the possible environmental and social impacts of the options.
- Analyze the effectiveness of the options within different institutional structures.
- Analyze the compatibility of options with the fire management policies of neighbouring countries and regional fora as well as the standards of international climate and biological diversity conventions.
- Conduct a second round of stakeholder consultations.
- Define the most promising options.

Articulate policy: This is the process of formally debating the short-listed options in the appropriate political forum and passing necessary enabling legislation.

Design instruments and institutions: The regulations, procedures, resources and institutional structure needed to implement the chosen policies.

Select technology: Sometimes the type of technology is an integral part of policy implementation, so the selection of scientific equipment, GIS, remote sensing equipment, and aircraft may become a policy as well as a technical decision. Arrangements for sharing equipment with neighbouring countries should be part of this process.

4.5 International cooperation and assistance

Many of the developing nations of the Asia-Pacific Region lack the expertise and resources to formulate and implement fire management policy. Aside from altruism, their neighbours and the international community have an incentive to help them bring runaway fire regimes under control for the sake of regional air quality, managing the emissions of greenhouse gases, and protecting biological diversity. Cooperation and assistance can take the forms of joint scientific investigations, technical assistance, information-sharing, assistance with monitoring and detection, sharing of fire-fighting equipment and personnel, and financial aid. The generally disappointing level of effectiveness of international fire management assistance to Indonesia over the past 16 years serves as a warning that such assistance must be coordinated; should be provided within a viable institutional and organizational framework, and most importantly, be backed by strong political will from the host country government.

4.6 Regional cooperation

Due to the size and diversity of the region, direct cooperation is most likely at the sub-regional level. The most active sub-region with respect to fire management is Southeast Asia, spurred on by recurrent major fire episodes in Indonesia that have taken a heavy toll on the economies and public health of Malaysia, Singapore, Brunei and Indonesia (EEPSEA/WWF 1998), as well as severely straining diplomatic relations within ASEAN. A model for such cooperation is the recently-finalized, ASEAN-wide Regional haze Action Plan (RHAP) consisting of Prevention, Monitoring, and Mitigation components that are assigned to Malaysia, Singapore and Indonesia, respectively . Each nation must also develop a National haze Action Plan (NHAP) that incorporates the three components. A Regional Technical Assistance (RETA) Project was established within the ASEAN Secretariat with Asian Development Bank funding to develop a management system to implement the plan.

5. CONCLUSIONS AND RECOMMENDATIONS

The fire regimes of many of the vegetation formations of the Asia-Pacific region are changing in ways that adversely affect the atmosphere, ecological processes, biological diversity and in some cases, agricultural and forest productivity. Alterations in the fire regimes of the tropical rain forests have been particularly pronounced, especially in Indonesia over the past two decades. Humans are largely responsible for changes in fire regimes through careless logging, forest degradation and conversion, and undisciplined use of fire for land clearance. Other factors have contributed to the increased incidence of vegetation fire including weak or inappropriate land use zoning, policies, institutions, and management, inequitable land tenure arrangements, growing rural populations, and poorly-planned infrastructure development.

Fire is a traditional land management tool in most countries of the region, and many governments have been slow to match the growing fire threat with effective fire management policy and capability. Government efforts to manage fire are often unpopular among both rural residents and commercial land users, especially if management requires changing the rules of access to resources. Among the countries in the region, Australia has the most severe fire regimes, and has been most successful at developing the knowledge and capability to manage fire to meet specific land management objectives under various climatic and ecological conditions. India and the Philippines have given forest-dependent communities the responsibility to manage fire as part of community forest management agreements, providing a promising approach for developing countries.

Recommendations for developing fire management policy must be tailored to the conditions, needs, and resources of specific countries, but the following guidelines are broadly applicable, and are important take-away points from this paper:

- Know what fire regimes you want: determine what fire regimes are possible under the prevailing climate, ecological conditions, and land use, and of these, which are most desirable and practicable.
- Manage fire to meet specific objectives: objectives may include maintenance of ecological processes or key species, protection of human or natural values, or avoidance of atmospheric or other off-site impacts.
- Design fire management policy within the context of other land use policy and trends: to the extent possible, address related or underlying factors that increase fire risk.
- Develop fire management policy systematically within a comprehensive framework: *Ad hoc* efforts may be needed to address acute fire management deficiencies, but only a comprehensive framework of law, institutions, and resources will be effective in the long term. Policy formulation should not be donor or technology-driven,.
- Involve partners: communities, NGOs, the private sector, and neighbouring country governments should be participants in fire policy formulation and fire management. Successful policy formulation depends on asking the right questions of the right people.
- Change attitudes: effective fire management requires changing attitudes of key actors at the community level, in the private sector, and in government.
- Critically evaluate procedures and technology: Imported technology and procedures may not meet needs or be impractical within resource constraints.
- Assign responsibility to the appropriate level of government: Some fire management functions such as prediction and satellite detection may best be done at the national level, while suppression may be most effectively achieved at the province or district level.

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COMMENTS ON THE SITUATION IN THE ASIA-PACIFIC REGION

A.H. Moosvi[3]

In most of South Asia, forest fire statistics are either non-existent or unreliable. Because of lack of standardization of reporting formats and valuation norms fire occurrence and damage data where available are of little use in policy and plan making. In India, furthermore, public accounting procedures have the effect of concealing fire occurrence/damage reports as otherwise the forest staff recording and reporting the episode will be liable for the loss as if his failure had caused the fire. Public policy on accounting thus inhibits he development of fire databases and further impedes the process of sensitization of the public to the ecological, economic and the human health impact of forest fires. As a result, fires seldom find a focus in national policy.

Fire protection strategies and programmes generally do not reflect the interest and the world view of the people who are invariably blamed for starting the fires in the first place. In many countries of the region, there is no mechanism or framework linking foresters and land-use managers with the forest dwellers in policy-level partnership which would regulate the use of fire as a means of achieving sustainable forest management objectives.

Fire protection strategy planning has to be country specific and in accord with the forest policy, bio-diversity status and the on-going programmes in the forest sector in each country. It should recognize the connection the forest and the wildlife issues have with the nature and extent of the dependence of the local people on forest fire as a resource management tool. India, for example, has the world's largest population of forest-resident and forest-dependent people with nearly 250 million of them inhabiting 150,000 villages in and around the forests. Their reasons for using fire, and the "where" and "when" of it, should obviously be the most critical guideline in the policy formulation exercise not only because India has opted for the participatory mode of forest management but also because the fringe-of-the-forest people are the most important stakeholders in the forest as also the most decisive in the prevention and the control of fires.

Forest fire policies are impacted by policies outside the forest sector also, as in Brazil and Indonesia (policy on change of land-use), West Africa (process of structural adjustment), India (rural employment and tribal welfare), and in sectors like mining, agriculture, power and industry. Fire policy has therefore to be a part of the overall conservation strategy of the countries concerned.

Policy needs to focus on prevention rather than suppression. The latter is vastly more "media-friendly" and dramatic, and tends to attract the most attention. People's participation and the building of public awareness around the health, ecological and the economic effects of wildfires have together to define the low-cost, low technology strategies that are naturally suited to fire management planning models in the developing countries.

FAO being the traditional forum for debate and dialogue as well as a leading international exchange for information on forest sector issues, the South Asian countries stand to gain immensely from FAO's technical support in the following areas of fire management:

(a) Fire data-base standardization, design and *in-situ* implementation.
(b) Studies on bench-mark fire regimes, in representative ecosystems in each country, and on the scope of prescribed fire therein.
(c) Development of valuation and assessment norms for the economic, ecological and human-health impacts of fires.
(d) Capacity-building in the national forest-sector institutions to install and maintain fire databases, monitoring and evaluation protocols; to develop research programmes, and to run training programmes in fire management planning rather than in fire-fighting only.

[3] Forest Management Consultant, India.

(e) Feasibility studies of control/suppression technologies suitable to the low-cost economies of the region.

REPORT OF THE WORKING GROUP ON ASIA-PACIFIC REGION

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INTRODUCTION

The Working Group (WG) based its discussions on the background paper prepared by the FAO consultant J. Schweithelm, the discussions in plenary and the experience of its members.

The WG decided to concentrate its discussions on land use policies concerning forestry only, since forestry is one of many alternative land uses. It also decided to interpret “forest fire” as referring to all vegetation fires (agricultural fires, bush, forest fire, conversion fires and ‘development fires’). Development fires are those that relate to land conversion goals set by the government as part of broader goals which seek to generate economic and social development. They are therefore not accidental, but are linked to the country’s development plans.

The discussion was focused on national policies. It was recognized that policies can be at regional or national level, but since those at regional level are often more related to political considerations, the group felt it most relevant to focus its attention on national actions which can be targeting government, local people, etc.

Several countries in the region were discussed in order to identify different issues and policies affecting forest fires and to draw broad conclusions for the region. In this discussion the WG noted that there is a wide diversity between the countries in the region in geography, stage of development, natural resources, climate, political structures, population density, cultural makeup, etc. All have an impact of policies relating to forest fires. It was noted that Australia and New Zealand differ from other countries in that the main fire issues relate to climate and to forest management methods.

PROBLEMS IDENTIFIED

From the country-level discussion the WG identified the following issues as of major importance:

1. Land Conversion

Although fire is used by all stakeholders, the goal of economic development in many of the countries of the region is the reason for the following types of land conversion:

i. Conversion to tree crops (e.g. oil palm, rubber, cinnamon and others);
ii. Conversion to timber and pulp estates.

In this type of conversion, large stakeholders receive incentives from the government which promote the conversion of primary forest to timber, pulp and tree crop estates. Land clearing is usually done by fire as the cheapest and most rapid method. This pressure on forests is added to further by the pressure from the international community to open up sound investment opportunities. This has caused the conversion of significant areas of forest land to, for example, oil palm, with fire as the tool of clearance.

The practice of zero burning is now being required of most large holders. However enforcement is often poor and fire problems continue despite the laws and regulations. It was noted that the returns from oil palm and other plantations are often not sufficient to counteract the higher costs involved in zero burning. This is often because only the short-term benefits of zero burning, and not the long-term benefits, are calculated.

2. Land practises by farmers

Farmers use fire in land clearing. They have few options since fire is the cheapest or the only land clearing method. They also use fire as a tool to encroach on natural forests.

3. Social causes

In addition to being a legitimate land-clearing tool, fires are used as weapons in land use conflicts in situations with unclear land tenure, and as a cover-up by large stakeholders who have not met their planting commitments.

4. Early warning systems

When early warning is applied, it must be associated with awareness-building campaigns if the warnings are to be effective.

5. Reverse migration to rural areas

Because of the economic crises, reverse migration is putting more pressure on the forest at its margins.

6. Fire reporting and the statistics

Because of weak statistics, it is difficult to asses the fire problem. Statistics should therefore be improved.

7. Ecology and biodiversity losses

The quantification of these must be improved, not just the value of marketed products.

SOLUTIONS

1. Improve the enforcement and economic incentives and disincentives for small and large holders alike not to burn, or only to burn at specific times. Zero burning could be applied by large holders.

2. Land tenure should be clear. Compensation rules for small and large holders alike should be implemented.
3. Early warning systems are helpful tools.
4. Local people should be trained in prevention as well as in fire control, fire suppression and fire-fighting.
5. Fire command structures in government and within specific departments should be clear and responsibility should be identified.
6. Awareness campaigns for small holders and the private sector in the use of fires should be implemented. The private sector could be involved in sponsorship of these activities.
7. Fire should be treated as a forest management issue.
8. Where local people are the cause of fires, they should be included in the development of the fire policies and in fire management.
9. The skills of foresters to work closely with local communities under developed.
10. Efforts should be made to build a sense of ownership of local people over the forest.
11. Improved and standardized databases should be developed on fires.
12. Research should be expanded on the impact of fire on biodiversity and conservation.
13. Forest boundaries should be clearly demarcated and strictly enforced by communities and government.

THE ROLE OF FAO AND OTHER INTERNATIONAL INSTITUTIONS

The WG identified the following areas where FAO and other international organizations had an important role to play in supporting the efforts of national governments:

- Provide technical assistance;
- Training in appropriate low-tech fire suppression technology;
- Encourage the sharing of information;
- Facilitate the coordination of donor efforts;
- Improve and standardize databases on fires;
- Disseminate fire data and management techniques;
- Address regional level issues through training and information activities.

The WG considered that fire issues should become an ongoing part of the forestry programmes of these international organizations.

RESEARCH

The WG identified the following as some of the important areas where further research is required:

- Development of a typology for fire regimes and their impacts;
- Assessment of the effect of recurrent fires on biodiversity;
- Assessment of the effects of fires on ecological processes, especially in tropical rainforest;
- Assessment of the effect of fires on global environment change;
- Identification of underlying human related causes of fires.

PUBLIC POLICIES AFFECTING FOREST FIRES IN THE MEDITERRANEAN BASIN

Daniel Alexandrian
François Esnault[4]

CHARACTERISTICS OF FIRES IN THE MEDITERRANEAN BASIN

This document relates to the 23 Mediterranean countries: Albania, Algeria, Bosnia, Croatia, Cyprus, Egypt, France, Greece, Iran, Israel, Italy, Jordan, Lebanon, Libya, Malta, Morocco, Portugal, Slovenia, Spain, Syria, Tunisia, Turkey, the former Yugoslavia. All these countries have a more or less long dry season: in the north of the Mediterranean, between 1 and 3 months of dry season on the French and Italian coasts; in the south, more than 7 months of dry season on the Libyan and Egyptian coasts [53].

Statistical data sources

Various data sources have been used:

- the common data base on forest fires of the European Union countries (Spain, France, Greece, Italy and Portugal), supplemented for the most recent period by several publications [43],
- many sources for the other countries, in particular national publications and papers written for symposiums or international reviews.

The analyzes carried out in the past by several experts (Le Houerou [30], Goldammer [23], Mol and Kuçükosmanoglu [44]) were also used. Lastly, the figures collected were presented for correction to the FAO (Geneva).

Four main statistical problems must be underlined:

- Some countries do not have statistics. Several countries do not have a data collection system (Egypt, Malta). There are two main reasons for that: small extent of forests or low incidence of fires.
- Recent years are badly indicated. Paradoxically, in spite of our efforts, it was very difficult to find data for the most recent years concerning the number and the area of fires.
- The long statistical series must be interpreted carefully. Some data are very old, sometimes more than one century (Algeria [25], Cyprus [19]). The forest context may have significantly changed; political events also may also have affected the country and modified the way of tallying fires. In the former Yugoslavia, for example, the national statistics existing before the break-up of the socialist republic were replaced by those published by the new republics (Croatia [2], Slovenia [36]), so an over-estimation is possible when these republics reconstituted their statistics *a posteriori*. Over such a long period, the systems for collecting information may have evolved (e.g. the case of Algeria after the war of independence).
- There is no common definition for all countries. There are almost as many definitions as countries. In Cyprus [11], only fires started in national forests less than 1 km from the boundaries are entered in the database. In Spain and in Portugal [15, 43], a forest fire is an uncontrolled fire in a forested area reaching a vegetation which was not intended to burn. This situation makes the comparisons between countries more difficult.

[4] Agence MTDA, Aix-en-Provence, France.

Main lessons to be learnt

Fire represents the most important natural threat to forests or wooded areas of the Mediterranean basin. It destroys many more trees than all other natural calamities: parasite attacks, insects, tornadoes, frost. Human action, direct or indirect (illegal felling, overgrazing), is obviously excluded from this comparison.

To measure the total impact of fires, it is interesting to use the Annual Average Risk (AAR) [30], expressed as a percentage of the wooded area burnt each year. Using the national statistics collected, the average value obtained for the Mediterranean basin is equal to 0.8 (a 125-year fire interval). Two countries have a AAR higher than 2 (a fire interval lower than 50 years): Israel and Portugal. When limited to only the Mediterranean part of the countries (difficult to establish with certainty), the AAR reaches 1.4 (a 70-year fire interval), with a maximum of 3.8 for Italy (a 26-year fire interval).

Within countries like Portugal, Italy or Greece, some areas are especially affected: Sardinia, Puglia, Sicily, some Greek islands. In these areas, the AAR exceeds 4, that is to say a fire interval lower than 25 years. The fire pressure prevents any forest reconstitution there and condemns the soil to desertification or at the very least the (**matorralization)** [53].

The average annual number of forest fires in the whole Mediterranean basin is close to 50,000 today, that is to say twice as many as during the Seventies. The statistical series do not coincide and it is not possible to measure with certainty the evolution over the whole area. In the countries where data have been available since the fifties through to the seventies, a large increase starting from the beginning of the Seventies can be observed: Spain (from 1,900 to 8,000), Italy (from 3,400 to 10,500), Greece (from 700 to 1,100), Morocco (from 150 to 200), Turkey (from 600 to 1,400). Only the former Yugoslavia deviates from the general trend (from 900 to 800).

The annual cumulated burnt area in the Mediterranean countries can be estimated at approximately 600,000 ha, that is to say almost twice as much as during the seventies. The trend observed is, however, much less uniform than for fire incidence. Aggravation is clear in Greece (from 12,000 to 39,000 ha), in Italy (from 43,000 to 118,000 ha), in Morocco (from 2,000 to 3,100 ha), in Spain (from 50,000 to 208,000 ha) and in the former Yugoslavia (from 5,000 to 13,000 ha). In Portugal, the same trend is visible, although the statistical series starts later. In Algeria and Cyprus, there is no significant evolution, but some years present a very high maximum (1957, 1958 and 1983 in Algeria; 1974 in Cyprus). Lastly, there is no evolution in Croatia, France, Israel or Turkey.

It is important to note that no country shows an improvement of the situation, despite all the measures undertaken [30].

Unlike the other parts of the world which have an important percentage of fires of natural origin (lightning), **the Mediterranean basin is marked by the prevalence of fires of human origin.** Natural causes only represent a small percentage of all fires (from 1 to 5 percent according to countries), probably because of the absence of climatic phenomena such as dry storms.

The other characteristic common to all the Mediterranean basin is the high percentage of fires from unknown causes. In most countries, they are in the majority: 56 percent on average in the 5 countries of southern Europe; between 50 and 77 percent in most of the others (Cyprus, Israel, Morocco, Tunisia, Turkey). It is to be noted, however, that some countries are characterized by a relatively low proportion of fires of unknown cause, between 25 and 47 percent (Croatia [2], Greece [49], Portugal [18]).

Among the known causes, those which are involuntary (negligence or accidents) are the most frequent in all countries, except in Turkey where voluntary fires seem to be in the majority [8].

The accidental causes vary between countries: some are dependent of fixed installations (powerlines, rubbish dumps) and some are directly related to a human activity (badly controlled charcoal kilns, uncontrolled burning, smokers, campfires, shepherds' fires). The list is very long and any synthesis is thus impossible. It seems, however, that these involuntary fires are directly related to agricultural and forestry activities: the parties at fault in fires are mainly the permanent inhabitants (seldom passing tourists).

Paradoxically, **the fundamental cause of forest fires is linked to the standard of living and increase of the populations.** Some examples are:

- Western Europe has experienced a deep social and economic modification which has resulted in a transfer of population from the countryside to the cities, a considerable deceleration of the demographic growth, an abandonment of the arable lands, a disinterest in the forest resource to the benefit of other sources of energy. This change caused an increase in the amount of fuel, an extension of wooded areas, an erosion of the financial value of the wooded lands, a loss of population with responsibility with regard to the forest. This period was marked by a significant increase in fire incidence [30].
- on the contrary, in the Maghreb countries, the demographic dynamism was maintained, especially in forest villages. The demand for food and energy (firewood) increased to the point of seriously reducing the forest area. In addition, forest fires are seen by the inhabitants as a direct threat to their living conditions. The fire incidence remains at a relatively constant level.

SPECIFIC POLICIES

We classically arranged these policies into four categories:

- *prevention*, including all the measures intended to prevent forest fires from occurring;
- *pre-suppression*, re-uniting all the provisions intended to improve the intervention and safety in the event of fire;
- *suppression*, including all the means of intervention, whatever they are; and
- *repair of the damage*, i.e. the measures taken after the fires to limit their negative consequences.

Prevention

Knowledge of the causes is a precondition for the implementation of adapted solutions. Important means and an original methodology were developed in Portugal. After an increase of fire incidence at the end of eighties, the Portuguese authorities created brigades for fire research, made up of forest guards. Their objective was to investigate each fire and identify the cause of it. Scientific methods of investigation were progressively developed. Within a few years, the country passed from 80 percent of fires of unknown origin to less than 20 percent. Moreover, this experiment made it possible to show that the great majority of fires was related to negligence (43 percent), followed by arson (34 percent) [18].

Almost **all Mediterranean countries adopted measures to increase public awareness of forest fires.** The target is the adult public located in areas of risk, residents or tourists. School children are also the object of specific programs[7].

For the general public, the mass media are used: TV spots, posters, radio advertisements. In Spain, stage performances are also used in rural zones insisting on the consequences of forest fires. During the seventies, the authorities chose an animal symbolizing the forest [42].

The messages have evolved. At the start, posters tended to cause fear. Then, stress was laid on the ecological risk. Currently, messages are rather utilitarian (what to do in the event of fire).

Among the legal provisions implemented, two deserve to be underlined:

- Punishments imposed upon the parties at fault in a fire. The majority of the Mediterranean countries have a legal arsenal against the parties at fault in fires. The punishments for voluntary fire are always much more severe than those for involuntary fire. They are various, from forced work in Morocco [69], Algeria [25] and Tunisia [10]) or life sentence in France, to imprisonment terms of a few months only in Cyprus. In certain cases such as Portugal [26]and Israel [54], the punishments were re-inforced after the country experienced a wave of arson. It can be observed, nevertheless, that the heavier the punishments provided by the law, the more difficult it is to prove arson and the more the courts hesitate to condemn arsonists [22].

- The right of use regulations. Many countries prohibit the use of fire (including smoking) in forests and near their boundaries during the period regarded at risk. This prohibition aims also at land owners. This regulation is completed by fines, sometimes rather high. Other countries (Spain, Italy, France, Cyprus) prohibit access to forests as much for prevention as for civil safety, i.e. to prevent civil populations from being encircled by the flames [22].

Fires due to installations (railways, dumps, power lines) exist in almost all the countries to a different extent. Contrary to arson, the identification of accidental fires is generally easy. The mechanisms of ignition are known as are the technical measures. Paradoxically, their processing is poorly considered in the list of measures taken.

Pre-suppression

The forecast of weather conditions is used to mobilize the means in advance. From this point of view, the American fire behaviour model is often used (Israel [65], Syria [29], Spain [14]). The countries have also made great efforts to obtain weather stations recording temperature, humidity, wind speed and wind direction.

Monitoring from lookout towers is a very widespread technique (Syria [1], Israel [54], Jordan [58], Turkey [56], Yugoslavia [59], Morocco [69]). Some of them are assisted by automatic infra-red systems (Spain [38]). This network is supplemented by ground patrols made up of foresters having a good knowledge of the area (Tunisia [10], Morocco [69], Algeria [25]). In many countries private planes assigned to monitoring patrol on the days of risk (Algeria, Croatia, France, Spain) [43].

However, the statistics very often reveal that **the inhabitants raise the alarm** before the lookout towers or the patrols (France). But, when fires are detected by the official network, the information reported is more accurate.

Once the alarm is given, fire-fighting requires **a perfect coordination of the means with radios.** Large efforts have been made during recent years (Turkey, Algeria, Morocco, Tunisia). However, several problems exist:

- the areas at risk are often on a steep terrain which prevents communications. It is then necessary to increase relays on hill tops.
- the reservation of a frequency band for the authorities. In certain countries, this field is reserved for the military.

Management of forests against fires is carried out in a very similar way throughout the Mediterranean basin. It is based on the creation of tracks, firebreaks and water reserves. This work is often designed within the framework of traditional management projects (Algeria, Tunisia). When the network is considered sufficient, the question of its maintenance arises (those who created and those who maintain those investments are not the same authorities). These infrastructures, sometimes designed 20 years ago, are no longer technically adapted to the current materials (large water carriers, air tanker helicopters).

A good knowledge of the area is necessary to optimize fire-fighting. In countries with a high density of inhabitants close to the forest, mapping does not appear necessary (North Africa). In European countries having undergone a strong rural depopulation, it is an absolute necessity (it is subsidized by the European Union [51]). Sometimes, the military authority is the owner and exclusive user of the maps, so it is difficult for the forest services to access the data.

Several countries adopted provisions within their forestry laws aiming at obliging the owners to clear the undergrowth along the roadways or/and railways (France, Israel, Italy, Spain, Turkey) [22]. Undergrowth clearance can be interpreted as much as a measure of prevention (aiming at avoiding the ignitions) as a measure of pre-suppression (aiming at making roads safe).

In France, the law obliges owners to clear the undergrowth within a perimeter of 50 metres around their house (self-protection). In reality, this provision is little applied because of the cost and the land problems.

Suppression

Recent data on this subject are very difficult to obtain. For the air tankers (planes or helicopters), fewer and thus easier to record than vehicles, a range from 1 to 4, for example, can be noted in absolute value between two neighbouring countries: a little more than 30 units in Portugal against 140 in Spain. In relative value, on the other hand, the 5 countries of southern Europe have all approximately one unit for 100,000 ha of Mediterranean forest. International cooperation is one of the concerns of the European Union [23, 18].

As regards strategy, information is even more difficult to obtain. In France, the objective is an initial attack in less than 10 minutes [45]. This strategy is based on anticipation: according to the risk level, vehicles are placed close to forested areas and air tankers are airborne before any fire is reported. Under certain particularly unfavourable conditions, it was shown that to be effective, the initial attack needed to be carried out in a still shorter time.

The repair of the damage

All the trees are not totally destroyed by fire. Some are simply licked by the flames. **The first measures consist of urgently evaluating their chances of survival.** Many specialists recommend that trees weakened by the flames be abundantly sprinkled with water immediately after the fire.

Fight against erosion is the second priority. The Mediterranean area is characterized by steeply sloping terrain and heavy rains in the autumn. When the canopy disappears, there is a risk of erosion or mud flows. The felling of burnt trees and their disposal along the contour lines makes it possible to retain the soil and stones on the slopes.

The felling of burnt trees has been improved in recent years, in particular in southern Europe, for various reasons:

- economic reasons: even if the wood loses its value, it can always be sold as firewood (in Portugal, there is an economy based on the felling and the marketing of burnt trees) [33],
- safety reasons: the burnt trees located near roads or lanes used by the public can fall during wind,
- ecological reasons: the felling of the aerial part burnt is a desirable operation to facilitate recovery,
- aesthetic reasons: when the fire is located near urban areas, the aim is to eliminate the black trunks visible from the inhabited areas.

Once urgent works are completed, there is the question of the future of damaged areas.

Reforestation is employed under certain conditions:

- it is sometimes an action provided by law (the Turkish constitution states, for example, that the burned areas must be reforested). It is the same in Portugal and in Spain. However, taking into account the areas burnt and the amounts of money to be spent, this provision is not always applied,
- reforestation is essential sometimes for reasons of soil stability or to prevent the advance of deserts [4].

The policy pursued by the European Union is no more to reforest identically, but initially to measure the chances of survival of the plantations to be made, by first evaluating the fire hazard [51].

SECTORAL POLICIES

Effects on fire incidence

Forest fires sometimes reveal tensions existing in a given space. Here are some examples, drawn from existing literature.

Fire as an instrument of war. During the conflicts and the wars, fire is used either to drive out men from the heathlands or the mountains, or to besiege a city and to throw on the roads its inhabitants [46, 16]. Bombardments are often also at the origin of fires. The wars in Lebanon, Yugoslavia and more so the Algerian war of independence were marked by an increase in fire incidence. In 1993, the shifts in population on the border between Albania and Greece seem to be accompanied by fire starts. In several countries, fires related to conflicts form part of the causes officially listed in the national data bases.

Fire as a response of hostility to political changes. The national Turkish, Greek and Cypriot experts explain the variations of their long statistical series by the major political events, which, about every 4 years, shake the country (national, senatorial elections) [8, 21].

Fire as a way of affirming its right of use. In many countries, the right of use prevails on the right of ownership, in particular in the south of the Mediterranean basin (Morocco [69], Tunisia [10], Libya [4]). At all times, villagers used the forests to feed their cattle, to seek firewood, to make charcoal. When a government or a community proposes to recover these lands to assign them to an exclusive use (for example, reforestation), tensions appear (Turkey [5]). In a gesture of appeasement and prevention, the State can agree to sign contracts of land use with the former users (Libya [4]).

Fire as an instrument of land appropriation. In Turkey, Greece and Cyprus, forests are almost entirely owned by the State, villages or the church. But the limits of properties are not always clearly established (in Greece [21], the *cadastre* only covers one quarter of the country). Fires are often ignited on the boundaries of public property. The aim of the arsonist is to use or to settle on public lands. If no control takes place, the lands are declared private.

Fire as a way of changing lands use. Many countries have laws which stipulate that the burnt forests should preserve their forest vocation for a more or less long period (generally 10 years). The objective is to avoid intentional fires in order to transform a wooded land into a site approved for development. The interest of this provision has been measured through two experiments:

- in 1983, the Greek Parliament adopted a law aimed at legalizing the houses built illegally on burnt lands [20]. There then followed an wave of fires of doubtful origin. The law was then repealed (according to certain recent information, this law would have been voted once again in 1998).
- all the studies made in France and Spain (countries protected by this provision) on the gradual change of burnt lands, show there is no relationship between the areas devoted to urbanization and arson which has taken place in the past [60].

Fire as a means of subsistence. In the countries of the European Union, fire-fighting is carried out by volunteers, not professionals, and as such they receive an allowance proportional to the number of hours spent fighting fires. In certain economically underprivileged zones (Sardinia, South Italy), fires intentionally set by the firemen are often reported.

Fire as a response to the subsidies system. The European Union grants a substantial financial help to the stock breeders of nursing cows. To be given these subsidies, three conditions are required: to be declared as a farmer to the local authorities; to have a sufficient area of land; to have a healthy herd**.** Corsica is an island where there is a tradition of pastoral fires, lit with the aim of regenerating pastures for animals which are left in total freedom. An investigation showed that the granting of these subsidies stimulated forest fires for several years. Noting a generalized diversion of the European Commission financial support, the European Union suspended its subsidies [13, 17]. This decision seems to have led to a decrease in fire incidence in Corsica.

Effects on burnt area

Forest fires are also revealing policies which affect land management.

Fire in the face of a forest whose area increases. Public support for the agricultural sector is provided within the European Union to reduce areas of production (Portugal, Spain, France) [51]. First of all, for the voluntary reservation of fallow of 10 percent of the total area of the farms. Subsides are granted to owners of vineyards to remove their vines. Subsides are also granted to farmers who reforest their land (since the subsides have been given during 15 years now, this measure is comparable to a final "freezing" of agricultural land). All these measures contribute to extending combustible areas (waste lands) and to reduce the obstacles to the natural advance of fires.

Fire in the face of widespread urbanization. In several countries where the abandoned fields are numerous, the individual houses and the villages formerly located in full agricultural zones are found to be encircled by forests and directly threatened by fires. In addition, after a movement of urban concentration in the Sixties, the populations now prefer to settle around the towns in wooded areas. In case of fire, this means concentrating on the protection of houses, which decreases their effectiveness. Portugal and Spain have each year some properties are destroyed and sometimes human life is lost [33]. France adopted a law in 1995 aimed at prohibiting or regulating all new constructions in areas at risk. This regulation imposed by the State is then included in urban development plans of the towns (Risk Prevention Plan).

Fire in the face of disparate private ownership. In Italy, Spain, Portugal and France, forests are mostly privately owned[21]. The case of Portugal is significant [51]. More than 80 percent of forests are held by private owners having less than 1 ha. Moreover, since many Portuguese emigrated for economic reasons to neighbouring countries, very many lots are currently without identified owners. The situation is likely to worsen still since the transfer of the real estate is carried out either by property fragmentation or by joint possession. Under these conditions, it is almost impossible to promote an improvement of forest management in order to fight fires effectively.

Fire in the face of forest taxation. Taxation has a very important influence on forest management. But, in southern Europe, taxation penalizes owners heavily and does not encourage them to protect their property. In Spain, death duty is indexed to the monetary value on the day of transfer [51]. The tax on the assets is calculated by adding the annual monetary values of the forest. So, the owners are obliged to pay an amount of money sometimes higher than the forest revenue. That leads them to exploit their forest prematurely. The annual tax on the income is calculated by dividing the amount of the forest income by the rotation of the cuts. This way does not take into account the very important fluctuations in forest incomes and obliges the owners to pay each year a disproportionate tax compared to the receipts. Again, the owners can be encouraged to increase the rotation of the cuts or to choose short rotation species. In Portugal, death duty is also very heavy. It fluctuates between 4 and 76 percent of the value of the assets. The recipients are constrained to pay the death duty by dividing up the land and selling part of the inheritance. In France, the law allows an exemption from death duty up to three-quarters of the value of a wooded area, if the owner undertakes to implement for 30 years a management plan approved by the government. This provision is however unsuited to the Mediterranean area and is reserved only for properties of more than 25 ha.

CONCLUSION

With 50,000 fires and 600,000 ha burned on average each year (of which 40,000 fires and 500,000 ha in the European Union countries), forest fires in the Mediterranean basin represent a significant part of all the fires which occur in the world. **Several experts evaluate at one billion US dollars the total cost of fire-fighting and safety devices**[30]**.**

Here are some characteristics of these fires:

- there is a strong opposition between the two banks of the Mediterranean: in the North, the forest is little logged and little maintained (its area increases and it burns); in the South, it is (over) logged (its area sometimes decreases and it burns less),

- in some littoral areas of Europe, the fire interval is shorter than 25 years; these areas run a significant risk of turning into a desert,
- most of the fires (over 95 percent) are caused by Man, mostly unintentionally,
- the phenomenon is independent of "El Niño", contrary to recent observations made in South-East Asia.

Despite the efforts made, in particular in the countries of Southern Europe, the phenomenon is far from stabilizing and even appears to be increasing significantly in most of the 23 countries studied. Among the explanatory factors, several assumptions are possible:

- nowadays, forest statistics are better kept than 20 years ago. Some of the increases observed might in fact be due only to an improvement of the quality of the data kept.
- the spread of forests, which is observed in most of the countries to the North of the Mediterranean, increases the possibilities of the extension of fires and is affecting the global statistics. Hence the risk of fires spreading over larger areas than in the past (like some recent fires in Spain).
- the measures adopted until now gave priority to fire-fighting (and the preparations for fire- fighting: pre-suppression), to the detriment of prevention. However, the positive results of the fire-fighting lead to in an increase in the quantity of fuel, therefore an increase in the risk, making the control of future fires increasingly difficult.
- there is little adaptation of the measures taken in the context of each country. This is particularly the case in the field of preparation for fire-fighting where ready-made solutions are applied («general standards» for track networks density, without taking into account the available intervention means). It is also the case in the field of prevention, where the public information campaigns aim at an undifferentiated target (whatever the causes of fires). It can be noted that the prevention measures intended to fight the causes of fires generally represent only a rather poor share of the budgets (13 percent of the projects financed by the Commission).
- the policies affecting forests fires are numerous and their consequences are unforeseeable. War, political change, right of user, right of ownership, search for employment, granting of subsidies... many events can be at the origin of an increase in the number of fires. The decrease of cultivated areas, urbanization, fragmented private property, forest taxation... There also exist many sources of aggravation of the situation, of which some can completely destroy all the efforts made directly to fight fires.

ANNEX - COUNTRY BRIEFS

Albania [30, 35, 44, 52]

- Studied statistical period: 1980-1995
- Average number of fires per year: 200
- Average area burnt per year: 300 ha
- Trend: number of fires and burnt area trebled in 15 years

No statistics regarding the causes of fire have been found; according to the literature, negligence is said to be the first cause of fires.

The information available indicates that efforts have been made to build lookout towers. The forest law of 1992 grants to the village populations the right to use public and communal forests.

Algeria [25, 30, 53]

- Studied statistical period: 1955-1991
- Average number of fires per year: 1,000
- Average area burnt per year: 41,000 ha (maximum 221,000 ha in 1983)
- Trend: apparent stability over a long period

The statistics on the causes of fire are very old (end of last century) and cannot describe the present situation.

The measures adopted are traditional: creation of access, water points, lookout towers, undergrowth clearance, with particular orientation towards the bulk-heading of forest massifs (fuel breaks). The projects have been presented within the framework of forest management plans. The 1985-1990 programme planned a reinforcement of this step.

Bosnia-Herzegovinia

- Studied statistical[5] period: 1991-1995
- Average number of fires per year: 140
- Average area burnt per year: 880 ha
- Trend: impossible to determine over such a short period

No statistics concerning the causes of fire have been found, nor information regarding the adopted measures.

Croatia [2, 16, 28]

- Studied statistical period: 1973-1994
- Average number of fires per year: 200
- Average area burnt per year: 8 600 ha (maximum 21,000 ha in 1990)
- Trend: apparent stability of figures

The main causes of fire are the burning of agricultural or forestry waste, as well as negligence.

[5] Data provided by FAO Geneva.

At the time of the loan was underwritten at the World Bank, the following priority axes were defined for the protection and the reconstruction of the Croatian forest: to reduce the number of fires, to attack incipient fires quickly, to set up specific measures during high-risk days.

Cyprus [11, 12, 19, 21, 30, 44, 53]

- Studied statistical period: 1955-1995
- Average number of fires per year: 60
- Average area burnt per year: 2,000 ha (maximum 26,000 ha in 1974)
- Trend: relative stability of the figures

According to statistics on the causes of fires, a majority of fires with a known cause are due to negligence (hunters, visitors, military training).

The measures adopted are usually: information of the public, regulation, equipment of the forest massifs, improvement in the transmissions.

Egypt [30, 53]

No information concerning the statistics, the causes of fire and the measures adopted have been found.

France [7, 13, 15, 17, 18, 21, 23, 30, 37, 43, 44, 45, 50, 51, 53,]

- Studied statistical period: 1974-1997
- Average number of fires per year: 4500
- Average area burnt per year: 36,000 ha
- Trend: relative stability of the figures (slight decrease during the nineties)

The main causes of fire are negligence (42 percent), accidents (27 percent) and the cases of arson (11 percent). The public is not allowed in some wooded areas during the summer.

Priority is given to speedy attack on incipient fires. Everything is done so as to reduce the time interval between the start of a fire and the first attack: aerial survey with aircraft equipped with suppression means, pre-positioning of firemen on the ground. A study showed that France is the country in the Mediterranean basin devoting the most important budget to forests fires ($ 50 US/ha). In addition, the widespread urbanization in forests causes many problems: fire starts, dispersion of fire suppression means, destruction of goods. New laws make compulsory the taking into account of the risk in the construction projects.

Greece [15, 18, 20, 21, 23, 30, 44, 49, 51, 53, 67]

- Studied statistical period: 1955-1996
- Average number of fires per year: 950
- Average area burnt per year: 27,000 ha (maximum 110,000 ha in 1988 - and 1998?)
- Trend: the number of fires increased from 700 to 1,100, burned areas from 12,000 to 39,000 ha; average area burned by fire has doubled and is almost 40 ha; the number of killed and wounded persons has increased steadily since 1977.

The main causes of fire are negligence (43 percent) and the cases of arson (30 percent). As part of negligence, burning is very largely in the lead (17 percent), then comes cigarette ends (10 percent) and the domestic garbage dumps (6 percent).

The existence of many islands is a handicap for the rapidity of the initial attack. Moreover, the country has to face the problem involved by the division of the territory (identification of the owners, fights for the use of land). The recording of the owners on the land register is being accelerated in high risk areas. A council of «wise men» has been set up in the communities to arbitrate in conflicts of use. Land management policies are being implemented, seeking a political consensus between the State, the communities and the population.

Iran [53]

- Studied statistical period: 1982-1995
- Average[6] number of fires per year: 130
- Average area burnt per year: 5,400 ha (maximum 33,000 ha in 1993)
- Trend: it seems that the number of fires is increasing.

No data regarding the causes of fire and the measures adopted has been found.

Israel [6, 30, 44, 53, 54, 64, 65, 66]

- Studied statistical period: 1977-1992
- Average number of fires per year: 970
- Average area burnt per year: 3,500 ha (maximum 14,600 ha in 1988)
- Trend: increase in the number of fires and burned areas

The main causes of fire are arson and negligence.

A reinforcement of the legislation concerning pyromaniacs and negligent people was considered in 1986, as well as the possibility of concluding agreements with shepherds for the use of the public forest lands. The other measures adopted conform to the usual pattern.

Italy [15, 18, 21, 23, 30, 31, 32, 43, 44, 47, 48, 53, 55]

- Studied statistical period: 1962-1996
- Average number of fires per year: 8,300
- Average area burnt per year: 94,000 ha (maximum 230,000 ha in 1981 and 1993)
- Trend: the number of fires increased from 3,400 to 10,500, areas burnt from 43,000 to 118,000 ha; average area burnt by fire (10 ha) hardly changed since 1962.

The main causes of fire are arson and negligence.

The country is characterized by a distribution of powers between the regional local authorities and the State. The State reinforced the punishment brought upon the authors of fires and the courts proved to be particularly severe in 93-94. A database concerning the causes of fires and the motivations of the authors is to be set up. A law was introduced to organize prevention and fire-fighting between the regions (risk index, available means and localization of emergency teams, reforestation standards). The Regions (for example Lazio) have organized themselves by taking initiatives of the lawful type: maintenance of forest use for the burnt lands, obligation to create a 10-metre wide fireproof strip around the fields, cleaning of the railway borders, prohibition of fires during the risk-period and up to 200 m from the forests, promotion of associations of civil volunteers, conditions of participation of civilians in fire-fighting.

[6] Data provided by FAO Geneva.

Jordan [30, 53, 58]

- Studied statistical period: 1980-1985
- Average number of fires per year: 60
- Average area burnt per year: 260 ha
- Trend: impossible to determine over such a short period

No data about the causes of fire has been found.

The measures adopted are the usual ones.

Lebanon [30, 46, 53]

- Studied statistical period: 1982-1985
- Average number of fires per year: unknown
- Average area burnt per year: 1,200 ha
- Trend: unknown

The principal causes of fire are fires set by shepherds, by hunters, by owners located near national forests. The war is also said to have caused fires (explosion of shells, HT lines cut by projectiles).

Among the adopted measures, the reinforcement of forest regulations, the equipment of forest massifs, staff training were considered.

Libya [4, 30, 53]

- Studied statistical period: 1982-1985
- Average number of fires per year: 3
- Average area burnt per year: 50 ha
- Trend: unknown

The main causes of fires are, by order of decreasing importance: picnics, imprudence, fires set by shepherds and arson.
The law of 1982 regulates the use of fire, defines a framework for the preparation of charcoal and deals with the conditions of remuneration of the people voluntarily taking part in emergency staff in the event of disaster. Public information measures the public have also been introduced.

Malta [30, 53]

No information concerning the statistics, the causes of fire and the measures adopted has been found.

Morocco [30, 53, 69]

- Studied statistical period: 1960-1996
- Average number of fires per year: 200
- Average area burnt per year: 3,000 ha (maximum 11,000 ha in 1983)
- Trend: the number of fires increased from 150 to 200, areas burnt from 2,000 to 3,400 ha

The main causes of fire are imprudence and arson.

The measures adopted are the usual ones and relate in particular to the equipment of the wooded massifs. It was also decided to delimit the public forest field, but this task runs up against the right of use of the village populations.

Portugal [15, 18, 23, 26, 30, 33, 43, 44, 51, 53, 57]

- Studied statistical period: 1958-1996
- Average number of fires per year: 5,300
- Average area burnt per year: 42,600 ha (maximum 182,000 ha in 1991)
- Trend: the number of fires is increasing steadily, from 100 to 20,000 at the beginning to the end of the period; areas burnt increased from 4,000 to 80,000 ha during the same period.

The main causes of fire are negligence and arson.

Measures were taken to reduce the number of fires: creation of forest brigades to determine the origin of fires, reinforcement of the penal sanctions, obligation to reconstitute the burnt forest identically. The priority was also granted to the forestry treatments intended to make the forests less combustible: replanting fire-prone species does not give a right to obtain government financial aid, obligatory impact study for a project of plantations based on *Eucalyptus*, important financial aid for the plantation of traditional species, administrative framework for the clearings to prevent early wood harvest, special protection of the forests of holm and cork oaks, monitoring of the abandonment of cultivated lands.

Slovenia [36]

- Studied statistical period: 1990-1995
- Average number of fires per year: 100
- Average area burnt per year: 800 ha
- Trend: impossible to determine over a so short period

No data regarding the causes of fire and the measures adopted has been found.

Spain [7, 14, 15, 18, 23, 27, 30, 38, 39, 40, 41, 42, 44, 51, 53, 60, 61, 62, 63]

- Studied statistical period: 1961-1996
- Average number of fires per year: 7,200
- Average area burnt per year: 157,000 ha (maximum 486,000 ha in 1985)
- Trend: the number of fires increased from 1900 to 8,000 (nearly 20,000 today), burnt areas from 50,000 to 208,000 ha; Four rather recent years had global statistics exceeding 400,000 ha (78, 85, 89, 94)

The main causes of fire are arson and negligence (discarded cigarette ends, campfires lit by hikers).

New orientations were decided in 1994. The operations of prevention and fire-fighting must be studied within the framework of a cost-benefit analysis by taking account of the limitation of the means, the ecological and economic value of the goods to be protected, the space and temporal distribution of the risk. The research of the causes of fires and the authors of fires has priority (specialized brigades, use of new technologies of investigation, toll-free numbers, contribution of all the administrations of a given region directed by an *ad hoc* committee, etc.). The management of the territory is the core concern of the authorities (consequences of the Common Agricultural Policy, financing of the creation or maintenance of the fire walls, parsimonious reforestation after fire, development of controlled fires). Measures aimed at coordinating the efforts of each region are being considered (public awareness campaign based on the same message and use of the same symbol in all regions, use of the same emergency means). Prevention has also taken rather singular forms (stage performances in country areas).

Syria [1, 29, 30, 53]

- Studied statistical period: 1976-1991
- Average number of fires per year: 170
- Average area burnt per year: 1,400 ha
- Trend: impossible to determine over such a short period

The main causes of fire are, by order of decreasing importance, the cleaning of fields by fire, discarded cigarettes, the carelessness of hikers, malevolent acts (arson), the carelessness of shepherds and hunters.

The usual measures are adopted.

Tunisia [3, 10, 30, 53]

- Studied statistical period: 1981-1997
- Average number of fires per year: 100
- Average area burnt per year: 1,600 ha
- Trend: impossible to determine over such a short period.

The main causes of fire are accidents and negligence.

The usual measures are adopted: creation of tracks, of water tanks, of lookout towers, of radio operator relay. Other axes were explored such as the education of the public, the control of fires, preventive silviculture, the reinforcement of the repressive regulations and the reinforcement of administrative staff.

Turkey [5, 8, 9, 24, 30, 44, 53, 56, 68]

- Studied statistical period: 1955-1996
- Average number of fires per year: 1100
- Average area burnt per year: 14,000 ha (maximum 43,000 ha in 1977)
- Trend: the number of fires increased from 600 to 1400, burned areas remained rather stable

The main causes of fire are both arson and negligence.

The rise in the standard of living of the village populations is one of the priorities: nearly nine million people live directly or indirectly out of the forest, which places the country in an intermediate situation between the countries of the north and of the south of the Mediterranean basin. The other usual measures are adopted.

Ex-Yugoslavia [30, 34, 44, 53, 59]

- Studied statistical period: 1962-1996
- Average number of fires per year: 870
- Average area burnt per year: 9,400 ha (maximum 43,000 ha in 1985)
- Trend: the number of fires passed from 900 to 800, burnt areas from 5,000 to 13,000 ha

The main causes of fire are due to negligence.

The usual measures are adopted.

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1955					61			499														878	
1956					126			1187														1118	
1957					63			460														779	1
1958					128			861									64					725	
1959					77			403									39					436	1
1960					70			729								59	59					504	
1961					55			1020								105	108		1680			620	1
1962					57			790			3935					122	168		2022			717	1
1963					67			759			1323					138	89		1302			455	
1964					65			926			1935					329	70		1645			768	
1965					40			1256			3631					124	92		1686			415	
1966					53			660			3214					108	63		1443			433	
1967					48			526			3655					150	81		2299			473	1
1968					43			549			2905					110	88		2109			387	1
1969					47			650			2677					191	74		1494			714	1
1970					51			524			6579					207	121		3203			790	
1971					58			538			5617					124	49		1714			651	1
1972					61			384			2358					168	76		2148			440	
1973				331	57			529			5681					168	130		3765			1208	1
1974				135	42			673			5055					213	258		3980			769	
1975				229	26		4017	647			4257					293	350		4242			811	
1976				251	20		9800	522			4457					184	289		4596	115		702	
1977				126	22		2432	1049		680	8878					217	162		2148	153		1615	
1978				228	65		6973	670		975	11052					348	2241		8324	103		1122	
1979				128	88		4551	962		888	10325					162	1355		7167	97		1303	
1980	73			323	91		5040	1158		678	11963	60				211	1731		7193	270		1094	
1981	42			200	82		5173	1139		731	14503	90				233	3038		10882	276	92	982	
1982	35	638		236	97		5308	1045	15	1117	9557	58		0		182	2229		6443	157	76	951	1
1983	96	990		296	55		4659	968		1233	7956	73		3		338	4503		4880	210	141	968	1
1984	192	562		226	76		5672	1284	30	908	8482	48		3		211	6377		7224	211	121	1433	
1985	71	747		406	74		6249	1442	75	834	18664	41		3		249	7218	72	12284	310	75	1793	1
1986	134	1170		172	50		4353	1082	79	577	9398					183	4348		7574	55	88	1526	
1987	102	1321		131	62		3043	1266	10	1035	11972					145	6977		8679	319	202	1310	
1988	121	1146		197	86		2837	1898	73	1354	13558					277	5643		9595	228	155	1367	
1989	70	595		119	66		6743	1284	116	1024	9669					156	20155		20384	176	68	1633	

COMMENTS ON THE SITUATION IN THE MEDITERRANEAN BASIN

Ricardo Vélez[7]

FIRE CAUSES: TRADITIONAL PRACTICES OF BURNING AND LAND ABANDONMENT

Statistics on the causes of forest fires in the Mediterranean region are far from complete, but it is evident that the majority of fires are set by people. Natural agents such as lightning do indeed cause forest fires, and when they occur in isolated areas the extent of the damage can be enormous. For example, lightning was the cause of a fire that burnt more than 30,000 ha in Ayora-Enguera, Spain, in 1979 On average, however, the number of naturally occurring fires is small in comparison with those caused by humans.

An important source of fires are shepherds who ignite forest and grassland to promote new flushes of growth for grazing animals. When this is done without the necessary precautions and coincides with high climatic risk, forest fires are practically inevitable.

Farmers also use fire to eliminate crop stubble, and push back the forest to make room for agricultural expansion. In spite of the obvious risks, farmers can often be observed setting fire to agricultural residues even when large out-of-control fires are burning in the same area.

Official statistics of the causes of forest fires show high percentages in the unknown and arson categories. A number of sociological studies have been conducted by the Spanish Administration in the high risk areas after 1975. Different methodologies have been used. Group meetings and direct dicussions in public places have been usually the most fruitful ways to capture the opinions of rural people. To check the information obtained from the rural population, another survey has been conducted among foresters and local authorities.

Analyzes of historical records of fires through judiciary documents, forest management plans, old newspapers and pamphlets conducted by three universities in different regions provided a large amount of information on fire causes and fire regimes.

In the light of the conclusions of these studies a set of policies have heen designed to influence in the people's behaviour. Some of these policies are oriented towards persuasive methods. Some others are intended to change the forest and land use laws. A third group refers to represive actions.

Additional studies concerning rural economy are needed to explain the present violence of the forest fire problem. The rural population decline can explain the increasing fuel accumulation in the forest. At the same time, the progressive ageing of the remaining population maintains old practices like uncontrolled burning. Rural people have been burning in forest areas for centuries, but fires had never reached the present peak levels in terms of numbers and damage.

A programme of agreements between the Administration and the farmers to promote controlled burning could be a way to prevent wildfires in most regions. On the other hand, increasing mobile patrols in danger areas can be a useful way of reducing the present number of malicious fires.

Beside these measures, a permanent programme of education to prevent the wrong use of fire in wildlands is on the way. This activity is divided into targeted campaigns for every group of risk: farmers, shepherds, hikers, hunters and children.

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[7] Coordinator of the FAO/*Silva Mediterranea*, Network on Forest Fires, Spain.

Other policies should be reviewed to prevent unwanted side effects, like those of the European Union subsidies for livestock under extensive grazing and for land abandonment. The fire risk should be taken into consideration in the design of such a policies.

FIRE SUPPRESSION: SERIOUS CONSEQUENCES OF THE TRANSFER OF RESPONSIBILITY FROM FOREST SERVICES TO STRUCTURAL FIRE SERVICES

The last decade has seen very high investments in mechanization (aircraft, ground tankers) in the E.U. Mediterranean countries. In most cases, this has not been integrated in a general forest policy which ensures also the needed investments in silviculture and the creation of public awareness. So, the lack of a preventive policy has often times made the suppression efforts ineffective when the environmental conditions became extreme.

A vicious circle of defective fire prevention, high costs of suppression and again more fires is thus created with disastrous consequences.

The situation can even get worse when some Administrations try to cope with the problem by transferring all suppression responsibilities to the structural fire services.

These services work typically with mechanical equipment and usually have no experience in the use of specific forest fire-fighting techniques (personnel, tools, attack systems, etc).

The application of this policy has led to several large fires (Marseille, France 1997; Catalonia, Spain 1998; Athens, Greece 1998, etc).

On the contrary, there are many good experiences in other places (for instance, in other Spanish regions) where close cooperation among all agencies results in the correct use of resources and the efficient performance of the whole system.

The implementation of an integrated protection policy is a must, distributing all resources in a balanced way between prevention and suppression under the umbrella of a comprehensive forest policy.

REPORT OF THE WORKING GROUP ON THE MEDITERRANEAN BASIN

MEMBERS OF THE WORKING GROUP

Mr. Ertugrul Bilgili (Turkey) - Chairperson
Mr. Ricardo Velez (Spain) - Secretary
Ms. Mette Løyche Wilkie (FOR) - FO Technical Secretary
Mr. Daniel Alexandrian (France)
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Mr. Ali Temerit (Turkey)
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BACKGROUND INFORMATION

23 Mediterranean countries are covered: Albania, Algeria, Bosnia, Croatia, Cyprus, Egypt, France, Greece, Iran, Israel, Italy, Jordan, Lebanon, Libya, Malta, Morocco, Portugal, Slovenia, Spain, Syria, Tunisia, Turkey, Yugoslavia. All these countries have a more or less long dry season. In the North of the Mediterranean the dry season lasts between one and three months. In the South the dry season lasts for more than seven months in some countries. A low relative humidity and regular occurrence of strong winds, particularly along the coast, exacerbates the impacts of forest fires.
Total area burnt annually: 600,000 ha on average.
Number of fires per year: 50,000 on average.

MAIN ISSUES RAISED IN THE REGIONAL PAPER AND DURING DISCUSSIONS

- Limited access to reliable statistical information and lack of common definition of forest fires make comparison between countries difficult;
- The main trends over the last ten years are an increase in the number of fires - despite significant fire prevention activities - and a fluctuation in the size burnt every year related to weather conditions, with an increase of area burnt in some countries despite control efforts engaged;
- Most fires are caused by humans. Natural causes, such as lightning, account for less than 5 percent of all fires. However, lightning is becoming more important in terms of damage (due to land abandonment and increased fuel load of forests);
- The majority of human causes of fires are linked to agriculture and forestry activities. Other causes include: conflicts and war; as a means to claim ownership and change land use classification; and occupational problems, which can result in deliberate lighting of fire by people interested to be temporarily employed as fire-fighters;
- Western Europe has experienced land abandonment/depopulation of rural areas and a decrease in the demand for wood fuels in recent decades. This has lead to an increase in area of wooded land, increased fuel load in forests and a lack of feeling of responsibility for forest protection by the local population (and lack of people to detect and provide early suppression of forest fires). The

result: a significant increase in forest fires and the size of the areas burnt (due to the continuous forest cover) in such areas.

- In the Maghreb countries the demand for fuelwood and forest products has increased leading to over-exploitation of forest resources. Local people see fires as a direct threat to their livelihoods. The fire incidence has thus remained at a relatively constant level;
- The direct economic benefits from Mediterranean woodlands are low and the total economic value is perceived to be low;
- Urbanization in coastal areas is creating new risks for human life;
- Lack of well defined property boundaries and cadastral maps in some countries has lead to fires being used to claim additional land;
- Fire is a traditional land management tool, but is not always properly used;
- Current policies give priority to fire-fighting rather than fire prevention;
- Many small land owners and , in some areas, absent land owners makes it difficult to pursue coherent forest management policies and practices.

CONCLUSIONS REACHED CONCERNING POLICIES AFFECTING FOREST FIRES

Current fire policies

Exiting fire policies

- Fire prevention policies exist in all countries. However, implementation is not always effective.
- As a general rule resources are allocated to total fire control.
- Insufficient emphasis and resources are given to fire prevention and to silvicultural measures.

Problems regarding the implementation of fire policies

- Policies may not be appropriate (Fire causes are not well known and there is a lack of analysis of the distribution and underlying location-specific causes of fires, so policies may be inappropriate.)
- Scarcity of resources for the implementation of policies
- Lack of coordination between institutions and lack of consultation with stakeholders.
- Many small-scale landowners and/or absentee landowners.
- Social unrest.
- Lack of continuity in policies.

Other policies which affect the incidence and/or impact of forest fires

Policies with negative impacts

- EU Common Agricultural Policy (promoting the setting aside of agricultural areas and providing incentives for afforestation without any conditionality of an appropriate management of these plantations) has resulted in an increase in the forest/woodland areas, an increase in fuel load and a reduction in natural obstacles to the progression of fires since fire prevention and mitigation measures are seldom incorporated. When such areas catch fire, the area burnt is thus often larger.
- Abandonment of fields and farming practices in rural areas due to policies, which directly or indirectly promote urbanization has had similar effects. In addition such land abandonment has led to fewer people being present to assist in detection and early suppression of fires.
- An increase in areas being set aside for strict protection done without consultation with the local population has lead to conflicts and lack of interest in protecting such areas. Some fires are, as a consequence, lit on purpose.

Pre-conditions for improved fire policy formulation

- Political will.
- Collection, analysis and dissemination of information.
- Environmental valuation (extended cost-benefit analysis, which also incorporates the indirect benefits from forests and the total costs of forest fires).
- Clear fire policy objectives.
- Impact analysis of fire policy options.
- Public awareness of fire risks and impacts and support for policy measures.

Recommended principles for fire policy formulation

- Access to reliable information sources (including remote sensing imagery).
- Stronger emphasis on prevention of forest fires.
- Participation of stakeholders, especially private land owners.
- Locally and culturally appropriate policies.
- Integrated land use planning.
- Coordination of fire policies and other policies.
- Comprehensive policies which are valid for a long time, yet flexible to allow revisions as conditions change.

Examples of policy instruments for preventing or mitigating the impacts of forest fires

Direct government investment

- Infrastructure development and purchase of equipment.
- Implementation of silvicultural and other hazard reduction measures.
- Implementation of forest dependent income-generating activities to enhance the value of the forest.
- Education and training.
- Information collection, analysis and dissemination.
- Public awareness raising.

Institutional and organizational arrangements

- Participation of local actors.
- Designation of the forest service as the lead agency in forest fire management.
- Development of mechanisms for better coordination among institutions and organizations.

Regulatory policy measures

- Land use zoning including establishment of buffer zones.
- Issuing of permits for burning.
- Prohibition of use of fire (including smoking) in and near forests and restrictions on access to forests during periods of high risk.
- Prescribed burnings.

Economic instruments

- Tax breaks or subsidies to landowners for fire prevention and mitigation investments.
- Revision of incentives with negative effects.
- Fines for causing fires.

RECOMMENDATIONS ADDRESSED TO GOVERNMENTS, FAO OR OTHER INSTITUTIONS

The Working Group recommends that:

Governments

- Give more emphasis on fire prevention.
- Adapt legislation to the present conditions and remove contradictions between different policies affecting fires (e.g. policies on urbanization, infrastructure development, environment and forestry).
- Promote the integrated land use planning with special attention to forest/urban interface.
- Increase public awareness of risks and effects of forest fires.
- Promote appropriate silvicultural measures in public and private forests and woodlands.
- Support applied research & development programmes on forest fire management.

FAO

- Continue the current activities of developing a common, decentralized database (*Silva Mediterranea*).
- Provide training on forest fire prevention and suppression.
- Continue to act as a neutral policy forum.

Other organizations

- Coordinate activities and programmes related to forest fires.
- Assist in public awareness raising and extension activities.

PUBLIC POLICIES AFFECTING FOREST FIRES IN THE AMERICAS AND THE CARIBBEAN

Robert W. Mutch[8], Bryan Lee[9] and James H. Perkins[10]

ABSTRACT

Forest fires significantly affect people, property, and natural resources throughout the Americas and the Caribbean Region. This fact was dramatically emphasized during the El Niño year of 1998 when wildfires killed seventy people in Mexico; caused severe health problems from air pollution in Mexico, Central America, and the United States; caused the evacuation of 70,000 people from their homes in Florida; disrupted air travel due to lowered visibility; and damaged rain forests in Brazil and Mexico. Slash and burn agricultural practices, land clearing, widespread drought, and unnatural accumulations of fuels all combined to produce fires of disastrous proportions. The wildfires were a product not only of prevailing environmental and fuel conditions, but also of public policies and human practices. Superficially it would appear that policies that lead to improved emergency responses to forest fires could produce satisfactory solutions. But indicators point to the fact that increases in investments for only the emergency response to forest fires will eventually result in more damaging and more expensive forest fires in the future. The thesis developed here is that public policies that link sustainable land use practices with emergency preparedness are likely to be the most successful in the long run. Recommendations are presented that forge a link between sustainable practices and emergency preparedness. One of the strategies for fire adapted ecosystems in the Region is to increase the use of prescribed burning to restore the health and sustainability of forests and plant communities that evolved with fire. Since many people in Latin America rely on the traditional use of fire in agricultural practices, and many of these agricultural fires escaped to caused widespread wildfires in Mexico, Central America, and South America, another strategy is to work more closely with farmers through incentives and education programmes to produce safer burning practices.

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INTRODUCTION

Large forest fires around the world during the intense El Niño drought conditions of 1997-1998 focused public and media attention on the need to evaluate public policies and practices in the forestry and non-forestry sectors which directly or indirectly contribute to the impact of forest fires. The size and damage attributed to these fires is so immense that the Christian Science Monitor termed this "the Year the Earth Caught Fire." At times that seemed to be literally true as smoke palls blanketed large regional areas, disrupting air and sea navigation and causing serious public health threats. Seventy people were killed in Mexico alone as a result of the fires; and ecosystems that generally are not subjected to fires like the Amazon rain forest and cloud forest of Chiapas in Mexico sustained considerable damage.

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The extent and effects of forest fires are related not only to climatic and environmental conditions, but also to national policies, laws, and institutional objectives which affect such issues as human settlement, land tenure, environmental regulations, agricultural and forestry practices. This regional paper assesses the location, causes, and magnitude of the forest fire problem, resulting in:

1. A more accurate picture of the cost and implications of forest fires.
2. An indication of major social, economic, and environmental impacts.
3. An identification of critical regions and countries that are at high risk.
4. An identification of policies and practices to reduce the negative impacts of forest fires.

Based on regional assessments and dialogue among countries, it should be possible to develop an agenda for the transfer of successful policies and practices to improve institutional capacities to prevent, prepare for, and combat forest fires. New insights also will be gained in ways to prescribe fires to achieve resource benefits. Wildland fire management programmes in the Americas and the Caribbean will be described in terms of preventing or combating wildfires, or unwanted fires, and prescribing other fires to achieve beneficial objectives.

Many indicators point to the fact that increases in investments for only emergency responses to forest fires will result in more damaging and expensive forest fire emergencies in the future. Public policies and public education that link sustainable land use practices with emergency preparedness are likely to be the most successful in the long run.

REGIONAL OVERVIEW OF PUBLIC POLICIES AFFECTING FOREST FIRES

Large scale fires throughout the Americas and the Caribbean in 1998 clearly indicated that public policies and human practices, as well as prolonged drought, contributed to the severity of impacts to the forests. In the United States, for example, policy emphasis on fire exclusion over many decades this century has led to the build-up of unnatural accumulations of fuels within fire dependent ecosystems. Now when fires occur in these forests of long-needled pines, they are burning at much higher intensities than they did prior to 1900 when fires burned more frequently at lower intensities. The fires today have been more difficult to control due to the heavy fuels and have done considerable damage to homes in the wildland/urban interface and to natural resources.

Many policies that affect fire management programmes in the U.S. and elsewhere arise from legislation passed by federal governments. Occasionally this legislation can establish conflicting requirements for resource management agencies to follow. The United States Congress passed the Wilderness Act in 1964 that called for fire to play a more natural role to perpetuate fire-adapted wilderness ecosystems. Programmes were established that allowed lightning fires to burn under observation for days, weeks, or months. But the Clean Air Act, passed in 1970, required that prescribed fires had to be carefully regulated, so that smoke from these fires did not threaten the health and welfare of the general public. So legislation and policies are calling for more fire on the one hand, and on the other legislation and policies are establishing numerous restrictions to limit prescribed burning. Conflicts among various public policies need to be resolved in ways that help to sustain viable ecosystems.

Human practices can have as significant an effect on the forest fire situation as do public policies. When we review conditions in Mexico, Central America, and Brazil associated with the many wildfires in 1998, we learn that the sheer magnitude of the fires often was related to the significant amount of agricultural and land clearing burning that occurred as a result of long-standing tradition. Governments seemed almost powerless to curtail such burning, although attempts were made to do so. The large numbers of fires that were started for agricultural purposes eventually overwhelmed fire services. There were simply too many large fires for fire-fighters to be successful. In these instances, it was only the arrival of appreciable rain that finally brought a halt to the very serious fires.

Some countries in the Region also do not have policies established and implemented to apply systematic fire management strategies to respond quickly and aggressively to keep new fires small. Also, policies governing timber harvest and land settlement can contribute to an increase in flammability of tropical forests, making them more susceptible to damaging fires.

A report released by Worldwatch Institute in November 1998 called attention to the fact that violent weather has cost the world $89 million this year, more money than was lost from weather-related disasters in all of the 1980's[11]. In addition to the material losses, the disasters have killed an estimated 32,000 people and displaced 300 million. Although the majority of the losses were attributed to intense storms, a conclusion in the report is just as applicable to threats from forest fires:

> "Unless ravaged nations rebuild along a path of sustainable development that emphasizes restoring and maintaining healthy ecosystems, they risk even greater exposure to the devastation of unnatural disasters in the future."

THE AMERICAS AND THE CARIBBEAN REGION

This Region will be discussed in terms of the North America sub-Region (Canada and the United States) and the Latin America/Caribbean sub-Region. Mexico will be covered under Latin America due to the close cultural ties to this area.

North America

Canada and the United States enjoy a special richness in terms of per capita income and natural resources. Together, Canada and the U.S. cover nearly 18.8 million square kilometres, about 14 percent of the world's land area. The two countries share one of the longest common borders in the world, creating numerous opportunities for transboundary cooperation and agreements. Agreements exist, for example, for the sharing of fire-fighting resources across the border in both directions. One of the older fire-fighting compacts occurs in eastern Canada and north-eastern U.S. A similar type of agreement is being planned for western Canada and the north-western U.S.

Forests are a dominant feature of the North American landscape. Forests comprise almost half of Canada (Natural Resources Canada 1996) and a third of the United States (Brooks 1993). Provincial governments are responsible for managing 71 percent of Canadian forests and 23 percent are managed by Federal and Territorial governments (Natural Resources Canada 1996). The remaining 6 percent of Canada's forests are growing on private land.

Many public forests in the United States are managed by the Forest Service, Bureau of Land Management, Bureau of Indian Affairs, and the states to achieve multiple use objectives: recreation, water, timber harvest, wildlife habitat, and rangelands for domestic cattle. Private forests are managed primarily for fibre production. The National Park Service and Fish and Wildlife Service manage National Parks and Wildlife Refuges, respectively. All of these agencies and organizations maintain their own fire management capacity; and cooperate with each other on a regular basis. Depletion of old growth forests and the last remaining temperate rain forests in British Columbia, Canada, and in the Pacific Northwest of the United States has generated public concerns to stop logging in such areas. A movement has developed that makes it increasingly difficult to harvest timber on federal lands, posing difficulties in using thinning and silvicultural prescriptions to sustain viable ecosystems producing multiple objectives.

Many forests in the western U.S. especially are experiencing declines in health attributed to the exclusion of fire from fire-dependent ecosystems, changes in stand density and composition, widespread insect and disease epidemics, and drought. Many of these dead and dying forests are now more susceptible to high intensity, stand replacement crown fires. Costs of fire suppression, the size of wildfires, and the damages due to fires have increased significantly in the U.S. since the mid-1980s due to extended drought and unnatural accumulations of forest fuels.

[11] Newspaper article published in the Missoulian, November 28, 1998, titled "$89 billion in damage worldwide" and authored by Donna Abu-Nasr (Associated Press).

Latin America and the Caribbean

The Latin American and Caribbean (LAC) sub-Region includes countries with significant economic, social, and environmental diversity. Due to the great diversity of this area, it is not easy to summarize issues common to Brazil, the Andean countries, and the Caribbean Island States. The sub-Region does include features, however, that are common to many countries: high proportions of urban populations, high ethnic diversity, indigenous tribes, and expanding agricultural frontiers (United Nations Environment Programme 1997).

The LAC sub-Region has both the world's largest unfragmented tropical forests in Amazonia and some of the most endangered forests like Mata Atlantica on the east coast of Brazil. At the end of 1990, some 28 percent of the world's total forested area and 52 percent of its tropical forest were in Latin America and the Caribbean. In 1990, these forests covered 968 million hectares, or 48 percent of the land in the sub-Region (FAO 1993). The rapid transformation of tropical and other forests through pasture development, slash and burn agriculture, agrarian reforms, timber harvest, and other practices have all led to significant deforestation. These land use practices, many of which are unsustainable, have made many forested areas especially vulnerable to wildfires. The results of these devastating fires were readily visible in 1998 in Mexico, Central America, the Amazon Basin, Canada, and the U.S.

Most of the primeval forests of the Caribbean were cut in the early colonial period (UNEP 1997). Since then, an increasing problem has been the introduction of exotic species into successional forests.

CONTINENTAL FIRE REGIMES

Recurring fires are part of the natural environment of many ecosystems--as natural as rain, snow, or wind (Heinselman 1978). Evidence of past fires and their periodicity is found in charcoal layers in lakes and bogs; and in the fire-scarred cross sections of trees. Heinselman indicated that fire-adapted ecosystems in North America are termed fire-dependent, if disturbances by fire are essential to the functioning of these systems (1978).

Fire affects the functioning of ecosystems in numerous ways:

- Regulating plant succession.
- Regulating fuel accumulations.
- Controlling age, structure, and species composition of vegetation.
- Affecting insect and disease populations.
- Influencing nutrient cycles and energy flows.
- Regulating biotic productivity, diversity, and stability.
- Determining habitats for wildlife.

Lightning, volcanoes, and people have been igniting fires in wildland ecosystems for millennia. The current emphasis on ecosystem management calls for the maintenance of interactions between such disturbance processes and ecosystem functions. It is incumbent, therefore, on resource managers and fire managers to understand the historic frequency, intensity, and size of past fires. Such knowledge provides a frame of reference for prescribing appropriate management practices on a landscape scale. Many studies have described the historical occurrence of fires throughout the world. Swetnam (1993), for example, reported on 2000 years of fire history in giant sequoia groves in California. He found that frequent small fires occurred during a warm period from about AD 1000 to 1300, and less frequent but more widespread fires occurred during cooler periods from about AD 500-1000 and after 1300. Swain (1973) determined from lake sediment analysis in the Boundary Waters Canoe Area in Minnesota that tree species and fire had interacted in complex ways over a 10,000 year period. There is an even larger body of science that details the numerous effects of **wildland fires** on ecosystems. It is this knowledge of fire history, fire regimes, and fire effects that allows managers to develop fire protection strategies, fire prescriptions, and prescribed fire programmes to achieve a variety of resource management objectives. (Note: the term "wildland fire" is a rather universal concept applied in Canada and the United States to any fire that occurs in forest, shrubland, grassland, and tundra ecosystems. The term is an objective one and generally does not entail any value judgement as to whether the fire is good or bad. When a fire is determined to be an unwanted, or bad, fire, it is called a wildfire).

The role of fire as an important disturbance process has been highlighted in a classification of continental fire regimes (Kilgore and Heinselman 1990). They described a natural fire regime as the total pattern of fires over time that is characteristic of a region or ecosystem. Fire regimes are defined in terms of fire type and intensity, typical fire sizes and patterns, and fire frequency, or length of return intervals in years. Natural fire regimes of North America are placed into seven classes, ranging from Class 0 where fires are rare or absent to Class 6 where crown fires and severe surface fires occur at return intervals longer than 300 years. Intermediate fire regimes are characterized by increasing fire return intervals and increasing fire intensities. Class 2, for example, describes the situation for long-needled pines, like longleaf pine, ponderosa pine, and Jeffrey pine, where low intensity, surface fires occurred rather frequently (return intervals of less than 25 years). Lodgepole pine, jackpine, and the boreal forest of Canada and Alaska generally fall into Class 4 or Class 5, where high intensity crown fires occurred every 25 to 100 years; or every 100 to 300 years. White bark pine forests at higher elevations typically fall into Class 6 where higher intensity fires would occur at intervals greater than 300 years. At lower elevations white bark pine may fall into Fire Regime 4 or 5.

The noteworthy aspect of continental fire regimes is that very few plant communities, or ecosystems, in North America fall into Class 0 where fires are rare or absent. In other words, most ecosystems in Canada and the United States evolved in environments where wildland fires occurred in a consistent manner, establishing fire as a process that affects the numerous ecosystem functions described earlier. The pervasive importance of fire as an ecosystem process has been instrumental towards the end of the 20th century to shift public policies towards a greater emphasis on prescribed fire in the management of forests, shrublands, and grasslands.

The application of prescribed fire for many different purposes has attempted to mimic the natural role of fire in producing fire-related ecosystem effects. Sustaining the productivity of fire-adapted ecosystems generally requires the application of prescribed fire on a sufficiently large scale to ensure that various ecosystem processes are intact.

Forest communities in the Latin America/Caribbean sub-Region like the cloud forests of Mexico and the rain forests of the Amazon Basin generally fall into Class O where fires are rare or absent. This fact highlights the importance of protecting these forests from fire in drought years. It also underscores the importance of not modifying these forests in significant ways that may impact them irreversibly. However, the cerrado, or extensive savanna area found in central Brazil and other countries in South America, experiences frequent recurring fires and vegetation is adapted to fire disturbances.

It is important that public policies are established based on sound science. Decision-makers need to understand the consequences of alternative management strategies prior to designating new policies. Policy makers and decision-makers in the United States routinely are involved as participants in a one week Fire Management Leadership course that provides a focus on the basic principles of fire regimes and management strategies.

SYSTEMATIC FIRE MANAGEMENT

Basic principles

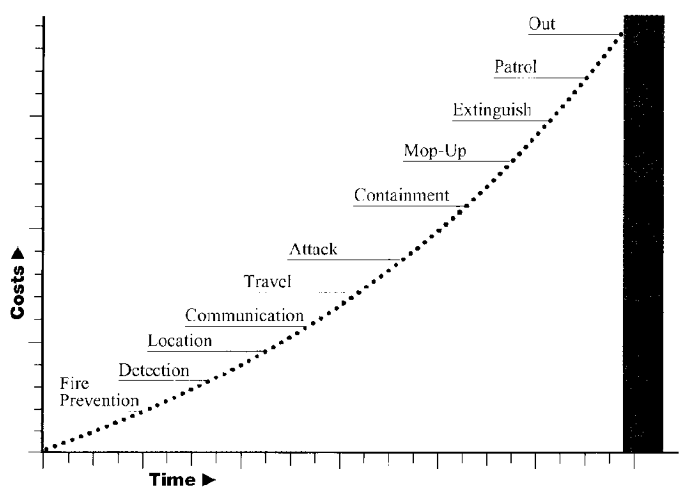
Systematic fire management (Burger *et al.* 1993) is a form of protecting life, property, and natural resources from damaging wildfires that is used by natural resource agencies around the world. It can be thought of as the steps taken by fire-fighting organizations prior to the occurrence of fires, during the active burning of fires, and after a fire has been contained and extinguished. It is also applicable to developing a new fire protection programme. Some of the overall principles that guide systematic fire management include:

1. The setting of priorities. No resource manager can assure that all fires can be prevented or easily extinguished in all of the areas for which they are responsible. Thus, managers designate such

protection priorities as critical protection, full protection, or limited protection based on life, property, and resource values at risk.

2. Distinguishing between wildfires and prescribed burning. Controlled burning may be used in a positive manner to reduce fire hazards or produce resource benefits.
3. Choosing fire protection implementation alternatives for different types of areas.
4. Developing extension programmes. Fires cannot be managed effectively without the understanding, cooperation, and assistance of local communities.
5. Training in fire-fighting and fire management skills. The secret to success is having people trained and equipped to produce disciplined responses to a wide variety of conditions.
6. Establishing interagency agreements and implementation plans. No single agency in the world has the resources to provide systematic fire protection alone due to the lack of sufficient budgets, staff, and equipment to cover all situations.
7. Preventing fires. It makes more sense to implement a grassroots programme to prevent damaging fires, rather than fighting them.
8. Recognizing the basic premise that "minutes count." All elements of the protection programme are designed to minimize the time it takes to stop the forward spread of a fire. As a fire spreads, damages and costs increase, and people's ability to suppress the fire diminishes (Figure 1).
9. Implementing initial attack procedures based on the concept that the "closest forces" to the fire are the forces most likely to be successful, because the time of response is reduced. In other words, fire protection needs to be de-centralized to the lowest possible level.

Figure 1. The suppression objective is to minimize fire size, which is related to cost and loss



Elements of systematic fire management

Systematic fire management can be thought of as a series of steps, from prevention through mop-up and patrol, which managers can use in any number of implementation alternatives. This series of steps includes the following elements:

- *Fire prevention*: Prevention activities take on two kinds of efforts--one to reduce fire brand production and one to reduce the susceptibility of the fuel bed to ignite (fuel treatment or modification). Keeping records of known fire causes helps to identify areas for fire prevention campaigns and methods.
- *Fire presuppression*: These are preparedness activities in anticipation of a fire. This element includes training, equipping, and pre-positioning fire-fighting resources.
- *Detection*: It is very important to detect a fire early when small and report it to the proper authorities. This can be done through infrared scanners, detection towers, aerial reconnaissance, and people patrolling. Procedures also should be established for the general public to report wildfires that they encounter.
- *Location*: Fires need to be located accurately on a map to guide those who will dispatch resources to the right area. This can be done as simply as placing pins in the map at the reported coordinates.

- *Communication*: Fire location is typically communicated through radio transmissions to the forces that will control the fire.
- *Dispatch*: The act of receiving the location of the fire, deciding what suppression forces are necessary to send to the fire, sending the forces, and supporting those resources once assigned to the fire.
- *Attack*: Having timely access to the fire area, whether by foot, vehicle, boat, or helicopter, is essential. The wildfire situation is evaluated and strategies and tactics are implemented to control the fire at as small a size as possible.
- *Mop-up*: Once the fire spread has been halted, it is necessary to extinguish all flames and cool all heat sources inside the perimeter of the fire. This must be done thoroughly to prevent future escapes.

These principles and elements are the minimum guidelines to be followed in implementing an effective programme of fire management to safeguard people, property, and natural resources. It also must be recognized that these steps identify an emergency response to suppress wildfires. Emergency responses, by themselves, will not be successful in the long run unless coupled with sustainable land use policies and practices. Strategies for sound timber harvest practices, settlement, community incentives, prescribed burning, and agro-forestry projects that reduce flammability should be developed and integrated on a landscape scale to reduce the threat of future fires.

THE EL NIÑO DROUGHT AND DEVASTATING 1998 FOREST FIRES IN THE REGION

The term El Niño originally was given to a warm current of water that comes to the coast of Peru and Ecuador every Christmas. The term now is reserved for the especially warm and long-lived currents that come every two to seven years, beginning in the summer and lasting for as long as 22 months. Through a series of connected events, the El Niño effects are transferred across the world's weather systems. In the Latin America and Caribbean Region this year, El Niño effects have caused devastating floods in Peru while serious forest fires burned in the state of Roraima in northern Brazil under the influence of prolonged drought.

Latin America

A June Situation Report produced by the Office of U.S. Foreign Disaster Assistance (1998) highlighted the seriousness of the drought-related burning conditions in Latin America. During 1998, Mexico and the entire Central American region were affected by drought exacerbated by the El Niño episode. The drought aggravated the effects of slash and burn agricultural practices in forest and grassland areas, leaving hundreds of fires burning. In addition to making the land more arid and therefore more flammable, the drought eliminated the cleaning effect that rains usually have on the region's air. The fires severely affected visibility and air quality in Mexico, Guatemala, Nicaragua, Honduras, El Salvador, and Costa Rica. The smoke from these fires also entered the southern and midwestern United States, prompting local warnings for residents with heart and respiratory conditions, and children, to limit their outdoor activities. Seventy fire-fighters and local residents died combating the fires in Mexico; and the fires burned more than 582,000 hectares[12]. Airport operations in affected areas throughout the region were disrupted and air traffic control procedures were adversely impacted by lingering smoke and haze. The U.S. Government eventually allocated over $7 million to assist with the fire-fighting efforts in Mexico and Central America.

Canada

The early onset of spring in 1998 resulted in a rash of fire activity in central Canada 2 to 3 weeks earlier than normal. A fire in the Swan Hills of Alberta required several communities to be evacuated in early May, some for a second time later the same month. 1998 was a record-breaking year for

[12] After this paper was prepared, SEMARNAP updated the area burned by wildfires in Mexico in 1998 from 582,000 hectares to 849,000 hectares.

resource mobilizations. A shortage of seasonal fire crews in Alberta necessitated interagency mobilization from other parts of Canada and the United States during the month of May.

As was the case in May and the early part of June, the western provinces again experienced difficult forest fire conditions in late July and August. British Columbia experienced the most active fire situation with 445 new fires in one week. Aircraft, personnel and equipment continued to be mobilized to the western provinces, primarily from Ontario and Quebec throughout the month of August.

Preliminary statistics indicate that 1998 will be the sixth worst fire season on record, in terms of area burned. The area burned in Alberta during the 1998 fire season was 570,000 ha, or more than seven times the five-year average of 78,000 ha.

Florida

A variety of factors combined to produce weather and fire behaviour conditions that severely taxed fire-fighting forces in Florida (National Interagency Fire Centre 1998). Many of the fires that burned under serious drought conditions grew to large size and threatened or damaged many homes and natural resources. Since late May, over 2500 fires had burned across nearly 200,000 hectares. By July 12, 370 homes were damaged or destroyed throughout northern and central Florida. Timber losses were estimated at US$ 350,000,000. Increasing precipitation after July 4, 1998, began to lessen overall fire potential.

FIRE MANAGEMENT IN NORTH AMERICA

Canada

Canada contains approximately 10 percent of the world's forests. The 400 million ha of forest covers approximately 40 percent of the country. Of this total, 244 million ha is productive forest. In 1994 the forests of Canada produced $27 billion in forest product exports, amounting to more than agriculture, mining, and fisheries combined (Canadian Council of Forest Ministers 1994).

Wildland fire is a natural force that has been shaping the Canadian landscape since the last ice age. The forests of Canada have not only adapted to fire, but are dependent upon periodic stand-replacing fires to maintain their existence. European settlers in Canada were not used to the level of natural fire experienced in North America. Early writings, art and photographs often described large fires. Settlers did not realize the key ecological role played by fire in the new world and fire was seen as negative, destructive, and undesirable (Simard 1997).

Fire statistics

Records of the national burned area in Canada extend back in time only as far as 1918. Prior to 1930 annual fire statistics were reported somewhat haphazardly (Ramsey and Higgins 1991). Inconsistencies also exist in that the Yukon and Northwest Territories (which contain large areas of forest) have only reported burned areas since 1946 and the provinces of Newfoundland and Prince Edward Island since 1947 and 1971, respectively (Van Wagner 1988). Also, some agencies prior to 1980 only reported fires receiving fire suppression actions.

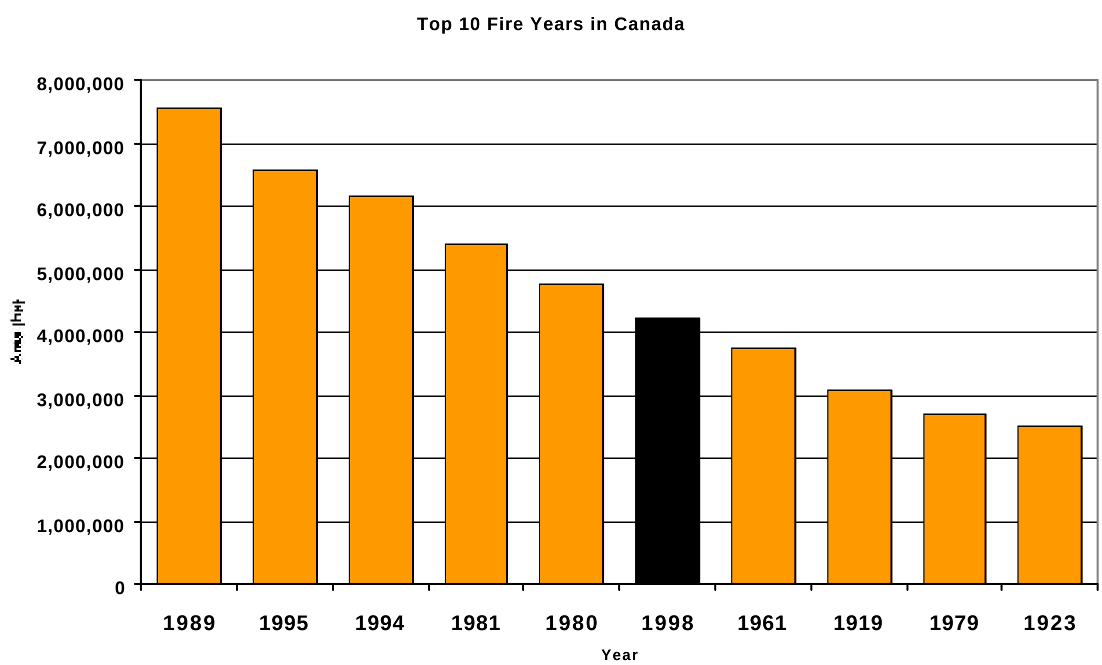
In spite of these limitations, the existing national fire statistics data base has provided fire researchers and managers with a means of comparing fire season severity over many decades and projecting future trends. More recently, it has been recognized that fire statistics serve many purposes, organizations, and communities (Simard 1997) including:

- international commitments (global biomass burning inventories, carbon budget, biodiversity conventions);

- national interests (criteria and indicators, sustainable forest management, the national forest strategy, public health and safety, biodiversity, atmospheric emissions);
- land management agencies (fire and sustainable forestry, landscape management, ecosystem management, wildlife management, watershed management);
- fire management agencies (fire planning, operations, suppression, prevention, prescribed fire, budgeting, audit and evaluation);
- fire science (fire history, the fire environment, fire management, fire ecology, fire economics, global climate change and fire);
- political leaders (fire management policies, appropriate levels of fire management);
- general public (health and safety, management of Canada's forests);
- media.

There can be considerable variability in the number of fires and area burned each year, (Figure 2). Not all fires are fully suppressed in Canada, with some fires receiving a modified response. Eight percent of the fires in 1995 received a modified response, but accounted for 60 percent of the area burned. On average, 10,000 fires burn 3 million ha annually (Figure 3), of which approximately 750 000 ha is commercial forest (an area equal to 3/4 of the annual area harvested).

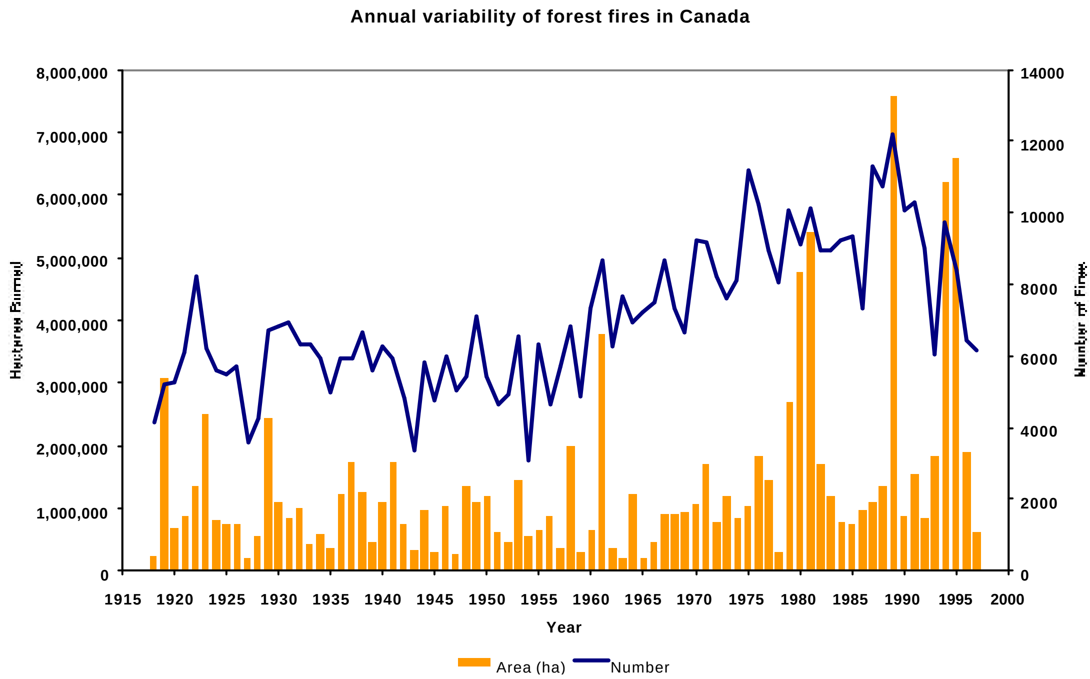
Figure 2. Top ten years for area burned in Canada (hectares)



Lightning is the cause of 35 percent of Canada's fires. This proportion, however, is responsible for 85 percent of the total area burned. This is largely due to the remoteness of much of Canada's forests which results in delayed detection and allows some fires to grow to a large size before control actions are taken.

Charcoal in lake sediments across the boreal zone in Canada is also being analyzed to determine the relationship between climate variability and fire regimes since the last Ice Age 10,000 years ago. It is hoped that historical climate/fire relationships will provide insight when projecting future fire regimes under a warming climate.

Figure 3. Annual variation of forest fire sizes and numbers 1918-1997



Institutional policies, agreements, and programmes

Ninety percent of Canada's forests are public lands. Forest fire management is the responsibility of 10 provinces and 2 territories. Large contiguous areas commonly fall under the jurisdiction of a single agency. Parks Canada also operates a fire management programme throughout its national parks and national historic sites.

The provinces, territories, and national parks are autonomous with respect to forest fire management. Each has their unique organizational structure and slightly different approach to forest fire management.

Information systems

The Canadian Forest Fire Danger Rating System (CFFDRS), developed by the Canadian Forest Service, has been universally adopted by all fire management agencies in Canada. This system is one of the primary information resources used by forest fire managers in their daily decision making and planning. The CFFDRS comprises two major subsystems, the Fire Weather Index (FWI) System and the Fire Behaviour Prediction (FBP) System. The CFFDRS remains one of the few nationally implemented fire danger rating systems in the world. Daily calculations of fire weather and fire behaviour potential are made from data recorded at more than 1,000 weather stations located across Canada.

The Canadian Forest Service also operates the Canadian Wildland Fire Information System (CWFIS). This system produces national fire danger maps on a daily basis during the fire season and distributes them to the public via a world wide web site. The maps and reports are consulted by the Canadian Interagency Forest Fire Centre, fire management agencies, air charter companies, and fire equipment distributors to facilitate interagency sharing of fire suppression resources.

National fire management capacity

A well developed fire management capacity exists within Canada. Fire management agencies have made use of science, technology, training, and organization to develop this capability. In spite of this, it is neither economically feasible nor ecologically desirable to eliminate all forest fires from Canada. This is especially true for the fire dependent Boreal Forest Region of Canada.

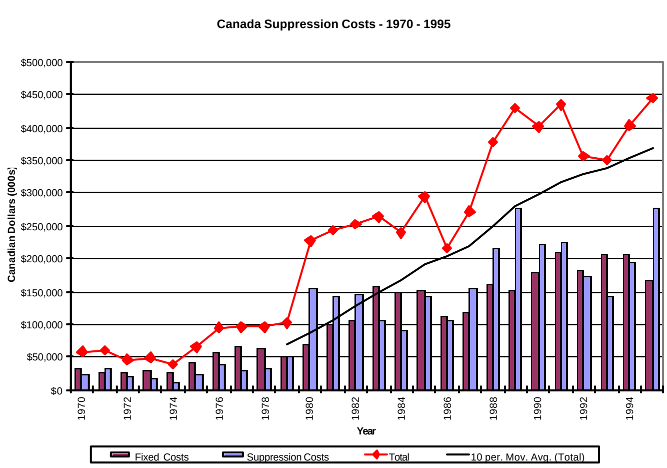
Fire suppression resources in Canada are shared on a formal basis under the Canadian Interagency Mutual Aid Resources Sharing (MARS) Agreement. This agreement recognizes three categories of resources: equipment, personnel, and aircraft. In addition to this intra-Canadian cooperative agreement, a Diplomatic Note signed with the United States authorizes the sharing of resources for fire suppression across the international border. The Canada/United States Reciprocal Forest Fire Agreement, combined with several other exemptions, allows for the quick movement of resources through Customs and Immigration. Such agreements are essential to efficient and cost effective fire management during severe fire seasons. Requests from other countries, other than the United States, are negotiated as and when required. The sharing of resources is coordinated by the Canadian Interagency Forest Fire Centre (CIFFC), located in Winnipeg, Manitoba.

The national air tanker fleet consists of 13 Canadair CL-215 skimming water bombers operated by the provinces on the behalf of Canada. These aircraft are among 29 CL-215s purchased by six provinces and the federal government under the Cooperative Supply Agreement, signed in the mid-1980s. Fifty CL 215/415 aircraft operate in Canada.

Major social, economic, and environmental impacts and benefits of fire

Fire management is big business in Canada with over 500 million dollars spent each year. The 10 year average shows that close to 10,000 fires per year burn 2.3 million ha of forest land. Both fixed costs and suppression costs have increased dramatically over the past 25 years (Figure 4) and the trend is for further increases in the future. In addition, over 365 communities in Canada are dependent on forest resources for their livelihood.

Figure 4. Canada suppression costs, 1970-1995



Climate change and boreal forest fire activity

The latest Intergovernmental Panel on Climate Change report affirms that anthropogenic activities will cause the earth's climate to warm considerably over the next century. Projected impacts are expected to be greatest over land surfaces at northern latitudes, raising concern over impending changes across the global boreal zone. Forest fire activity can be expected to increase quickly and significantly as climates warm, at a time when economic constraints and government downsizing are reducing the effectiveness of fire management agencies and forcing the rethinking of fire protection strategies. The result will be an increase in the frequency and extent of boreal fires, a reduction in mean fire return intervals, a shifting of age class distributions downwards, and a decrease in carbon stored in boreal forests.

United States

Declining forest health

Numerous ecosystem indicators from the Southeast to the West are highlighting alarming examples of declining forest health. Attempted fire exclusion practices, prolonged drought, and epidemic levels of insects and diseases have coincided to produce extensive forest mortality, or major changes in forest density and species composition. Gray (1992) called attention to a forest health emergency in parts of the western United States where trees have been killed across a large area in eastern Oregon and Washington. He indicated that similar problems extend over a much larger area south into Utah, Nevada, and California, and east into Idaho. Denser stands and unnatural fuel accumulations are also setting the stage for high intensity crown fires in Montana, Colorado, Arizona, New Mexico, and Nebraska, where the historical norm in long-needled pine forests was for more frequent low intensity surface fires (fire regime Class 2).

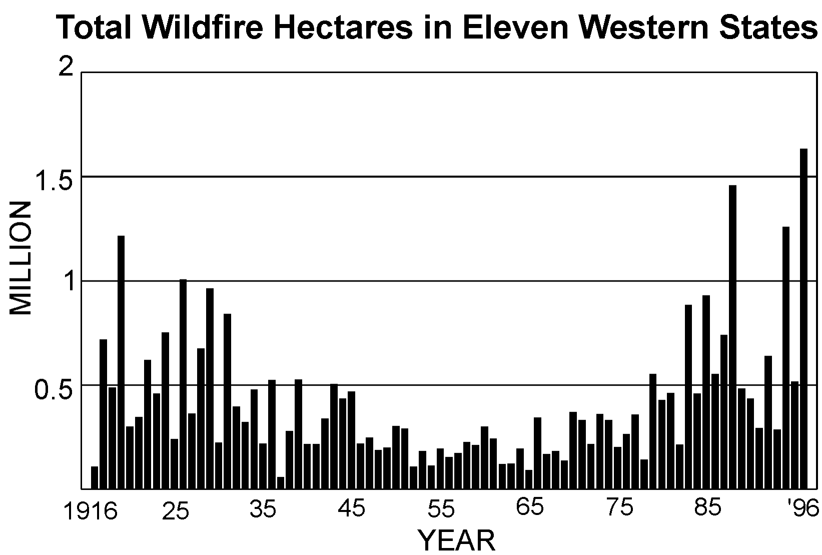
Since the 1980s, large wildfires in dead and dying western forests have accelerated the rate of forest mortality, threatening people, property, and natural resources (Mutch 1994). These wildfires also have emitted large amounts of particulate matter into the atmosphere. One study (Hardy and others 1992) estimated that more than 24 million kilograms of respirable particulate matter were produced over a 58-day period by the 1987 Silver Fire in south-western Oregon! Yet wildfires are generally looked upon as natural events by the Environmental Protection Agency, and are outside their purview as they promulgate clean air strategies. These wildfires, however, can no longer be considered natural events. More than 50 years ago Weaver (1943) reported that the "complete prevention of forest fires in the ponderosa pine region of California, Oregon, Washington, northern Idaho, and western Montana has certain undesirable ecological and silvicultural effects...conditions are already deplorable and are becoming increasingly serious over large areas." Also, Cooper (1961) stated that "fire has played a major role in shaping the world's grassland and forests. Attempts to eliminate it have introduced problems fully as serious as those created by accidental conflagrations."

Some have said that we have been engaged in a "grand ecological experiment" as we attempt to exclude fire from fire-adapted ecosystems. Even in the south-eastern United States where the majority of prescribed burning is conducted, a recent report indicated that there were over 36 million hectares of longleaf pine during the late nineteenth century. Current inventories accounted for 1.2 million hectares of longleaf pine today; and projected that longleaf pine was being lost at the rate of 40,000 hectares a year. One reason attributed to this decline was the absence of fire, contributing to a type conversion to hardwoods. More frequent fires would have favoured the fire resistant longleaf pine over fire sensitive hardwoods. The decline of longleaf pine is also due to timber harvest practices.

Public policies emphasized suppression

Some might question why resource management agencies have been slow in responding to clear warnings that were sounded in the 1940's and 1960's by people like Weaver and Cooper. Resource management and fire management policies, regulations, and practices evolved gradually over time; and were affected by many external public forces. Many of the early internal and external expectations were founded on the calamities brought about by catastrophic fires in the late 1800's and early 1900's. Wildland fires were viewed as the enemy to be eradicated from the forests, not as a natural disturbance process with many benefits. So it is not surprising in the aftermath of the extensive 1910 wildfires that public policies were developed that emphasized fire suppression programmes over prescribed fire programmes; programme emphasis that was universally accepted by society and politicians. But since 1910, a large body of scientific knowledge has developed regarding fire history, fire regimes, and fire effects; the decline in the health of ecosystems has reached alarming proportions; and large, high intensity wildfires are increasing in size since the mid-1980's (Figure 5). In the following section we shall review how public policies and legislation shaped the evolution of fire management practices.

Figure 5. Total wildfire hectares burned in the 11 western states on all Federal lands between 1916 and 1996



Public policies and wildland fire management eras

Pyne (1996) reported that if you follow the evolution of Forest Service fire programmes, you also define the national story of fire management over the years. He traced five historical eras, or 20-year periods, of fire control/management based on the type of problem fire and policies that characterized the era:

1. 1910-1929--Frontier Fire Problem
2. 1930-1949--Backcountry Fire Problem
3. 1950-1969--Mass Fire Problem
4. 1970-1989--Wilderness Fire Problem
5. 1990-Present--Intermix, or Wildland/Urban Interface, Fire Problem

The **Era of the Frontier Fire (1910-1929)** was heralded by the disastrous wildfires of 1910 that burned over 1.2 million hectares of northern Idaho and western Montana in just a few days in late August, killing 85 people, destroying communities, and severely impacting the forests of the region. These fires seriously challenged the ability of the newly formed Forest Service to demonstrate a competency in fire protection. The following year Congress passed the Weeks Act which authorized the Forest Service to acquire new National Forests in the eastern United States and to commence cooperative fire protection programmes with the states. These events set the Forest Service on a course to define national policies to protect forest resources from future fires through an aggressive campaign of fire suppression. Systematic fire protection as developed in California during this era under the leadership of Coert duBois eventually became the standard for national fire planning. The losers at this time were the proponents of "light burning" who argued that fire should be used in the forests as the only rational and economic strategy to protect forests by reducing fuels before wildfires occurred. The devastating 1910 fires sealed a public policy of fire suppression for years to come. The fire use strategy would only surface decades later as agencies began to re-introduce fire on a much larger scale in the late 1990s as a response to declining forest health and escalating fire suppression costs.

The **Era of Backcountry Fire (1930-1949)** referred to fires that occurred on remote wildlands, either in the backcountry far from developments or on cutover lands that had been abandoned. The conservation programmes of the Roosevelt Administration during this era provided both money and large numbers of conservation workers to extend fire protection measures to more remote sites. Also, in 1935 the Forest Service adopted its 10 a.m. fire control policy that required the control of a wildfire by 10 a.m. the day after it started. This policy, adopted by the other wildland fire agencies as well, brought the same level of fire protection to all lands regardless of values at risk. The policy would remain in effect until 1978. During this era some use of prescribed fire was made in the South in the management of southern pines, but it was not widely used throughout the country. This era also saw the commencement of the well-known Smoky Bear fire prevention programme sponsored by federal and state fire management organizations.

The **Era of Mass Fire (1950-1969)** was based on the behaviour and control of large fires, as fire control became a part of national defence policy largely due to the focus on the firestorms of World War II. Pyne (1996) defined the controlling doctrine of this era as the concept of conflagration control. He said that the idea was to isolate critical areas and to concentrate resources in such a way that small fires could not escalate into larger ones. One strategy, applied extensively in California during this era, was the construction of fuelbreaks to confine fires to pre-determined limits. Another strategy was the development of the interregional fire suppression, or Hotshot, crews of 20 people that could be deployed rapidly to any troublesome fires in the country. Forest Service fire research devoted considerable attention to better understanding the mechanisms of mass fires; and three forest fire research laboratories were built to strengthen a more fundamental approach to fire science. The Forest Service also established two equipment development centres in California and Montana that included projects to improve technology available for fire suppression.

In this post-war era considerable military equipment was made available to cooperators; and by 1956 air tankers and helicopters became standard components in the fire-fighting arsenal. Although this was an era largely devoted to the deployment of technology, the environmental movement was also gaining momentum. The Leopold Report of 1963 would have significant ramifications in altering the future of fire management policies and programmes within the National Park Service; and passage of the Wilderness Act in 1964 was to set the stage for the next era. Public policies again were shaping the mix and distribution of fire management programme elements.

The **Era of Wilderness Fire (1970-1989)** signalled a major course correction in fire management for the country. Signs were everywhere that fire suppression was at the point of diminishing returns, as infusions of new money to improve the fire department approach were finally resulting in larger and more damaging fires. Also, there was a growing body of scientific information indicating that fire was an important ecological process contributing to the health of fire-adapted ecosystems in North America. By 1978 the Forest Service abandoned its long standing 10 a.m. and 10-acre (4 hectare) fire control policy for a new one founded on fire by prescription to meet land management objectives. The new policy tried to establish a better balance between fire use and fire suppression, or between prescribed fires and wildfires.

The first prescribed natural fire plan was approved by the Chief of the Forest Service in 1972 for the White Cap drainage in the Selway-Bitterroot Wilderness (Mutch 1974). Four years earlier the National Park Service initiated a prescribed natural fire programme in Sequoia and Kings Canyon National Parks in California. This plan and the ones that followed in the Park Service were largely the result of the 1963 Leopold Report. These plans allowed for fires started by lightning to burn unimpeded as long as certain criteria were met.

This same period of time saw a major shift towards interagency cooperation as the only prudent way to provide a wide mix of fire management services in light of escalating fire costs. The National Interagency Fire Centre in Boise, Idaho, National Wildfire Coordinating Group (NWCG), and the National Advanced Resource Technology Centre (specializing in advanced fire training courses on an interagency basis) all indicated the desire on the part of fire officials at the national and state levels to work more in concert with each other in a routine way. NWCG, begun in 1976, brings together the heads of federal and state wildland fire organizations to coordinate fire management programme elements and policies. NWCG has been instrumental in standardizing common agency operating procedures related to fire prevention, certification and qualifications for suppression and prescribed fire personnel, aviation, chemical retardants, and smoke management. Agencies also adopted the National Interagency Incident Management System, which includes the Incident Command System to coordinate responses to emergencies regardless of jurisdiction. Another prominent and long-standing interagency partner is the National Weather Service, which provides fire weather forecasts, meteorological services, and instructors for training courses.

The **Era of the Intermix Fire, or Wildland/Urban Interface Fire, (1990-Present)** was the culmination of several years of catastrophic fires that had been attacking people where they lived--in homes surrounded by wildland fuels. Although this phenomenon had been occurring in California for years, it took the loss of 1400 homes and 44 lives in the interface in 1985 from one end of the country to the other finally serving as a catalyst for action. A national conference on the problem in Denver, Colorado, in 1986 led to a national initiative to seek meaningful solutions. This initiative brought together diverse participants including federal and state fire services, volunteer fire departments, urban fire departments, the National Fire Protection Association, and many others.

The wildland/urban interface issue is still playing itself out in a very public arena. During the siege of fires in Florida in June and July of 1998, over 70,000 people were evacuated from their homes as a safety precaution; and over 350 homes were damaged or destroyed. During the fires that burned 81,000 hectares of chaparral in southern California in November 1993, over 1000 homes were destroyed. Some people who live in the wildlands are beginning to realize that they must begin to be more responsible in designing homes and living environments that will allow them to co-exist successfully with fire. It has been demonstrated repeatedly that the fire services alone cannot be successful in reducing the impacts of wildfires on people and their property. The homeowners must take appropriate steps in building design, subdivision design, and defensible space to allow the fire-fighters to be successful.

The Incident Command System (ICS) which was developed in southern California much earlier, finally came of age during this era and allowed fire services to be more effective in suppressing multi-jurisdictional fires. ICS establishes an organization, common terminology, and common communication systems, so that diverse fire services can coordinate fire command, planning, operations, logistics, and finance functions on any given incident. ICS allows agencies to work more closely together without abdicating individual agency responsibilities to their own lands.

Summarizing effects of public policies in U.S.

In summarizing the effects of public policies on fire management practices in the United States, Pyne (1996) indicated that many of the goals of fire management have been, and will continue to be, mandated by political acts. The most significant form of political control has been through legislation enacted by Congress. These Acts generally have not translated directly into fire management guidance and programmes, but the various agencies involved have developed such guidance from the Acts to manage their lands. The Clarke-McNary Act of 1924, for example, set the stage for cooperative forest fire programmes between states and the Federal government. The Wilderness Act, passed in 1964, stated that wildernesses should be managed to perpetuate natural ecosystems. Since fire is a natural disturbance process affecting many ecosystem functions, this legislation established the basis for providing fire management plans in wilderness that allowed lightning fires to burn under prescription. The Wilderness Act also prohibited certain kinds of fire suppression techniques in designated wildernesses like the use of mechanized equipment.

Pyne (1996) mentioned other statutes and court rulings that influence fire programmes. The National Trail Systems Act, the Wild and Scenic Rivers Act, the Wild Horse and Burro Act, the Clean Air Act, the Clean Water Act, the Endangered Species Act, the National Historic Preservation Act, and the American Indian Religious Act all shape Federal agency fire management programmes, the implementation of programmes, and the evaluation and review of programmes. Most state fire agencies operate under a somewhat analogous regulatory context. Fire programmes with significant environmental consequences also must follow a review process outlined in provisions of the National Environmental Policy Act. As legislation has increased regarding the management of public lands, the chance for contradictory goals also increases. For example, the Wilderness Act sets direction for using prescribed natural fires (lightning fires that are allowed to burn under prescription) in the management of fire dependent wilderness ecosystems, but the Clean Air Act specifies that visibility and public health should not be impaired by smoke. Agencies must negotiate a complex path in steering fire management programmes through this maze of potentially conflicting legislation.

Wildfire occurrence and cause

An accurate data base indicating the occurrence and causes of wildfires by year is absolutely essential to the management of an effective fire programme. It is next to impossible, for example, to design specific fire prevention campaigns, if one cannot identify the causes of wildfires in a systematic way. If critical fire starting causes remain unknown, then it becomes extremely difficult to mount a significant prevention effort. Tracking fire numbers and sizes over the years also allows an organization to monitor and evaluate the performance of its various fire management programmes. In many countries, however, a thorough and accurate data base on wildfire statistics and prescribed fire statistics is almost non-existent. In fact, in one country wildfires are deliberately under reported, since reporting a damaging forest fire can be career threatening. In the United States, on the other hand, an individual would be disciplined for not accurately reporting fires that occurred. California receives the most money for fire suppression programmes of any other state, because they have demonstrated over the years with data that they have the most damaging fires.

At the present time federal and state agencies do not have a common system for reporting wildfires, although a uniform national system would be highly desirable. All agencies, however, maintain and publish wildfire statistics on an annual basis. The following two tables represent wildfire number and size by cause for State and Federal lands in 1995.

Table 1. Number of fires and hectares burned by cause on State lands in 1995

Statistical Cause	*Number of Wildfires*	*Hectares Burned*
Lightning	3,726	103,580
Campfire	2,133	6,343
Smoking	4,681	10,039
Debris burning	36,056	113,072
Arson	29,349	168,039
Equipment	7,333	47,398
Railroad	1,751	13,700
Children	5,814	7,976
Miscellaneous	22,675	65,820
Total	113,518	535,967

Table 2. Number of fires and hectares burned by cause on Federal lands in 1995

Statistical Cause	*Number of Wildfires*	*Hectares Burned*
Lightning	5,248	245,354
Equipment	527	16,736
Smoking	595	9,489
Campfire	1,797	13,161
Debris Burning	1,496	18,036
Railroad	177	1,025
Arson	2,323	33,416
Children	746	1,648
Miscellaneous	2,592	62,671
TOTAL	15,501	401,536

1994 fire season leads to fire policy review

The 1994 fire season created a renewed awareness and concern among Federal land management agencies and their constituents regarding the serious impacts of wildfires. Thirty-four fire-fighter fatalities that season coupled with the expenditure of almost one billion dollars of Federal emergency fire-fighting funds provided a rude wake-up call. It became critical to review conditions and recommend programme changes to reduce future impacts of wildfires. A Federal Wildland Fire Management Policy and Programme Review was chartered by the Secretaries of Agriculture and Interior “to ensure that uniform federal policies and cohesive interagency and intergovernmental fire management programmes exist." The review process was directed by an interagency Steering Group whose members represented the Departments of Agriculture and Interior, the U.S. Fire Administration, the National Weather Service, the Federal Emergency Management Agency, and the Environmental Protection Agency.

In their cover letter accepting the Final Report of the Review (December 18, 1995), the Secretaries of Agriculture and Interior underscored their commitment to fire-fighter and public safety: "no resource or property value is worth endangering people." The Secretaries also proclaimed that:

> "The philosophy, as well as the specific policies and recommendations, of the Report continues to move our approach to wildland fire management beyond the traditional realms of fire suppression by further integrating fire into the management of our lands and resources in an ongoing and systematic manner, consistent with public health and environmental quality considerations. We strongly support the integration of wildland fire into our land management planning and implementation activities. Managers must learn to use fire as one of the basic tools for accomplishing their resource management objectives."

The Report highlighted the fact that "the planning, implementation, and monitoring of wildland fire management actions will be done on an interagency basis with the involvement of all partners." The term "partners" is all encompassing, including the Federal land management and regulatory agencies; tribal governments; Department of Defence; State, county, and local governments; the private sector; and the public.

The following guiding principles and policies were deemed fundamental to the success of wildland fire management programmes:

1. Fire-fighter and public safety is the first priority.
2. The role of wildland fire as an essential ecological process and natural change agent will be incorporated into the planning process.
3. Fire management plans will support resource management plans.
4. Sound risk management is a foundation for all fire management activities.
5. Fire management programmes are economically viable.
6. Fire management plans and activities are based upon the best available science.
7. Fire management plans and activities incorporate public health and environmental quality considerations.
8. Federal, State, Tribal, and local interagency coordination and cooperation are essential.
9. Standardization of policies and procedures among Federal agencies is an ongoing objective.

The new fire management policy describes three operational fire management strategies:

1. Aggressive initial attack, if no approved plans exist that identify appropriate management responses.
2. Managing a wildland fire under an appropriate management response as directed by approved plans. This may include allowing a natural fire to burn to achieve resource management objectives. Or it may require suppressing a wildfire with an appropriate response.
3. Conducting prescribed fires ignited by managers to achieve resource management objectives identified in approved plans.

Wildfire suppression

According to the new Federal Fire Policy Report, almost 100 years of fire exclusion, coupled with other resource management activities, has altered the landscape and resulted in millions of hectares of forests and rangelands at extremely high risk for devastating fires to occur. This trend impacts all aspects of interagency preparedness and suppression, including safety, planning, priority setting, and organizational response capability. Since work forces and budgets are diminishing, it is critical that all interagency partners work together to arrive at common solutions and successful strategies. Wildfire preparedness and suppression costs are shown in Tables 3 and 4.

Table 3. Federal land management agencies' wildfire preparedness costs, Fiscal Years 1992-1996 (Dollars in thousands)

Agency	*1992*	*1993*	*1994*	*1995*	*1996*
Forest Service	188,525	247,678	260,200	287,018	287,906
Bureau of Land Mgt.	65,305	68,707	61,493	66,998	66,880
National Park Service	13,927	15,427	15,344	13,559	19,465
Bureau of Indian Affairs	25,317	24,230	25,112	24,133	25,704
Fish & Wildlife Service	12,554	15,244	14,242	13,745	15,320
Total	305,628	371,286	376,391	405,453	415,275

Table 4. Federal land management agencies' total wildfire suppression expenditures, Fiscal Years 1993-1997 (Dollars in thousands)

Agency	*1993*	*1994*	*1995*	*1996*	*1997*
Forest Service	121,383	690,930	197,573	524,825	178,095
Bureau of Land Mgt.	40,339	97,115	63,792	98,433	60,305
National Park Service	5,006	14,104	21,257	19,891	6,845
Bureau of Indian Affairs	18,969	52,417	37,753	43,510	32,770
Fish & Wildlife Service	1,616	3,281	1,675	2,643	2,685
Total	187,313	857,847	322,050	689,302	280,700

The following preparedness and suppression goals were formulated to guide agencies in responding to wildfire threats:

- Every fire-fighter, fireline supervisor, fire manager, and agency administrator will take positive action to ensure compliance with established safe fire-fighting practices.
- Federal agencies will maintain preparedness planning and suppression programmes to prevent unacceptable losses from fire.
- Fire-fighter and public safety is the first priority when managing wildland fire.
- Federal agencies will maintain sufficient fire suppression and support capability.

Prescribed fire

How widespread is the use of prescribed fire to produce beneficial results in the United States today? A recent survey (Ward and others 1993) indicated that over two million hectares are treated annually by prescribed fire in the United States. Over 70 percent of all prescribed burning, or about 1.4 million hectares, were in the Southeast. Purposes for using prescribed fire included hazard reduction, silviculture, wildlife habitat improvement, range improvement, vegetation management, and other reasons. The survey grouped such prescribed burning reasons as watershed management, insect and disease control, and research in the category called "other". Resource management agencies and private timber companies cooperate with State Air Quality Bureaux to prescribe burn in a way that reduces adverse effects on human health and visibility. We can see from this survey that prescribed burning practices are concentrated in the south-eastern states. Also, although 2 million hectares burned annually appears to be a large number, people are projecting a much greater need for prescribed fire in the future to maintain, or restore, the health of fire-adapted ecosystems.

For example, the new Federal Fire Policy states that: “Managing for landscape health requires expansion of cooperative interagency prescribed fire programmes. Agencies must make a commitment with highly qualified people, from leader to practitioner, and provide funding mechanisms to conduct the programme.” Recent fire fatalities have focused attention on the need to reduce hazardous fuel concentrations. Many areas need immediate treatment of live and dead vegetation to prevent large, life-threatening, high intensity wildfires. Fuel treatment alternatives include mechanical, chemical, biological, and manual methods, in addition to the use of fire.

A double standard

The Report on the new Federal Fire Policy stated that "*although fire is used to accomplish resource objectives in many areas of the United States, other than in the South it is rarely used enough to improve ecosystem health or to reduce fuel hazards on a landscape scale.*" Thus, a change in direction is clearly indicated-and that change has been embodied in the concept of ecosystem management where we attempt to sustain the productivity of all components of ecosystems, allowing society to enjoy the by-products of healthy systems. As we have already noted, recurring fire is an integral disturbance process to the functioning of fire-adapted ecosystems. But a double standard is impairing our ability to prescribe fire on the landscape on a large enough scale to truly sustain healthy systems (Mutch 1997). The double standard is simply one where practically any strategy can be adopted in suppressing a wildfire, any amount of money can be spent in implementing that strategy, and any outcome can be realized from good to bad. No matter how adverse the outcome (including the burning of 81,000 hectares and the destruction of over 1000 homes in southern California in 1993), politicians and the general public will support the fire-fighter.

A prescribed fire, on the other hand, can be well-planned and well-executed by qualified people, but the moment something starts to go awry the support from politicians and the public, and even internally, is quickly lost. The reprisal is generally immediate because the agency started the fire and it is their fault if something goes wrong. This double standard is part of the tradition and culture of many wildland fire management agencies, since the wildfire suppression decision is generously funded and essentially risk-free in the public arena. The double standard even carries over into the way that regulatory agencies evaluate wildland fire programmes. Thus, the wildfire and its smoke are considered natural events by the Environmental Protection Agency, and are not included in strategies to achieve clean air standards.

We have learned by now that it is not a question of if we are going to have wildland fires, but simply a matter of when and where. And the wildfires are occurring at increasing frequencies and intensities, producing large volumes of smoke over extensive areas. Wildfire smoke is bad smoke. This doesn't mean that prescribed fire smoke is good smoke, but it may be better smoke if emissions can be timed to mitigate the future production of unregulated wildfire smoke. Residents of the wildland/urban interface, air and water quality regulators, endangered species specialists, and resource managers need to plan for the "when" of fire occurrence. An enlightened tolerance on the part of all sectors of society needs to accommodate prescribed fire on a landscape scale, coupled with other management practices, as part of the solution in sustaining healthy ecosystems to benefit people. This will require confronting the numerous barriers imposed either directly or indirectly by the double standard, and seeking appropriate solutions that better balance essential and strong fire suppression programmes with equally well-supported prescribed fire programmes. The list of elements receiving preferential treatment under the double standard is a varied one: liability, air quality, water quality, threatened and endangered species, risks, and funding. In most cases these considerations do not hamper operational practices in suppressing a wildfire. But this very same list can pose distinct barriers to prescribed fire practices.

As noted earlier, one of the Guiding Principles of the new Federal Fire Policy is that "sound risk management is a foundation for all fire management activities." Risks and uncertainties related to fire management activities must be understood, analyzed, communicated, and managed as they relate to the cost of either doing or not doing an activity. Some managers have been unwilling to accept the risk of potential negative consequences associated with prescribed fires. But it is becoming increasingly apparent in regard to the Go/No-Go Decision on prescribed fires that there is risk both ways. The potential risk of a prescribed fire escaping is being countered more and more by the increasing risk posed by hazardous fuel accumulations. A valid risk assessment must accommodate risks associated with all aspects of the Go/No-Go decision.

New initiatives

There are some breakthroughs today, however, in providing more latitude for expansive prescribed fire programmes. The state of Florida, for example, has enacted innovative legislation that provides more protection for prescribed burning personnel in terms of liability. A cooperative programme in Oregon among federal and state agencies is developing a fire emissions trade-off model to predict the smoke emissions produced from prescribed fires and wildfires in the Blue Mountains of north-eastern Oregon (USDA Forest Service 1993). The ultimate goal of this effort is to implement a level of prescribed burning that minimizes total smoke emissions. The Western States Air Resources Council (WESTAR), a non-profit association of air quality agencies in the fourteen western states, has drafted an initiative called "Forest Health Initiative to Restore Ecosystems" (FIRES). WESTAR's intent of FIRES is to "address forest health-air quality technical and policy issues of concern to Congress, the western state air regulators, federal land management agencies, and the public" (WESTAR 1994). The goal of the three-year project is to bring together a broad-based consortium to develop regional solutions based on strong science to balance the needs of forest health while protecting air quality. All of these initiatives and others are providing more latitude for prescribed fire programmes to evolve in a more supportive environment. Obviously, two additional elements that need to be better resolved are the important issues of sufficient funding and the better sharing of risk by all stakeholders. Some progress is being achieved here as well.

Because many stands are now excessively dense and contain many dead and dying trees (Mutch *et al.* 1993), salvage logging, thinning, and partial cutting may be necessary before initiating extensive prescribed burning programmes. In other situations resource managers and fire managers have been able to proceed with landscape scale prescribed burns:

- 6,500 hectare prescribed fire on the Santa Fe National Forest in 1993.
- 400 hectare prescribed fire on the Boise National Forest in 1994.
- 280 hectare prescribed fire on the Lolo National Forest in 1994.
- 2,400 hectare prescribed fire on the Umatilla National Forest in 1994.
- 2,000 hectare prescribed fire on the Tetlin Wildlife Refuge in Alaska in 1993.

Managers are clearly beginning to apply prescribed fire on scales large enough to produce meaningful ecosystem effects.

Concern over another severe fire season in California in 1993 led to the establishment of a special interagency Fire Strategies Team in June 1994. The Team was composed of 13 different state, federal, and local fire and resource agencies, as well as 11 other private and local participants with diverse interests in watershed, fire, and environmental issues. The vision of the Team is to develop strategies to change the historical pattern of spending millions of dollars extinguishing large, damaging fires to a more balanced fuels and pre-fire management programme (Board of Forestry 1995). Key goals of the Team are to achieve a sustainable ecosystem and the maintenance of healthy forests while providing defensible space for the protection of life and property.

Resource management agencies, regulatory agencies, politicians, and society have a challenging opportunity to implement meaningful resource management and fire management programmes at a scale large enough truly to sustain the health of fire-adapted ecosystems to benefit people, property, and natural resources. This will require cooperation and consensus-building at a level never before experienced in resource management. **People need to move away from litigation and the courtroom as strategies for managing natural resources.** The emphasis now should be devoted towards the decades of research results that provide the basis for managing ecosystems more in harmony with disturbance factors to foster the health, resilience, and productivity of ecosystems. Examples already exist where the double standard is being confronted and prior obstacles are being converted into opportunities for success. We simply need to build on those successes.

FIRE MANAGEMENT IN LATIN AMERICA AND THE CARIBBEAN

Introduction

Latin America and the Caribbean Region is an extensive area with many land use practices, laws, and regulations. In this report, the region is divided into four major areas for ease of discussion and presentation: Mexico, Central America, South America, and the Caribbean.

Fire as a land use tool is deeply rooted in the culture, society, and traditions of most countries in the region. Fire has been used to prepare agricultural lands for crops or grazing, to open impenetrable lands to new agricultural uses, to facilitate hunting, or for maintaining an open nature to the landscape.

Natural resource officials throughout the Southern Hemisphere recognize uncontrolled wildfire as a fast emerging significant environmental concern. This was a recurring theme in the presentations offered at the 1st South American Seminar on Control of Forest Fires, Belo Horizonte, Brazil (Ribeiro *et al.* 1998). The seven Central American governments also convened a meeting at the close of the 1998 wildfire season to discuss joint solutions to the wildland fire issue (CCAD 1998). This meeting was held in San Pedro Sula, Honduras, June 23 to 24, 1998. The proceedings from this meeting recognized that there is a serious problem. Recommendations were to be carried forward to a meeting of all Presidents of the Central American governments in October 1998.

The continuing use of fire for land-use practices, population pressures, and a decrease in the economic stature of many of the people in the region are primary causes for the increase in the wildland fire problem (Yegres 1998).

The exact scope of the problem is difficult to determine. Fire statistics in many cases are non-existent, significantly incomplete, or misleading. There is not a common understanding or definition of what constitutes a wildland fire. Reviewing available statistics suggests that 50 to 95 percent of wildfire starts in the region are the result of agricultural burns or land clearing burns escaping control. Agricultural burning has been occurring for so many centuries that there is little to no concern registered when there are vast quantities of smoke in the air, or when many hectares are on fire. During the early months of 1998, satellite imagery heightened government and international awareness regarding the vast number of “hot spots” throughout Central America. Satellite imagery cannot differentiate the unmanaged and uncontrolled wildfires from the controlled burns.

Many countries have established plantations for future wood fibre needs. These plantations are at risk. Venezuela has found that as the plantations become more widespread, the risk of loss increases (Yegres 1998). Chile (Sanhueza 1998) has been proactive in the fire management programme, since the creation of their vast plantations. They have a very proactive programme in cooperation with private industry.

Human livelihood and welfare are directly threatened by the loss of crops, communities, and life (Perkins 1998, Weeden 1998). Guatemala experienced fires in 1998 that were rumoured to have burned many community crops. The same situation was reported throughout much of Central America.

Mexico

Wildfire management was first formalized in 1950 with the creation of the forest fire section in the Forestry Directorate. Fire programme responsibilities were under the Minister of Agriculture and Water Resources (SARH) for many years. The new administration, elected in 1994, created the Secretary of the Environment, Natural Resources, and Fisheries (SEMARNAP). The change was initially difficult, because the creation of a new Ministry did not have the infrastructure that a fire management programme needs. The first few years were a struggle as the fire programme managed to reacquire the vehicles, equipment, and administrative structure that it needed to operate successfully. SEMARNAP has responsibility for all forest fire activities in the country with offices in each of the 32 states. The extent of fire management operations depends on the severity of the fire problem. Each state office of SEMARNAP is autonomous and manages its own fire prevention, preparedness, and fire suppression programme. SEMARNAP maintains a system of professional fire crews, detection towers, and some aircraft. SEMARNAP has primary responsibility for all fire activities: prevention, preparation, and fire suppression. The fire crews perform the initial attack function. In the absence of a SEMARNAP crew, state, municipal, or volunteer crews will perform the initial action until such time as SEMARNAP fire-fighting resources can arrive to assist or assume responsibility.

Figure 6. Annual variability in size and number of wildfires in Mexico, 1980-1998

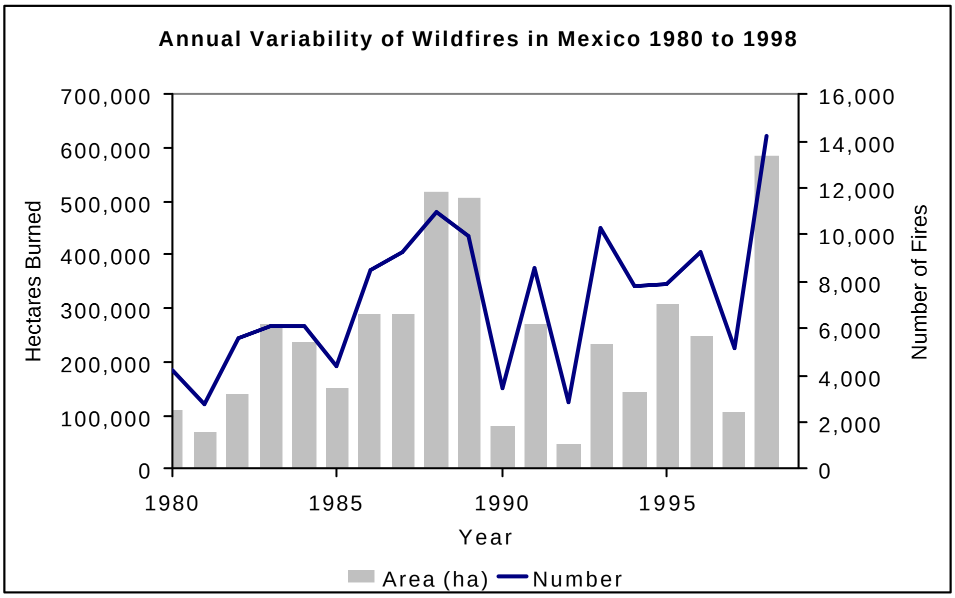


Table 4. Fire statistics and fire causes in Mexico, 1991-1997

Fire Averages 1991 - 1997		*Cause*	*Percent Occurrence*
Number of Wildfires/Year	8,024	Agricultural	53.6
Hectares Burned/Year	264,152	Intentional	16.4
Grass/Brush 72%		Smoking	10.0
Forested 23%		Camp fires	8.6
Average Wildfire Size, has	33	Other	11.4

When the situation is beyond the available resources of SEMARNAP, the military and Civil defence authorities assist. The military will provide personnel under the direction of SEMARNAP personnel. The Civil Defence authority does not have sufficient personnel, but can provide logistics and administrative support.

Institutional policies, agreements, and programmes

The majority of forested public lands belong to the people. The authorities are sometimes at odds with the local people, especially when there is an indiscriminate use of fire. The Organic Law of 1994 specifically charges SEMARNAP to encourage the protection, restoration, and conservation of ecosystems and natural resources. The National Development Plan, under the Organic Law, is intended to slow down ecological deterioration through sustainable development. The forest fire protection programme has the responsibility of coordinating activities with all levels of government, as well as the coordination of international assistance as it relates to fulfilling the intent of the Organic Law. An important ingredient is that each local federal office is encouraged to develop agreements or “memorandums of understanding” with state and local officials to share and coordinate fire-fighting activities.

Mexico is establishing campaigns to disseminate information on the importance and benefits of forest ecosystems. The culture is such that the forest has always been a source of materials or a barrier to agricultural use, hence the desire to educate the country on the role of the forest. There are laws that address the fire use issue. The problem is a cultural and social issue. There is not a general sense that the forests should be protected. Agricultural burns and land clearing burns that escape into the forest are not viewed as problems at the local level. The prevention and awareness problem becomes and education and enforcement issue.

National fire management capacity

There is a well-developed infrastructure for the fire-fighting efforts in Mexico. They have a strong emphasis on training and maintain a vast number of well-equipped fire-fighting resources. Mexico is a large country and clearly desires to amplify the number of resources and equipment available for the programme.

The following is what Mexico had available before the fires of 1998 when their budget doubled:

- 150 fire brigades (400 more including municipal, volunteer, and state crews)
- 6 helicopters (4 contracted and 2 SEMARNAP)
- 2 detection aircraft
- 64 lookout towers

Training (1997)
- 516 courses
- 15,480 participants trained

Fire-fighting equipment
- 651 radios
- Personal Protective clothing for the 150 fire brigades
- Fire-fighting tools including back pack pumps

Mexico's institutional capacity was severely challenged in 1998. Early in the year, SEMARNAP officials recognized that 1998 was going to a very difficult year and that they would not have the monetary or fire-fighting resources to manage fires. The average budget for the 1990 decade has been approximately US$ 6.2 million. Going into 1998, the budget was just under US$10 million. The budget was ultimately doubled to about US$ 20 million. This enabled Mexico to contract more resources. Aircraft use as measured by litres of water or retardant drops was 1,500 percent higher than average. A tragic footnote to the fire season was the loss of 70 lives during the season.

Major social, economic, and environmental impacts and benefits of fires

Average annual losses have been estimated at over US$ 150 million (Martinez 1998). However, these numbers do not reflect loss of real estate or economic livelihood. Eighty percent of fires occur in grass and brush. These vegetation types are prone to a quicker recovery than forested species. In sensitive watersheds, however, there can be a serious short-term impact from erosion and high loads of sediment in domestic water supplies. Crown fires that destroy forests are becoming more problematic.

Martinez (1998) highlighted Mexico's concerns as:

- Loss of forest cover and biodiversity
- Soil erosion and altering the hydrologic cycle
- Negative effects on scenic and recreation areas
- Increase in environmental contamination
- Harm to fauna and their habitat

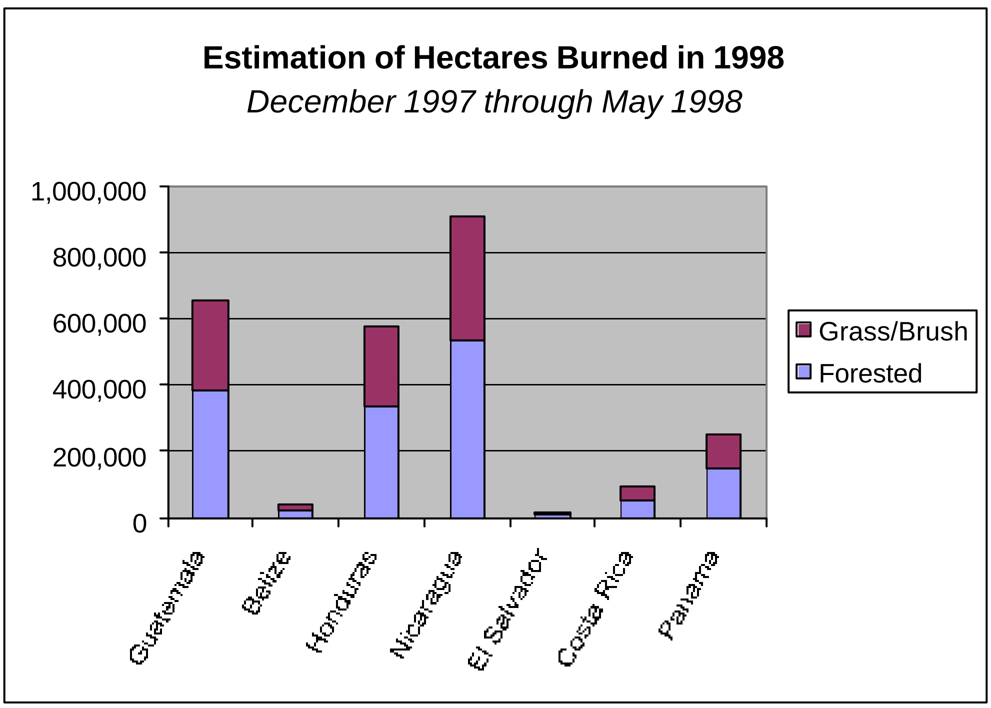
Many more harmful effects can be added to this list. Smoke is a significant health and economic issue. The 1998 fires brought the issue of smoke to an international level when Texas raised concern over the smoke haze that hovered over much of the State during the peak of the fire season. This smoke was from the fires in Mexico as well as from the Central American countries. Human-caused fires account for 93 percent of the fires in Mexico. Since this is a human caused problem, it does ultimately have a human solution.

Fire does have recognized benefits. The expanse of pine-types within Mexico indicates that there is a role for fire on the landscape. Prescribed fire could become a major influence in the prevention of wildfires, but the programme is in its infancy and such developments are still in the future. Also, fire plays a cultural role in Mexico for agricultural purposes.

Central America

There are many approaches to wildland fire management in Central America. Fire has quickly become a major environmental problem for countries that are experiencing economic difficulty. Costa Rica and Honduras have well-developed fire programmes. They had an early recognition of fire and its impact on their natural resources. Honduras, because of the expanse of pines, has been prescribed burning for many years. Costa Rica experienced uncontrolled agricultural burning that was threatening their parks and protected areas. In contrast, Nicaragua is struggling to redefine their programme. In Guatemala, there is recognition that a programme is needed and they initiated training and programme development before the onset of the fires of 1998.

Figure 7. Area burned in Central America, 12/97-5/98



Most of the countries in Central America were affected to some degree by the effects of the El Niño drought. The region experienced an unprecedented amount of burned area with over 2.5 million hectares affected in 1998. Nicaragua accounted for 36 percent of the area burned, Guatemala 26 percent, and Honduras 23 percent. The problem overwhelmed the region quickly, especially in countries that do not have well-developed systematic fire management policies.

Nicaragua, Honduras, and Guatemala were especially impacted. Escaped agricultural burns, or burns from land clearing practices, were the major problem (CCAD 1998). Government Ministers and programme leaders for Forestry and National Parks from throughout Central America gathered in San Pedro Sula, Honduras, June 23 and 24, 1998 (CCAD 1998). The purpose was to discuss the impacts of the the1998 fire season and to determine what the countries might be able to do collectively. Many excellent solutions were proposed at this meeting:

- Assure that the local communities and indigenous people are included in the proposed solutions.
- Search for and develop alternative solutions for agricultural burning.
- Adopt and implement within the region a farmer-to-farmer extension programme as a mechanism to encourage sustainable use of natural resources and to improve agricultural techniques.

All of the countries have been actively seeking technical training to improve the fire management techniques and practices of managers. The Spanish speaking countries have attended international courses on fire-fighting methodology in the U.S., Spain, and Mexico. The Office of Foreign Disaster Assistance has been proactive in developing and offering courses throughout Central America Costa Rica, Nicaragua and Guatemala will be used as Central American examples to illustrate the different approaches used in wildfire management programmes in the region.

Costa Rica

Before 1985 there was not a strong wildfire programme. Loss of tropical habitat, indiscriminate burning, and several large fires precipitated a need to develop a fire management programme. They proactively sought out international assistance. Legislation was passed in 1986 that brought about a change of attitude on fire use. Its main purpose was to discourage the rampant use of uncontrolled fire. There were fines associated with the law. Approval of an additional forestry law in 1996 has raised even further the consciousness that uncontrolled fire had to be halted.

Success in Costa Rica lies in the formation of regional and local fire management committees. The current emphasis in Costa Rica is to decentralize federal efforts and encourage the provinces and local communities to get involved and to be responsible for their areas. There is an economic incentive for the communities to be involved. The Central Government provides funding for tools, equipment, training, education, etc. Also, the National Security (Insurance) Institute is also providing large amounts of funding to ensure success of the programme. These committees are formed by volunteers, with professional and technical assistance provided by the government. They are responsible for preventing fires, as well as organizing to suppress fires. An example of success is in the Guanacaste region where there are 85 volunteer fire-fighting brigades.

Nicaragua

Nicaragua has a serious fire problem. There is little information, however, on the country's programme because of the current restructuring process. Nicaragua is in a developmental stage with their programme (Alfaro 1998). The Ministry of Environment and Natural Resources is being restructured. There are few human or material resources dedicated to the fire management programme. This is primarily due to the lack of adequate funding. The 911,760 hectares affected by the fires of 1998 are reinforcing the need to accelerate the process. According to the Ministry, there is a significant problem with fires as demonstrated by the 1988 to 1997 ten year averages: 5,970 fires for an average of 373,299 hectares burned per year (an average 62 hectares per fire).

Guatemala

Guatemala was moderately prepared for the fire events of 1998. Like many other Central American countries, the number of fires and the scale of the fires eventually overwhelmed their capabilities.

Responsibility lies predominantly with local authorities. Initial response is provided by local volunteers, or on State responsibility lands by government personnel. Effective use of specialized fire-fighting tools is on the increase. When the situation becomes too complex or large, the regional governor assumes emergency management responsibility. There is a governmental structure for emergency response. The Petén region of northern Guatemala was well prepared for the fire events of May 1998. The situation over-extended their abilities, but their organizational expertise facilitated their ability to manage the situation. Previously that year, international specialists worked on emergency management techniques with Emergency Coordination Management officials in the Petén. The training was evident in their efficiency in coordinating activities (Perkins *et al.* 1998). There were military, Civil Defence, volunteers, and local forestry officials working together to achieve control of the wildfire situation.

There is no national authority for fire suppression. Each region is responsible for initiating fire suppression, preparedness, and prevention actions. There is a high degree of international involvement, since areas within Guatemala are under development and the Mayan Ruins serve as a catalyst for action. Wildfire protection programmes are divided among the respective natural resource agencies with Civil Defence having the ultimate authority. The Civil Defence authority does not actively engage in suppression actions at the national level. They do become involved locally as was evident in the Petén. The national civil defence agency steps in once there is a presidential disaster declaration.

South America

South America can be characterized by a long-term proactive programme found in Chile, a programme that is rebuilding in Argentina, and a relatively "new" programme in Uruguay. Countries like Ecuador recognize the problem, but fires are not frequent enough to warrant major government action.

Chile

Chile has had a strong fire management programme for several decades (Sanhueza 1998). The fire management programme has been under the National Forestry Corporation (CONAF). CONAF is a unique federal agency in that it is run like a private company, but under the auspices of the Ministry of Agriculture. Wildfire protection responsibilities formally began in 1962 with the national police (Reyes Morandé 1998). The Ministry of Agriculture involvement began in 1965. CONAF assumed responsibility 1973. CONAF began as a forest fire protection programme and evolved to a more comprehensive fire management programme more recently. CONAF's programme is organized in a similar way to Mexico's, a central office with strong Regional or State divisions of the federal programme.

Throughout the central portion of the country there are over two million hectares of plantations. The plantations are predominantly Monterey pine (Pinus radiata). These plantations are an important economic resource for the country. Most of the plantations are owned and managed by large forest industries. A law passed in 1974 encouraged forestry development. There were economic rewards for the afforestation of previously "unforested" lands. Management plans required the landholders to include a forest fire protection programme for their lands. Plans included provisions for prevention, readiness, and fire suppression.

Fire suppression effectiveness can be measured by the reduction of average fire size. Through the 1960's and 1970's average fire size was about 38.2 hectares. This was reduced to an average size of 10 hectares per fire in the 1990's..

CONAF has responsibilities for all national lands, parks and forested reserves. CONAF also provides protection for landowners with small forests. Large landholders are responsible for their own lands and they suppress fires on adjoining lands since it is in their best interest to do so. Volunteer fire departments play a role in the suppression of wildfires in the vicinity of their respective communities.

Success in fire management is due in large part to the cooperation between the government and forest landholders to form an effective detection, initial response, and fire prevention programme. The private landholders embraced the responsibility for the protection of their own properties in the early 1980's. According to Reyes Morandé (1998), reasons for the success in the fire management programme include:

- A unified structure between private industry and the federal government that facilitates homogeneous actions throughout the country.
- A clear definition of land ownership.
- Only one federal entity responsible for forest policy.
- A private forest industry that protects its own investments.

CONAF is recognized by its neighbours for their superior programme. Chile has provided help to neighbouring countries in the form of handcrews and aircraft. Chile aided Argentina with their fires in 1987.

Table 5. Fire statistics and fire causes for Chile, 1989-1998

10 Year Fire Averages 1989 to 1998		*Cause*	*Percent Occurrence*
Number of Wildfires/Year	5,260	Agricultural	7
Hectares Burned/Year	53,192	Intentional	29
Grass/Brush 61%		Forest Slash	7
Forested 29%		Unknown	13
Average Wildfire Size, Has	10	Transit	30
		Other	14

The private sector and federal government invest about US$ 19.8 million in prevention, presuppression, and training (US$ 12 million by forest industry and US$ 7.8 million by the government). This funding supports a total of about 2,500 dedicated employees in the fire management programme. Fire-fighting resources include the following components:

- 30 operations centres
- 209 observation towers
- 187 prevention technicians
- 151 fire-fighting units (8 to 15 fire-fighters per unit)
- 19 tanker trucks
- 22 helitack crews
- Aircraft: 22 helicopters, 14 air tankers, and 7 coordinating aircraft

Venezuela

The Forestry Law of 1970 placed fire control responsibility in the Ministry of Environment and Renewable Natural Resources. The fire control programme is designed to support local organizations through central operations centres which provide transportation, food, equipment, etc. There are regional examples of excellence where there are economic incentives to prevent and control wildfires. Venezuela's suppression effectiveness was demonstrated by their involvement with helping Brazil during the fire events of early 1998.

Venezuela is predominantly classified as tropical. Natural fire causes are rare, thus the fire problem is a human problem. The dry tropical forests are deemed to be those at greatest risk. There is tremendous population pressure in these areas. A rise in fire occurrence is expected (Yegres 1998).

The eastern portion of the country has experienced a rise in plantations. The programme began in 1969 through a major governmental afforestation programme. There are approximately one half million hectares of plantation. This has been a region of high lightning occurrence, thus there is a high risk of fires and fire losses. The potential economic impact gave rise to fire control efforts. There have been large fires in the recent past. There is a system of detection towers, aerial detection, ground patrols, and trained fire-fighting crews. Helicopters are used to transport fire-fighting personnel. The programme is well defined in this region. Largely due to the potential economic loss, there are many trained professionals performing fire-fighting duties (Yegres 1998). More than a dozen fire technicians have taken advantage of training opportunities internationally. Yegres (1998) laments that many of the trained professionals have other duties and do not have the time to devote fully to wildfire management.

Table 6. Fire statistics and fire causes for Venezuela, 1982-1991

10 Year Fire Averages 1982 to 1991		*Cause*	*Percent Occurrence*
Number of Wildfires/Year	1,546	Agricultural	30
Hectares Burned/Year	45,100	Intentional	33
Grass/Brush 61%		Forest Slash	9
Forested 29%		Unknown	20
Average Wildfire Size, Has	29	Urban	6
		Other	2

Uruguay

Ninety percent of Uruguay is classified as grasslands (Baptista 1998). Fire is used to improve forage for cattle. Fires do escape control and move into other lands, protected-forested areas, or into plantations. Due to the vastness of the grasslands, Uruguay does not have a serious forest fire problem.

The first Forestry Law was passed in 1968 and the second in 1987. The laws attempted to discourage the cutting of indigenous forest species and encouraged the creation of artificial forests. Today there are approximately 310,000 hectares of plantations. Fire problems began to rise as the number and extent of plantations grow. When the programme started and plantations were isolated, the fires were manageable. As the plantations aged and increased plantings placed more plantations adjacent to one another, the fire problem became more serious.

Fire suppression is the responsibility of the Director of National Fire-fighters. There are approximately 1,500 fire-fighters. These fire-fighters are divided into fire brigades. Initial attack is primarily done by the industrial forest land owners in the plantation areas. When the situation is severe, the Public Works Department and the Defence Ministry get involved. There are no aerial resources for suppression. Aerial detection is employed.

Brazil

Introduction. As the ecosystems of Brazil vary from north to south, so, too, is there a great diversity of fire behaviour conditions as one moves from the tropical rain forest, to the caatinga in the north-east, to the cerrado, or savanna in the central part of the country, to the Mata Atlantica, or temperate rain forests along the coast in the east, to the forests of the south. The fire management system that evolves for Brazil must take into consideration the significant differences associated with these major ecosystems. There is a lot known about the fire relationships of the cerrado, less known about fire in the rain forest, and even less knowledge about fire in some of the other ecosystems. The following discussion of fire in the cerrado has been adapted from Coutinho's (1982) paper on the "Ecological Effects of Fire in Brazilian Cerrado".

Cerrado. The cerrado is a complex of plant formations formed by grasslands, intermediate savanna, and dry forests. The core zone of distribution of the cerrado is centred on the great plateau of central Brazil, covering 1,500,000 square kilometres. If the peripheral areas to the core zone are included, the total area for this vegetation complex may reach approximately 1,800,000 square kilometres. This enormous area covered with cerrado is a mosaic of different types determined primarily by the pattern and intensity of the fires and the soil types.

Fire is considered to be an important ecological factor in cerrado ecosystems. Charcoal fragments found in the soil of cerrado around Brasilia were carbon dated as being 1,600 years old. Thus, fire was already present in this area at least 1,200 years before the arrival of the Portuguese discoverers. Anthropological research has shown that people have inhabited central Brazil for more than 10,000 years. Indians undoubtedly used fire for many purposes at the time of colonization. The Caiapos Indians from central Brazil believed that fire was given to them in primeval eras by Bebgororoti, a mythological creature, who brought fire down from the sky during a violent storm.

Although Coutinho stated that there are no known scientific records of natural fires in the cerrado, others have reported lightning fires in places like Emas National Park. It has been estimated that each area of cerrado in long-settled regions is burned once every two years. This usually occurs during the colder and drier months of May to September. The greatest incidence of fire occurs during July and August. Fires can be widespread during these months throughout the cerrado. In 1991, for example, a prolonged drought contributed to the reported burning of one percent of the state of Mato Grosso. In 1994, 70 percent of Brasilia National Park burned, all of Emas National Park burned, and all of the 562,000 hectares of Araguaia National Park burned. Araguaia National Park is located on Ilha Bananal in Tocantins State, the largest fluvial island in the world. All of this island burned as well in 1994. All of these areas are located in the cerrado. Such fires can impair ground and air transportation and cause many problems for people with respiratory diseases.

Tropical Rain Forest. Although the rain forest is generally believed to have little incidence of fire due to the moist environment, there is evidence that fires can occur under the right conditions. These fires are most often related to human activities, since tropical thunderstorms are accompanied by heavy rains that preclude the ignition of fires by lightning most of the time.

The abundance of charcoal of mid- to late-Holocene origin commonly found in rain forest soils of the upper Rio Negro in Venezuela indicates that fire has been a disturbance factor for a long time (Sandford and others 1985). The Rio Negro study concluded that episodes of fire disturbance have modified the forest during the mid- to late-Holocene, perhaps as a result of different climatic circumstances, perhaps as a result of human intervention alone, or possibly as a result of the interaction of human disturbance and climate.

Burning in the Amazon region today is primarily associated with the clearing of forests for agriculture, pastures, logging, and other purposes. Fearnside (1990) reported that by 1988 approximately 400,000 square kilometres, or 8 percent of the Amazon region, had been cleared, and the cleared area was increasing at about 35,000 square kilometres annually. More recent estimates place the annual clearing and burning of the Brazilian Amazon at an average of 15,000 km² (Nepstad *et al.* 1998); and about 517,000 km² of forests in the Brazilian Amazon had been clear-cut and burned by 1996. In the Amazon region, most of the deforested areas are maintained as cattle pasture. The large ranchers account for about 75 percent of the clearing for pastures and small farmers account for the rest. Fearnside (1990) reported that pasture burns are done every 2-3 years in cattle pastures that are being maintained for grazing. Uhl and Buschbacher (1985) have described the increased probability of fire spreading from cattle pastures into surrounding forests where selective logging has occurred.

Amazonian fires have been classified into three major types (Nepstad *et al.,* in press):

- "Deforestation fires" are associated with forests that are burned following clear-cutting to prepare the land for pastures, agriculture, or plantations.
- "Forest surface fires" occur when fires escape into standing primary or logged forests, burning surface fuels on the forest floor.
- "Fires on deforested land" refers to fires burning in pastures, secondary forests, and other vegetation on lands that had once been forested.

Fires can be further divided into those fires ignited intentionally for pasture and land management purposes and those fires that accidentally escape into adjacent areas.

Of the three types of fires in the Amazon, the fires associated with deforestation have the greatest ecological impacts because they lead to the rapid replacement of rain forest species by more fire prone vegetation (Nepstad *et al.,* in press). This is a serious feedback cycle in which the flammability of Amazon vegetation increases over time.

Although the environment of the natural rain forest is not conducive to the ignition and propagation of fires, once the forest has been cut and allowed to dry for several weeks its flammability is greatly increased. Consumption rates of the biomass vary based on conditions at the time of burning. The 1982-1983 fires in East Kalimantan in Borneo, the 1997-1998 fires in Indonesia, and the 1998 fires in Roraima, Brazil, demonstrated that serious fires can occur in tropical forests following severe drought and disturbance. Repeated burning in the Amazon region can lead to the dominance of the vegetation by fire resistant palm species and grass. Once Amazonian forests have been burned, they become more vulnerable to repeated burning in subsequent years (Nepstad *et al.*, in press).

Forests of the Northeast. Ecosystems of the Caatinga Region and deciduous forests of the north-east are found in a hot, dry, and thorny landscape (Ministry of Environment 1996). Temperatures here are very high, relative humidities are low, and the climate is especially arid. Ecosystems of this region occupy an area of 939,391 square kilometres. Degradation of the natural vegetation has occurred primarily due to exploitation of forests for wood, conversions of vegetation to cattle pastures, and the effects of fires.

The Atlantic Forest (Mata Atlantica). Although this ecosystem is also a rain forest, it is not an extension of the Amazon Forest but an entirely different plant formation (UNDP 1993). It contains an exceptional biological diversity. At the time of Brazil's discovery, the Atlantic Forest had an area of

1.5 million square kilometres that extended almost continuously along the Brazilian coastline. Due to its closeness to population centres with their demand for wood, presently there is only 10 percent left of its original extent. The remaining forest is highly fragmented and contains many threatened species of plants and animals. The Atlantic Forest is quite susceptible to fire and current policy calls for its direct protection from fire.

Forests of the South. The ecosystems of the pine forest region cover an area of 220,363 square kilometres (Ministry of Environment 1996). Elevations here are generally greater than 500 meters and it has a temperate climate without a pronounced dry season. This is the area of the Parana pine, a species with high economic and landscape values. The remaining native vegetation represents only 23 percent of the total area. Land in this area is largely dedicated to agriculture.

In the extreme south of Brazil, south of the pine forest region, is an area of about 203,875 square kilometres that consisted in the past of seasonal forests. About 50 percent of the area is still covered by some form of native vegetation. Grassy areas, shrubs, and planted forests are also found here.

PREVFOGO: Brazil's national fire management programme

Wildfires in Brazil's diverse ecosystems have produced many adverse effects for all segments of society:

- Atmospheric pollution.
- Smoke effects on public health in critical areas.
- Disruption of air and ground transportation services by smoke, affecting private citizens, commercial and civil aviation, and the Ministry of the Air Force.
- Potential contributions to global climate change through the production of "greenhouse gases".
- Reduction in water quality.
- Disruption of electric power transmission.
- Threats to life and property.
- Loss of biological diversity.
- Threats to commercial plantations of trees.

These numerous adverse effects of uncontrolled fires led to the creation of PREVFOGO (a National System for Wildland Fire Prevention and Suppression) through the Federal Government's Law Decree No. 97,635, dated April 10, 1989. In a document signed by IBAMA President Tania Munhoz in November 1990 the objective of PREVFOGO was defined as:

> "...systematizing, in an integrated and objective way, the interesting information, including the prioritization of affected areas, the ways of identification of fire and burning focuses in real time, the material and human resources to be mobilized, and the integrated communication system. It also envisions the implementation of an appropriate prevention programme, thus guaranteeing the effective reduction of forest fires and burnings in Brazil and their consequences; and disciplining the use of fire through controlled burning based on appropriate technical and scientific knowledge."

What this objective calls for is the development of a systematic fire protection programme for Brazil with all of the essential elements in place to provide future benefits to the diverse sectors of society. Achieving this important goal is a difficult and challenging task, but t is a task that must be accomplished with skill, motivation, and continuity of effort. The antithesis of this goal is surely something that no one wants. As Jose de Paiva Netto stated, "the destruction of nature is the extinction of the human race."

The PREVFOGO strategy to produce a systematic programme of fire protection was designed around a network that included:

- A National Centre at IBAMA headquarters in Brasilia. The National Centre would work in an integrated manner with all public and private organizations involved within fire-fighting and controlled fires.

- State Centres located at the State Superintendencies of IBAMA or other agencies through agreements. The State Centres would be responsible for implementing fire policies and implementing fire programmes for the States. The effective fire-fighting actions in the States would be assigned to the Fire Departments, who would be provided with the resources needed to purchase appropriate equipment. Fire-fighting personnel also would be provided by IBAMA staff and trained volunteer brigades.
- Regional and Municipal Centres would be responsible for fire-fighting and executive actions in cooperation with the Bombeiros and existing forestry companies in their respective areas.

PREVFOGO is located within IBAMA's Directorate of Control and Supervision.

Cooperative arrangements

On August 7, 1991, IBAMA and the USDA Forest Service signed a Memorandum of Understanding that established a cooperative programme between the two countries in the areas of fire science and fire management. The purpose of the cooperation is to reduce the extent and environmental impacts of fires within savanna and tropical forest regions. The cooperation involves supporting IBAMA's development of a national strategy for fire management that reduces fire impacts, development of administrative structures for implementation, and development of human and physical resources to attain objectives. The cooperation includes fire assessment, scientific exchanges and research, technical support, and fire management applications.

Current PREVFOGO programme

PREVFOGO is concentrating on five priority areas (Cornacchia and Pedreira 1998):

- Administer rural extension and education programmes with the farmers to reduce the number of wildfires that arise from agricultural burning.
- Develop fire management plans for IBAMA's Conservation Units to use suppression and prescribed fire to minimize adverse impacts on ecosystems.
- Monitor "hot spots" by satellite to provide information on problem areas.
- Provide training in fire prevention and fire-fighting, aerial fire-fighting methods for pilots, and fire cause determination
- Prepare brigades to carry out actions to prevent and fight wildfires in Conservation Units; and work with enforcement authorities to ensure that regulations are being met.

Individual states in Brazil also have developed plans for the protection of forests from fire (Government of Parana State 1998; Cavalcanti 1998).

Lessons learned: Roraima experience can guide future policies

It may be informative to use the Roraima Fires in northern Brazil as a case example to examine lessons learned in terms of what worked well and what did not work so well during the 1998 year of El Niño. Interviews with Bombeiros who were on the Roraima Fires listed the following positive aspects of their assignment:

1. Bombeiros with previous wildland fire training were especially effective in dealing with this complex situation.
2. For not having any pre-arranged agreements among the various agencies, the interagency cooperation on the fires worked well. Many agencies and organizations integrated their activities in a positive way, including Roraima State government, Army, Air Force, Bombeiros, IBAMA, Civil Defence, Meteorological Service, Argentina, and Venezuela.
3. Air Operations training at the National Interagency Fire Centre in Boise, Idaho, was helpful in the coordination of air operations on the fires.
4. The Incident Command System (ICS) for fulfilling command and control functions on the fires worked well, given the fact there were no prior arrangements for this system to be used by all

agencies. The Governor and Army General in charge in Roraima were supportive of the ICS process.

5. It was very useful that IBAMA in Brasilia (PREVOFOGO) requested that bombeiros with wildland fire experience conduct a fire assessment in Roraima to describe the situation and recommend necessary fire suppression actions. Captain Gilberto Mendes and Captain Wanius de Amorim from Rio de Janeiro, along with Giovanni Cornacchia of PREVFOGO, conducted this assessment from March 15 to March 23. They flew a reconnaissance over 400 km, mapping the location and extent of the fires with GPS and comparing locations with satellite images of the fires. Eventually a good map was developed that clearly showed the serious extent of the fire problems. The Governor eventually used their map and assessment report in a request to Brasilia for emergency funds. Brasilia initially released $1.5 million Reais for fire-fighting and support following this documented request.
6. The Army did an excellent job in providing logistical support for the fire-fighters, including tents, food, transportation, etc.
7. Helicopters from Minas Gerais and Venezuela worked especially well on the fires due to prior experience on forest fires. Other helicopters also worked well, but pilots would benefit from special training in the use of helicopters on wildland fires.
8. The Bombeiros from Rio de Janeiro came fully equipped to be a self-sustaining fire-fighting unit, requiring little in the way of outside support. On the C-130s that transported them they brought a van, fire-fighting engine, handtools, chain saws, tents, 5 GPS units, headlamps, batteries, first aid kits, a doctor, and radios. They also bought 10 new chain saws to be better prepared for fighting fires in the rain forest.
9. There was an efficient mobilization with the C-130's once the order was received to go to Roraima.
10. Daily operation plans were developed by some units to direct actions and provide necessary information for others.

Bombeiros and others also called attention to the following issues that impeded a more successful response to the fires in Roraima:

1. Outside resources were not mobilized quickly enough to reach the fires early and keep them small. Many fires were burning in January, February, and early March with only one Captain and 10 fire-fighters from Roraima available for fire suppression! The situation was overwhelming by the time bombeiros arrived from other States. Bombeiros worked hard under these difficult circumstances, but it was the arrival of rain later in March that presented the situation from becoming much worse.
2. There was not an integrated communication system on the fires, allowing all of the different organizations to talk to each other with a single radio with multiple channels to cover all frequencies. Each organization had its own internal communication system, but not a common system with each other. Also, there was not an effective communication link between the Area Command Centre in Boa Vista and the field Command Centres.
3. Bombeiros did not have the right type of equipment for rain forest conditions; and there was not enough equipment.
4. There were not enough fire-fighters to be successful under the prevailing conditions in Roraima. There were 700-1,000 people engaged in the fire-fighting operations. Estimates ranged in the neighbourhood of 10,000 or more fire-fighters needed by the time people showed up in mid-March. A smaller number of trained and well-equipped fire-fighters arriving in January and February could have greatly reduced the severity of the impacts and the costs.
5. Many more fire-fighters need to receive wildland fire training prior to the fire season, including bombeiros in the Amazon region whose training is more geared to structural fire-fighting. Volunteer brigades at the local level also need to be equipped and trained to serve as first responders to fire emergencies.
6. Air support was not continuously available to meet the needs of fire-fighters on the ground. The military diverted helicopters to missions other than the support of fire-fighters.
7. Farmers kept burning even during the burning ban when the fire danger was so high. It took the threat of arrest to convince the farmers to stop burning. (Note: The Yanomami tribe, on the other hand, said they would not burn until told by the bombeiros that it was okay to burn again).
8. The Command Centre in Boa Vista tried to produce daily plans, but the planning process was more on the order of reporting what had occurred rather than directing priorities for future operations to guide field commanders. More experience and training in the ICS process would

help to overcome this shortcoming. People should fill the ICS positions within Command Centres based on knowledge of fire-fighting operations and not on military rank.

9. There was not a process in place for the daily evaluation of the performance of fire-fighters on the various fires. Evaluations should be conducted to ensure that fire-fighters are meeting incident objectives.

These lessons learned from Roraima in Brazil are somewhat indicative of strengths and problems experienced on the fires in Mexico and Central America. Public policies could be developed to build on the strengths of the Roraima response and minimize the negative features. Of course, policies that serve as incentives for the local people to invest more in fire prevention and sustainable land use practices are critically important as well.

PROARCO

The Roraima fires underscored the growing realization that forests in the Amazon were becoming increasingly vulnerable to fires in drought years. Fire risk was especially acute in the "Arc of Deforestation" in the southern Amazon where timber harvest, agriculture, and other land management practices have greatly increased the flammability of vegetation. This continuous arc is about 3,000 kilometres long and 600 kilometres wide. The response of the government of Brazil to this problem was to request a loan from The World Bank in support of a project called PROARCO, a programme for the prevention and control of burning and forest fires in the Deforestation Arc. Planning for the project began in the spring of 1998 and The World Bank approved a loan for US$ 15 million on September 10, 1998, to prevent and control large-scale wildfires in the southern part of the Brazilian Amazon. The programme is jointly administered by IBAMA, the Brazilian Government's official Environment Agency, and the Ministry for the Environment, Water Resources, and the Amazon Region.

PROARCO was designed around the following components (Ministry for the Environment and IBAMA 1998):

- Monitoring agricultural burning and forest fires (including the monitoring of fire risk).
- Enforcing regulations regarding the use of fire in land management.
- Preventing forest fires (including the training of farmers to burn using appropriate precautions and safeguards).
- Combating of forest fires.
- Establishing a strategic task force (providing overall coordination).

Benefits of the PROARCO effort could include a reduced occurrence of large scale, damaging fires through fire prevention and fire suppression; more sustainable land use practices; improved partnerships among federal, state, municipal, and non-governmental organizations and agencies; de-centralization of actions to the local level; and better protection of the Amazon rain forest.

Trinidad and Tobago: A Caribbean case example

Introduction

Each dry season (approximately January to May**)** forested and agricultural lands and open areas in Trinidad and Tobago experience numerous forest and bush fires (Trinidad Forestry Division 1998). The extent of damage caused by these fires varies with the severity of the dry season. For example, while the severe drought of the 1987 dry season resulted in burning over 20,000 hectares of forest and agricultural lands, the area burned in subsequent years was substantially reduced. In 1996, 2,664 hectares burned; and 446 hectares burned in 1997.

Gains in reducing area burned were not only a function of milder dry seasons, but fire preparedness measures and public education programmes also were effective in curtailing damage from wildfires.

The National Forest Fire Plan Committee, first appointed in 1988, has been instrumental in guiding and implementing the Forest Fire Protection Plan for Trinidad. The Committee's Chairman is the Director of Forestry. Each representative on the Committee is responsible for mobilizing and directing the resources of his or her agency to fulfil the national forest fire protection effort.

Policies and objectives

The overall objectives of the Forest Resources Policy of Trinidad and Tobago are to:

- Allocate an adequate area of land in strategic places for forestry purposes.
- Manage these resources for optimum combinations of their productive, protective, recreational, aesthetic, scientific, and educational capabilities.

Implied in the above statements is the need to protect not only commercial timber from fire, but also other values related to watersheds, wildlife, aesthetic and recreational uses, and soil fertility. Since fires on these Caribbean islands are due entirely to the activities of people, there is little evidence to suggest that fire was a natural element influencing the evolution, succession, and development of the forests. Indigenous forests generally are not adapted to withstand intense or repeated fires. The Forest Fire Protection Plan therefore seeks to reduce the extent of damage due to forest fires within acceptable limits. The Plan also focuses on those agricultural and other private lands subjected to slash-and-burn agriculture. Such agricultural burning has been identified as a major fire risk, since these fires easily escape to adjacent lands. Strategies to reduce these fire losses emphasize fire prevention campaigns and enforcing laws related to the Agricultural Fires Act. This Act defines the fire season, makes arrangements for the issuance of fire permits, and establishes offences for non-compliance with the various provisions.

The Plan covers all lands to which the Agricultural Fires Act applies. Priority is also given to state-owned protection forests, forest plantations, and other areas of high ecological value. Overall objectives of the Plan are to:

- Educate citizens on the values and benefits of forest resources and the detrimental effects of forest and bush fires.
- Prevent as many fires as possible.
- Reduce damages and losses from fires by maintaining a state of preparedness for fire detection and control commensurate with the existing levels of fire danger.

Annual fire management costs for 1998 included 500,000 Trinidad dollars for the capital costs for purchase of vehicles, communications, and fire-fighting tools and equipment and 1,286,000 Trinidad dollars for such recurrent costs as clearing fire traces and patrols for fire detection and suppression.

Economic and social impacts of forest fires

Forest fires in Trinidad result in significant consequences to society:

- Direct loss of timber and other raw materials.
- Loss and decline of future timber yields as a result of subsequent insect and disease problems. This problem is especially serious in teak plantations where future yields are affected by fires and rot.
- Cost of remedial work to restore infrastructures damaged directly or indirectly by fire. For example, fire-induced landslides can affect watercourses and roads.
- Damage caused by an increased incidence of flooding.
- Disruptions in the sustained supply of various utilities.
- The cost of reforesting burned areas.
- Health risks associated with increased particulate matter in the air.
- Loss of eco-tourism opportunities.

Fire statistics

Vegetation types most susceptible to fire are the savanna areas and teak forests. In 1997, for example, savannas comprised 38 percent of the area burned and teak forests accounted for 37 percent of the area burned. These types were followed by shrublands, pine forests, and natural forests. Annual numbers of fires reported by the Forestry Division vary between 146 and 764 over the past 12 years (Table 7).

Table 7. Fire numbers and area burned in Trinidad and Tobago, 1987-1998

Year	*Number of Fires*	*Area Burned (Ha.)*	*Ave. Fire Size Ha.*
1987	502	21,420	42.67
1988	583	5,495	9.42
1989	146	970	6.64
1990	234	1,100	4.7
1991	229	680	2.97
1992	431	2,710	6.29
1993	228	1,570	6.89
1994	256	2,600	10.15
1995	516	7,245	14.04
1996	178	2,664	14.97
1997	156	446	2.86
1998	764	10,289	13.46

LESSONS LEARNED: POLICIES, ACTIONS AND SOLUTIONS TO SUSTAIN HEALTHY ECOSYSTEMS

Sustainable land use policies and programme

The case has already been made in this paper that emergency responses by themselves will not be adequate in protecting the Region's forests from fire. In fact, a protection strategy that relies only on improving the capacity to respond well to emergencies is doomed to failure. There is evidence in the Region that this approach results in larger and more damaging emergencies in the future. The key to better safeguarding the Region's forests lies in forging a link between sustainable land use policies/practices and emergency preparedness. We are witnessing the effect of decades of fire exclusion on fire-adapted ecosystems in the United States and Canada. Widespread insect and disease epidemics, forest health decline, unnatural accumulations of forest fuels, and high intensity crown fires that threaten people, property, and natural resources have been the result of this strategy to exclude fire.

Current public policies in the U.S. presently call for ecosystem management plans and programmes to apply silvicultural and fire prescriptions on a much larger scale to reverse this trend and restore and sustain healthy forests. In fact, the single most important public policy change in the United States in the 1990s affecting forest management and fire management was the adoption of an ecosystem management model that replaced a decades-old traditional forestry model that emphasized timber harvest. The ecosystem management model called for sustaining the viability and productivity of all components of ecosystems and allowing society to benefit from the by-products of healthy systems.

Early fire policies in Canada, too, were based on the European model of fire exclusion. In spite of notable success with fire control, there was a growing realization that fire exclusion was neither physically possible, economically feasible, nor ecologically desirable (Canadian Forest Service 1997). A national workshop in Canada in 1996 summarized policy implications as follows:

> "Substance must be given to policies that state that fire suppression costs should be proportional to values at risk and that fire should assume a more natural role in managing the landscape."

Under Canada's 1991 Model Forest Programme, suggested actions are being tested in 10 sites across the nation (UNEP 1997). In 1992, Canada released a National Forest Strategy that identified 96 actions for sustainable forest management, but only one of the 96 action items was related to fire management. The recommendation has been made to establish a task group to develop recommendations for incorporating wildland fire considerations into Canada's National Forest Strategy (Canadian Forest Service 1997).

Since agricultural practices of fire use in tropical countries can degrade forest resources over time, there is a compelling need to enlist the small farmer as part of the solution in developing a conservation ethic. Some countries have used incentives effectively in this regard to gain the commitment of farmers towards more sustainable land use methods. Efforts to change the model of natural resource uses from their current extensive exploitation in the Amazon to a more sustainable model will require the better integration of public policies aimed at promoting economic development and settlement with those designed to conserve natural resources (Nepstad *et al.,* in press). The authors called for **policies that provide for increased agricultural productivity on deforested lands while at the same time providing disincentives for reckless uses of forested lands.**

Community based efforts

Global campaigns that call attention to the need to protect forest resources from fire can be useful in focusing attention on the critical nature of the problem. But no matter how valuable these global campaigns may be, ultimately the people who live and work in the affected areas must become involved in the conservation choices and strategies at the village level. Joint forest management (JFM) examples in India--cooperative efforts between the Indian Forest Service and local villages--have demonstrated on numerous occasions that it is better to develop partnerships with local people rather than exclude them or re-locate them. In other words, concerned global voices need to be augmented by informed village choices if conservation measures are to succeed in the long run.

The pressures of people and environmental factors often adversely impact natural resources. This fact is especially true in India where approximately 200,000 villages containing 250 million people are located within or near the 72 million hectares of India's forests. This statistic is similar to placing the entire population of the United States within the comparably sized National Forest System in that country! Villagers in India use fire during the dry season for many beneficial purposes, often without provisions for controlling the extent of these fires. Initiating joint forest management practices is essential to the welfare of people and natural resources. There are JFM examples in India where villagers gain certain uses of minor forest products from the Indian Forest Service and in return provide fire detection patrols and volunteer fire-fighting brigades.

During an earlier severe fire season in the Amazon Basin in Brazil, the agricultural burning of some farmers escaped to cause damage to their neighbours. Following this incident, the villagers agreed to cooperate and self-regulate their burning practices in the future. They banded together to burn cooperatively rather than individually, they determined which days were preferable for successful burning, and they developed an enforcement mechanism whereby villagers enforced regulations that all had adopted. The end result was a more efficient agricultural burning programme with fewer damaging escapes. This is a noteworthy but isolated example. It remains to be seen whether such grassroots initiatives will expand to become a normal way of sustaining healthy ecosystems over large areas in the future.

Wildfire prevention and education

Prevention and education are the essential keys to reducing the wildfire problem. It is important to educate the public that forests have many benefits; and that the indiscriminate use of fire and exploitation of the forests cannot continue. There is a world-wide focus on the fires in China, Indonesia, Brazil, Central America, Mexico, and the United States. This opportunity must be grasped and used as the backdrop for highlighting the importance of preventing catastrophic future events by adopting more sustainable land use policies and practices. It is far better to invest in effective programmes to prevent forest fires before they start, rather than spending enormous amounts of money in fighting a wildfire. Public policies could ensure that funds are allocated to produce a more balanced fire management programme by earmarking more support to fire prevention efforts.

International agreements and cooperation

Interagency and Regional cooperation concerning fire management has increased significantly during the last decade or so. In North America, under the North American Forestry Commission, there has been a Fire Management Working Group that brings together specialists from Canada, the United States, and Mexico to work on common problems. The Northeast Fire Compact between Canada and the north-east States has been in place for many years; and a Northwest Compact is being developed now to share fire-fighting resources both ways across the border between Canada and the United States. A more general agreement also exists between Canada and the United States for the exchange of fire-fighting resources. Agreements also exist along the border between Mexico and the United States to share resources. Central America has been especially proactive in developing cooperative efforts among all countries in this area. Central America countries meet periodically to establish common fire management policies and strategies to help each other. In South America, countries have sent fire-fighting resources across borders on an *ad hoc* basis to assist neighbours with serious fire threats. Venezuela and Argentina came to the aid of Brazil during the widespread fires in the State of Roraima in March and April of 1998.

The Central America Commission for Environment and Development (CCAD) is a good example of regional-level policy making in Central America. It was created in 1989 by the Presidents of Central America. It is composed of the heads of the ministries and agencies most directly responsible for environmental policy in each of the seven Central American countries. CCAD's principal mission is to promote policy coordination, develop new funding, build institutional capacities, make information available, and foster citizen participation in addressing the region's environmental problems.

In the United States, the National Wildfire Coordinating Group (NWCG) was organized in 1976 to bring together the leaders of Federal and State wildland fire organizations to coordinate fire management programme elements. NWCG has been instrumental in standardizing many aspects of wildfire and prescribed fire management, allowing all agencies to work more effectively together.

Such cooperation among agencies and countries can be significant in establishing shared data bases, strengthening policy making capabilities, developing institutional and legislative frameworks, and reinforcing high level policy forums.

Fire management organization and structure

Many countries do not have policies calling for a dedicated organization for fire management, or they have an organization on paper but not in practice. In some cases, there may be confusion as to which agency has authority for wildfire suppression. This may be for economic reasons or for not recognizing the need for fire management. Fire management may be nothing more than a local volunteer fire response as seen in Guatemala. Mexico and Chile, on the other hand, have either federal or private professional fire crews that perform most of the initial response to wildfires. If it exceeds the local response group's capability, then the response may be supported by a regional or state structure of civil defence or military officials. Intervention on the federal scale depends on the scope of the event, or the recognition that a problem exists.

Public policies could help establish more immediate and effective suppression responses to wildfires by calling for and funding protection organizations based on the principles of systematic fire management described earlier.

Controlled burning and education on proper burning techniques

Prescribed burning in "fire adapted" ecosystems, ecosystems where plant and animal species have evolved with fire, must occur. The U.S. and Canada have realized that large scale prescribed fires and silvicultural treatments need to occur, if the intensity of wildfire events is to be abated. Air quality issues will need to be resolved before this can occur on a significant scale. Education on the role of fire in maintaining healthy ecosystems needs to become an immediate priority. Prescribed burning to sustain the health of Brazil's cerrado ecosystems also is receiving some attention.

Banning slash-and-burn practices has been ineffective in the past because fire is an inexpensive method for land clearing. One effective strategy is to teach farmers the basics of sound controlled burning techniques. This has been recognized in places like Brazil and Mexico as a high priority requirement. Removing fire as an economic tool for land preparation will probably never be realized. Education on proper techniques and appropriate timing are avenues that should be pursued aggressively in the region. Some also are considering the substitution of alternative land use practices, like agroforestry, as an economically viable practice to replace slash-and-burn farming.

Environmental education efforts under way need to be reinforced and supplemented. Many countries have extensive programmes. Fire effects on ecosystems should be incorporated into curricula in elementary and high schools.

Internet resources could be enhanced. While researching this paper, it was difficult to find definitive sources of information. FAO and other international institutions could be the focal point for accumulating and disseminating such information.

Fire research in tropical ecosystems

Information on the effects of fire in tropical ecosystems needs immediate attention. Wildfires are burning in ecosystems that have not experienced fires on such a grand scale. Studies should be undertaken with the results readily available on the effects of the fires this year.

Assessing fire effects, both beneficial and deleterious, is difficult. Fire effects on tropical ecosystems are not well documented or well understood by governmental officials. Some fire-adapted species have received ample study. Loss of some habitats may be irreplaceable or slow to return. The effects may include the immediate loss of rare species, or intermediate to long-term losses of habitat that bird or animal life needs. For example, migrating neo-tropical birds are dependent on habitats in Central and South America, as well as in North America. The entire region needs to work together to preserve these habitats to assure that these species are not jeopardized.

Appropriate suppression tactics and tools need to be applied carefully in ecologically sensitive areas. Damage from tractors used in fire suppression may far exceed the potential damage from the actual fire event. Research needs to provide guidelines for the appropriate reforestation of burned areas, so that exotic species or off-site species are not introduced. Often in fire-adapted ecosystems the native vegetation quickly returns to protect the site and establish a new forest.

Training

Training is the cornerstone to safe and effective fire suppression. Fire-fighters who are not well prepared for their work in controlling wildfires place themselves at risk. Cooperative and effective training has occurred in the region and it needs to continue.

An international training effort initiated in 1983 brought students from 20 Spanish speaking countries to Marana, Arizona. Portugal and Brazil were also represented. Subsequent courses were sponsored in Mexico, Spain, Chile, Argentina, Venezuela, and Central America throughout the 1980s. The results of the training are still being seen today. Graduates from these courses hold important positions in their respective countries. Mexico, Venezuela, and others have taken the course work and adapted it to their local needs and train fire-fighters every year. Alfaro (1998), in her work in Central America, feels that advanced courses need to be offered to enhance the skills of some of the programmes.

On-the job training is also valuable in instilling proper practices for fire suppression and fire use. Approximately 30 fire-fighting officers from several States in Brazil have received fire suppression training as members of Hotshot Crews in the United States. Following these four month assignments, the fire-fighters returned home to adapt what they learned in developing fire-fighting courses designed for conditions in Brazil. They have now trained 2,000-3,000 additional fire-fighters in Brazil to fight wildfires.

Equipment

Light but durable handtools need to be made available to local fire-fighting resources, especially during the initial response phase. Quite often appropriate tools are not available, or the local tools are so large and heavy that it difficult to get a day's work out of fire-fighters. Fire-fighting is exhaustive work without providing tools too cumbersome to use. Some studies could also be undertaken to adapt tools to local situations. The machete may be the frequent tool of choice, but it is small and perhaps in need of improvements to make it more suited to wildland fire-fighting.

Aircraft are effective for reinforcing ground actions, but aerial resources are very expensive. It has been assumed that the aircraft is the answer to many of the concerns, but impenetrable tropical forests and dense forest canopies hinder the effectiveness of aerial retardants. New techniques, studies on the use of retardant, and training in the application and use of air resources should receive a high priority at some point. But a basic policy in any country should be to emphasize the training and equipping of basic fire brigades before launching major programmes of aerial support. Organized, well-equipped, and experienced people suppress wildfires, not aircraft working independently of people.

MANAGING FOR PRODUCTIVE ECOSYSTEMS

It appears clear that systematic fire protection is needed to sustain productive ecosystems to benefit people in diverse ways. But how does one know what success really looks like in trying to achieve this goal? Or more importantly, how does one even determine what the essential steps should be in the development of the fire management system? Are there indicators that can be described that would help measure progress towards success? Can these indicators be turned into qualitative or quantitative objectives that can be monitored and evaluated over time? Different segments of society undoubtedly have different sets of indicators that are important to them. Fire-fighters, or bombeiros, for example, might have one set of indicators, resource managers another, and society at large still other sets of expectations. These different expectations can be determined by having people describe their desired future conditions in terms of many different kinds of outputs.

A step-wise process that helps define desired future conditions and monitors and evaluates results (Oliver and others 1994) can be used to manage productive ecosystems and determine fire management objectives:

Step 1. Describe an historical range of variability of such elements as disturbance regimes (for fire that would include numbers of fires, intervals of time between fires, typical area burned of past fires, and typical fire intensities), vegetation density, species composition, and vegetation structure. Knowledge of this variability provides a reference for assessing the current conditions and the range of desired future conditions of the landscape. Historical ranges should be used as references and not as recipes. This step obviously requires good research results to be able to define ranges of historical variation.

The historical range of variability of conditions, processes, populations, or structures can be used as a reference in establishing the range of desired future conditions (Morgan and others 1994). Of course, the needs and values of society also need to be considered when identifying the range of desired future conditions. Although the historical range of variability is a useful concept, its application in certain ecosystems can be limited by lack of historical data.

Step 2. Assess possible current departures from historical ranges of variability to determine whether present trends are within or outside of these ranges.

Step 3. Involve scientists, the public, managers, and landowners in determining an acceptable range of variability (the desired future condition) using the historical range as a reference or guide.

Step 4. Involve all partners (agency personnel and citizens) in developing strategies on a landscape scale to produce desired future conditions within bounds of acceptable variation. This step would articulate such things as a range of fire suppression priorities and prescribed burning objectives in terms of areas and timing of burns.

Step 5. Monitor and evaluate results to be in a position to modify actions as new feedback information becomes available. In other words, the quantitative objectives determined for strategies in Step 4 are monitored and evaluated in Step 5.

Step 6. Highlight the consequences of alternative management actions so that various public groups appreciate the effects of different strategies. People need to well understand how different management actions will affect the various outcomes they desire, so that informed choices can be made and supported at all levels.

Step 7. Conduct education and awareness programmes at all levels, both internally and externally, so that people understand the application of ecosystem management principles in context with their own desire for meaningful outcomes. There are many audiences for such information, but one of the most important ones has to be young people at the elementary school and high school level.

Applying this step-wise analysis process to public and private forests could help resource managers and society make meaningful decisions about fire suppression priority areas, prescribed fire priority areas, target sizes for burned area over time, and fire intensity levels. Desired species composition, vegetation densities, and vegetation structure could also serve as indicators of future success. These management objectives could then be translated into specific fire prevention, fire suppression, and prescribed fire objectives for the fire management organization. This process also provides for the important elements of ownership, commitment, and support by people at the community, level regarding the strategies that are selected, because they have been part of the process in defining the desired future conditions.

CONCLUSIONS

A continued emphasis on the emergency response side of the wildfire problem will only result in future large and damaging fires. The way out of the emergency response trap is to couple emergency preparedness and response programmes with more sustainable land use policies and practices. Actively working towards more sustainable forestry practices is an important part of the strategy in better conserving natural resources for the betterment of society. Policy makers and the public need to understand that a strategy that only focuses on the emergency preparedness and response side will not be sufficient in the long run. Only when sustainable land use practices and emergency preparedness measures complement each other do long-term natural resource benefits accrue for society.

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REPORT OF THE WORKING GROUP ON AMERICAS AND CARIBBEAN

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MAIN POINTS RAISED IN THE DISCUSSION

(i) Policy formulation is a process – it should be guided by experience and should involve various (all) stakeholders. It should also be based on relevant know-how: both local knowledge and the findings of scientific research.

(ii) Recognize that land-use issues are at the heart of forest fire concerns. These issues include land allocation and management, land tenure and ease of access to land, regulating the cultural practices allowed on land and most importantly the value of forest land.

In many countries in the region, there are still vast amounts of forest that people have ready access to with concomitant low value attached to such lands. It has been proposed that **the demand/supply situation for land be manipulated through the creation of artificial scarcity of forest land, thereby increasing its value.**

(iii) Discussions also focussed on those forest management issues that are intimately linked to the incidence and severity of forest fires. These forest management issues include the temptation to concert natural forest with many species but with only a few of commercial value, to simpler, more management friendly stands and to agricultural and other purposes. Fires have traditionally been used as part of such land conversion practices – e.g. in slash and burn and in pasture management.

(iv) Changes in weather patterns We have just witnessed the most severe El Niño phenomenon of this century. This has had major adverse effects on weather patterns characterized by extreme drought on the one hand and severe flooding in some areas. Drought stricken areas have experiences some of the most catastrophic fires ever . When the predictions of global warming are factored in, there emerges the increased potential for forest fires in the region. Forest fires are therefore expected to continue to be of increasing importance in the future.

(v) International collaboration - Building an adequate capability to respond to the threat of forest fires requires a high investment and commitment of resources – financial, human, institutional and equipment. However, given the economic realities of most countries in the region, the accumulation of such resources impractical. Participation in regional and other international collaborative efforts provide a more productive alternative than individual effort. **Harmonization and compatibility of technology and terminology** are regarded as prerequisites to the effective participation in international efforts at sharing of resources and information.

(vi) Institutional arrangements. Discussions addressed the need to establish specialized forest fire protection agencies. The assignment of the responsibility to the traditional fire service was seen as counter-productive. The forest fire protection agency is better placed within the established forest service as operating objectives and scope of operations can be more easily harmonized. This arrangement will also facilitate the integration of forest fire protection with broader forest management and land-use issues. The **institutional arrangements for forest fire protection should also allow for some decentralization of decision-making** and the participation of stakeholders, particularly community groups.

(vii) Research and record keeping. The processes of policy formulation and programme implementation need to be guided by the best information available. This information can be obtained from two main sources: (a) results of research in other countries, and (b) the gathering of relevant data locally. In this regard, the wealth of indigenous knowledge possessed by local inhabitants should be fully utilized. There is also a very **pressing need to carry out thorough investigations into the causes of fire, so that appropriate measures to mitigate the impacts of such fires** can be implemented.

(viii) Wildfires have dramatic health impacts and other costs to society. Investments in fire management help mitigate these costs.

CONCLUSIONS AND RECOMMENDATIONS CONCERNING POLICIES AFFECTING FOREST FIRES

There is a need for **better allocation of scarce resources, both human and financial, between fire prevention, suppression and restoration/rehabilitation**. Particularly policies need to be more oriented to fire prevention and restoration.

While recommendations can be organized around prevention, suppression and recovery – especially to emphasize the first and last aspects of fire it is felt that many recommendations overlap particularly in the first two areas.

Public policies should stress the need and importance of adequate **fire knowledge and information systems**. Policies should facilitate:

- research is needed on fire particularly on root causes of fire and on recovery techniques;
- local knowledge of fire management suppression and recovery should be tapped and integrated into fire knowledge systems;
- there is a greater need for data and information sharing, facilitating access and transparency;
- educational, extension and public awareness programmes need to be developed which are appropriate to the various stakeholders;
- monitoring and prediction, forecasting, early warning systems need to be created on national, regional and global levels; and
- new information and communication technologies such as Internet should be exploited to the maximum extent possible.

Effective efforts to mitigate the negative effects of fire need policies that reinforce **decentralization, partnerships and participation:**

- policies on land tenure and rights over resources need to be appropriate to provide incentives for local people and forest owners to invest in fire management;
- equitable sharing of benefits from rural production systems including forestry are also needed;
- local people and others need to be better organized for fire management activities.

- mechanisms are needed to bring all the stakeholders together on fire issues.
- policies must encourage those most affected by decisions to have a role in decision making and planning;

Economic and financial policy

Policies should be adopted to increase the value of forests.

Credit policies should encourage land use options that are sustainable and not dependent on continued opening of the agricultural frontier or on uncontrolled slash and burn that increase the risks of negative fires.

Cost sharing for fire management should be encouraged between all relevant stakeholders (including innovative arrangements with insurers) and levels and parts of government.

Policies are needed which encourage the socio-economic development of forest and forest dependent communities which are compatible with sustainable development.

Funding mechanisms through such instruments as the clean development mechanism and carbon offsets should be used to promote and fund fire management activities.

Policies on settlement and infrastructure should be brought in line with sound fire management and prevention needs.

Institutional issues and policy

Local and community institutions often need strengthening and institution building.

While partnerships are necessary in phases of fire management there should be a unified national capability guided by a knowledge of the particular behaviour and impacts of vegetation fires.

Institutions need to allocate resources, human and financial to networking, cooperation and coordination.

Restoration and recovery policies

For both temperate and tropical forests, priority should be given to allowing natural recovery of the site to take place. In the case of the tropical forests, this may necessitate the exclusion of future burning, as burned sites are particularly sensitive to repeated burning causing dramatic changes in vegetation type.

It is also recommended that countries strengthen their knowledge of ecosystem recovery.

Fire damage to forests should not be allowed to contribute to land conversion to artificially regenerated forest or other land use.

RECOMMENDATIONS ADDRESSED SPECIFICALLY TO FAO AND OTHER INTERNATIONAL ORGANIZATIONS

FAO should take an active role in networking and facilitating the access to information and knowledge about all aspects of forest fires. In this regard it should stimulate existing and new regional networks.

FAO should facilitate and assure appropriate follow-up to the meeting.

FAO should strive to be proactive in forest fire policy issues.

PUBLIC POLICIES AFFECTING FOREST FIRES IN EUROPE AND BOREAL/TEMPERATE ASIA

Johann G. Goldammer[13]

SUMMARY

This report on public policies affecting forest fires covers Europe and the temperate and boreal regions of Asia. It includes all Western and Northern European countries (except Southern Europe, France and South-eastern Europe which are included in the Mediterranean report), the Russian Federation, and the countries located in the transition zone between the Central Asian steppes (Mongolia), the temperate forest countries of the Himalayas and the Far East (Nepal, Bhutan, South Korea, Japan), and the boreal forest (Northeast China).

Causes and impacts of fire in the Europe and the temperate-boreal Asian region are multi-facetted due to rich cultural diversity and a broad range of socio-economic and environmental conditions. Thus, it is prohibitive to draw any generalized conclusion or to develop recommendations which would lead to unified responses or to generally valid fire management strategies and public policies.

However, the country cases which were reported in detail reveal that appropriate public policy responses to wildfires in forest and other vegetation, e.g. steppe fires, mainly address humans as the most important fire source. Prevention has been recognized most important in designing policies and fire management strategies.

On the other hand, impacts or efficiency of policies on reduction of wildfire occurrence in many countries remain restricted due to economic constraints, especially in economies in transition from centrally planned to open market economies. For instance, the development of community-based fire management (participatory approach) and the enforcement of laws through governments often is limited by lacking adequate supply of infrastructures, personnel and equipment.

The forest estate structure as well as the ownership structure also vary from country to country. In the Nordic countries and Germany there is a large proportion of private, small-scale and often farm-related holdings. In the countries in transition the number of private, and often small, forest holdings is rapidly increasing, due to ongoing intensive restitution of property rights and privatization activities. The control of forestry and forest fire protection activities in some parts of the region is not always sufficient and effective.

Main fire problems have been identified (1) on terrain affected by industrial pollution or radioactive contamination, (2) in sparsely populated boreal forests of central Asia where fire management is limited by the lack of fire management resources, and (3) in regions where in which increasing burning activities lead to severe degradation in mountain forests, steppe, and steppe-forest ecotones in the transition zone between the tropics/subtropics and the boreal zone at the southern edge of the region.

New challenges in fire management are arising from the debate to use prescribed burning in forest and fire management in the boreal zone of the region, and in nature conservation and landscape management in temperate Europe. Only limited expertise in the use of prescribed fire is available in Europe and temperate-boreal Asia.

International cooperation in the field of fire management is increasing, e.g. transboundary mutual assistance agreements for wildfire disaster situations, exchange of fire management expertise, and international fire research programmes, both inside Europe and temperate-boreal Asia and in exchange with other regions.

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Although the magnitude of the fire problem in the Baltic region is smaller than in Mediterranean Europe or elsewhere in the world, new initiatives in international collaboration in fire management are currently being established.

Public policies at national and international levels increasingly build on synergistic efforts, especially within the European Community and the ECE region.

It could be concluded that, at political level, both internationally and nationally, fire management as part of sustainable forest management has been advanced. However, implementation of fire management still calls for further actions.

1. INTRODUCTION

Wildfires annually affect several hundred million hectares of forest and other vegetation in the world. In some ecosystems fire plays an ecologically significant role in maintaining biogeochemical cycles and disturbance dynamics. In other ecosystems fire may lead to the destruction of forests or to long-term site degradation. In most areas of the world wildfires burning under extreme weather conditions have detrimental impacts on economies, human health and safety, with consequences which are in significance and severity comparable to other major natural hazards.

Fires in forests and other vegetation produce gas and particle emissions that have impacts on the composition and functioning of the global atmosphere. These emissions interact with those from fossil-fuel burning and other technological sources which are the major cause for anthropogenic climate forcing. Smoke emissions from vegetation fires also cause visibility problems which may result in accidents and economic losses. Smoke generated by vegetation fires also affect human health and in some cases result in losses of human lives. Fire risk modelling in expected climate change scenarios indicates that within a relatively short period like the next three to four decades, the destructiveness of human-caused and natural wildfires will increase.

The objectives of fire-related policies, e.g. land-use policies, and fire management strategies encompass the reduction of the detrimental impacts of fire and the management of the beneficial effects of fire. They must address a broad range of elements and sectors of society, natural resources and environmental management, and technology development. Fire policies and strategies cannot be generalized due to the multi-directional and multi-dimensional effects of fire in the different vegetation zones and ecosystems and the manifold cultural, social, and economic factors involved.

Between 1997 and 1998 the El Niño-Southern Oscillation (ENSO) phenomenon generated climate extremes world-wide. Long-lasting droughts occurred in various regions of the world, particularly in South East Asia. The South East Asian region experienced the fifth ENSO and the fifth fire and smoke episode since the early 1980s. Media coverage and international political response created the impression that the magnitude of burning in Indonesia which led to extended smog formation over parts of the South East Asian region was unprecedentedly high and unexpected.

Additional international attention was given to fires burning in South and Central America, Southern Europe, and the Russian Far East between early and mid-1998. Altogether, the general impression was prevailing that between mid-1997 and 1998 the globe had experienced the most critical and extreme "year of fire" in recent history. However, such assessments were not based on data. The major reason for this is the lack of readily available and reliable global information and databases on current and historic fires.

In an endeavour to provide a current global state-of-knowledge summary on "Public Policies Affecting Fire" the FAO prepared five regional reports which cover (1) Europe and temperate-boreal Asia, (2) the Mediterranean region, (3) Africa, (4) Asia-Pacific, and (5) the Americas.

This report on public policies affecting forest fires covers Europe and the temperate-boreal Asian region. It includes all Western and Northern European countries (Southern Europe including France and South-eastern Europe are included in the Mediterranean report), the Russian Federation, and the countries located in the transition zone between the Central Asian steppes (Mongolia), the temperate forest countries of the Himalayas and the Far East (Nepal, Bhutan, South Korea, Japan), and the boreal forest (Northeast China). The remaining South Asian countries located in the tropical and sub-tropical zone are included in the Asia-Pacific report.

Within Europe and the temperate-boreal Asian region, four main fire problem zones can be distinguished on the base of socio-economic, demographic and climatic features:

- In the densely populated, industrialized countries of Western Europe (temperate and boreal Europe), South Korea and Japan, most of the forest and non-forest land which can potentially be affected by wildfires is under intensive management (forestry, agriculture, pastoralism) or protection (nature conservation areas, wilderness or nature reserves, etc.). Most fire-endangered forests are easily accessible and managed under the principles of forest protection. All wildfires caused by humans and lightning are suppressed. The use of prescribed fire in forestry, agriculture and pastoralism is very limited or non-existent. Traditional land-use, generally high environmental awareness and prevailing high living standards of both rural and urban population restrict the number of human-caused wildfires.
- The less industrialized temperate-boreal mountain regions along the Himalayas (Northern India, Nepal) and at the Southern limit of the Central-Eastern Asian boreal forest (Mongolia, China) experience increasing population density. Generally prevailing economic problems associated with low living standards, rapid land-use changes as well as the lack of access impose restrictions on efficient forest protection.
- In the less densely populated regions of north-eastern Asia (e.g. in Siberia, parts of Northeast China, and Northern Mongolia) difficult socio-economic conditions are associated with limited access and restricted capabilities to protect forests and other vegetation from wildfires. In addition, lightning fires are more common in these regions which are characterized predominantly by continental climate.
- New fire problems arise on terrain which is damaged by industrial pollution, e.g. in Eastern Europe, or contaminated by radionuclides, e.g. in areas affected by nuclear accidents (Chernobyl region) or former nuclear weapons test sites.

Since the magnitude of fire phenomena and fire problems is highest in boreal forests, this report first provides background information on the largest portion of Asia's boreal forest which is found on the territory of the Russian Federation. In **Annex IV** additional information is given on the role of emissions from boreal fires on the global atmosphere, climate change, and the possible feedback loops of climate change and fire occurrence.

It is followed by a section with fire statistical country briefs, grouped into sub-regions. Selected examples are given on the socio-economic implications and environmental impacts of fire in typical biogeographical regions. Finally the state of fire science, technology development, fire management and policy development in the region is reviewed.

2. THE EUROPEAN AND ASIAN BOREAL FOREST AND FIRE

The global circumpolar ecosystems include the boreal forest belt - the *taiga* - and the non-forested *tundra* ecosystems. The boreal forest biome occupies nearly one-third of the total global forested area. More than seventy percent of the global boreal forest cover is in boreal Asia, mainly in the Russian Federation, and represents the largest unbroken forested area of the globe; the remainder is in Canada and Alaska, and relatively small areas of boreal forests are found in the Northeast of China and in the Nordic countries.

The boreal climate has been classified into three sub-zones, the maritime, continental and high-continental sub-zones (Kuusela 1992). The maritime sub-zone has summer temperatures of 10-15°C, winter temperatures of 2-3°C, and annual precipitation of 400 to 800 mm. The continental sub-zone has long, cold winters with mean temperatures of -20 to -40°C, and summer mean temperatures of 10 to 20°C. The growing season is between 100 and 150 days, and annual precipitation ranges between 400 and 600 mm. The high continental sub-zone covers the largest portion of the boreal zone and is characterized by more extreme winters and milder summers.

The distinct climatic seasonality with a short vegetation period and low average temperatures leads to the accumulation of organic layers and widespread permafrost soils. Both features critically determine species composition and dynamics of the forest landscapes in which bogs and grasslands are intermixed. The main coniferous tree species are pine (*Pinus* spp.), larch (*Larix* spp.), spruce (*Picea* spp.), and fir (*Abies* spp.); the main broad-leaved trees are birch (*Betula* spp.), poplar (*Populus* spp.), and alder (*Alnus* spp.).

Over evolutionary time periods boreal ecosystems have been subjected to climate changes, and species were forced to migrate in accordance with advancing and retreating glacial land cover of icecaps. The boreal forest biome as developed in the present interglacial period - starting ca. 10,000 years ago - has been subjected to inter- and intra-annual climate variability associated with multi-year drought periods and extreme dry years, coupled with lightning fires and insects outbreaks.

The carbon stored in boreal ecosystems corresponds to ca. 37 percent of the total terrestrial global carbon pool (plant biomass and soil carbon). Thus, the magnitude of the boreal forest area suggests that it may play a critical role in the global climate system, e.g. as potential sink or source of atmospheric carbon.

While parts of the *taiga* are considered to be highly productive and economically valuable forests, their vulnerability has been largely disregarded in the past. Occasionally, inappropriate forestry practices, e.g. large-scale clear felling with subsequent degradation, go along with extended industrial pollution, oil pipeline leakages, radioactive contamination and ecosystem modification by dam and water reservoir construction.

The impacts of anthropogenic climate change on the boreal zone and its ecosystems as currently predicted by global circulation models (GCMs) are severe. Increase of average annual temperatures may lead to longer and warmer vegetation periods, typically characterized by increased occurrence and length of droughts and lightning activities. With increasing human interference, the danger of extreme and extended wildfires may also increase. Fires, droughts and melting of permafrost may release high amounts of carbon into the atmosphere, thus accelerating processes of current atmospheric changes critical for global climate change.

2.1 Extent and economic importance of the boreal forest biome

The world's total boreal forests and other wooded land within the boreal zone cover 1.2 billion hectares (ha) of which 920 million ha are closed forest. The latter number corresponds to ca. 29 percent of the world's total forest area and to 73 percent of its coniferous forest area (ECE/FAO 1985). About 800 million ha of boreal forests with a total growing stock (over bark) of ca. 95 billion m^3 are exploitable (41 percent and 45 percent respectively of the world total). The export value of forest products from boreal forests is ca. 47 percent of the world total (Kuusela 1990, 1992). The majority of the boreal forest lands (*taiga*) of Europe and Asia are located in Russia. The Russian Forest Fund comprises ca. 1,181 million ha out of which 1,111 million ha are under the control of the Federal Forest Service. The carbon stored in boreal ecosystems corresponds to ca. 37 percent of the total terrestrial global carbon pool (plant biomass and soil carbon). Thus, the magnitude of the boreal forest area suggests that it may play a critical role in the global climate system, e.g. as potential sink or source of atmospheric carbon.

2.2 Natural and human-caused fire disturbances

The distinct climatic seasonality of the boreal zone with a short vegetation period and low average temperatures leads to the accumulation of organic layers and widespread formation of permafrost soils. Both features critically determine species composition and dynamics of the forest landscapes in which bogs and grasslands are intermixed.

Among natural disturbances, fire (lightning fire) is the most important factor controlling forest age structure, species composition and physionomy, shaping landscape diversity, and influencing energy flows and biogeochemical cycles, particularly the global carbon cycle since prehistoric times (cf. monographs and synopses e.g. by Sofronov 1967, Slaughter *et al.* 1971, Zackrisson 1977, Sherbakov

1979, Viereck and Schandelmeier 1980, Heinselman 1981, Wein and MacLean 1983, Kurbatsky 1985, Johnson 1992, Sannikov 1992, Furyaev 1994, Shugart *et al.* 1992; Goldammer and Furyaev 1996). Small and large fires of varying intensity have different effects on the ecosystem. High-intensity fires lead to the replacement of forest stands by new successive sequences. The prevailing low-to medium-intensity surface fires (98 percent of all fires run as surface fires) favour the selection of fire-tolerant conifers such as pines (*Pinus* spp.) and larches (*Larix* spp.) and may repeatedly occur within the life span of a forest stand without eliminating it.

Large-scale forest disturbances connected with drought and fires are known from recent history. The Tunguska Meteorite Fall near Yenisseisk (ca. 60°54'N-101°57'E) on 30 June 1908, a cometary nucleus explosion at ca. 5 km altitude, was one of the more exceptional events which caused large-scale forest fires in the region of impact. Several years later, from June to August 1915, the largest fires ever recorded, occurred as a consequence of an extended drought in Central and East Siberia (Tobolsk, Tomsk, Yeniseisk, NE Irkutsk, S Yakutsk regions). Shostakovich (1925) estimated that the fires were burning for about 50 days in the region between 52-70°N and 69-112°E. The main centre of fires was between Angara River and Nijnya Tunguska, and the total area burned was estimated at 14.2 million ha. However, the smoke of these fires covered the region between 64-72°N and 61-133°E, corresponding to ca. 680 million ha.

It is not clear, however, whether lightning, humans or a combination of the two were the primary cause of the extended fires of 1915. In boreal Asia, fire has been for a long time an important tool for land clearing (conversion of boreal forest), silviculture (site preparation and improvement, species selection) and in maintaining agricultural systems, e.g. hunting societies, swidden agriculture, and pastoralism (Viro 1969, Pyne 1995, 1997). In addition to the natural fires, these old cultural practices brought a tremendous amount of fire into the landscapes of boreal Asia. In the early 20th century, the intensity of fire use in the agricultural sector began to decrease because conversion of forests into agricultural systems had been accomplished, and traditional small-sized fire systems (treatment of vegetation by free burning) became replaced by mechanized systems (use of fossil-fuel driven mechanical equipment). Despite the loss of traditional burning practices, however, humans are still the major source of vegetation fires; only 15 percent of the recorded fires in the Russian Federation are caused by lightning (Korovin 1994).

Statistics compiled by the Russian Federal Forest Service (see paragraph. 3.1.5 and Tab.2, **Annex I**) show that between 17,000 and 33,000 forest fires, mainly human-caused, occur each year, affecting up to 2 million ha of forest and other land. Since fires are monitored (and controlled) only on protected forest and pasture lands, it is estimated that the real figures on areas affected by fire in Asia's boreal vegetation is much higher. Observations from satellites indicate that during the 1987 fire season approximately 14.5 million ha were burned (Cahoon *et al.* 1994). In the same fire season ca. 1.3 million ha of forests were affected by fire in the montane-boreal forests of Northeast China, south of the Amur (Heilongjiang) River (Goldammer and Di 1990, Ende and Di 1990).

2.3 Other disturbances and fire: Non-sustainable forestry, industrial emissions and radionuclear contamination

2.3.1 Forestry

Traditional forestry practices and low-impact and sustainable use of non-wood forest products in boreal Asia are subjected to dramatic changes which are stimulated by increasing national and international demands for boreal timber and pulpwood. This has resulted in the widespread use of heavy machinery, large-scale clear fellings, and thereby in the alteration of the fuel complexes. Many clear-cut areas reportedly are not regenerating towards forest succession but are rather degrading into grass steppes which may become subjected to short-return interval fires. The opening of formerly closed remote forests by roads and the subsequent human interference bring new ignition risks. These direct effects on the ecosystem are in addition to the indirect effects induced by climate change, and both together will certainly contribute to an unprecedented change in fire regime.

2.3.2 Industrial emissions and nuclear accidents

Additional fire hazards and environmental consequences which are still mainly unpredictable are created on forest lands affected by industrial emissions. Russian scientists reported that in the Russian Federation ca. 9 million ha of forest lands are severely damaged by industrial pollution (Pisarenko and Strakhov 1993, Kharuk 1993). While it is known in general that availability of inflammable fuels makes dying and dead forest stands more susceptible to fire than living stands, other mechanisms are still unknown. For instance, what will be the effects of burning those chemical depositions which have caused the die-back of forests? How will these agents be converted and re-distributed? Many open questions remain to be answered.

The problems arising from fires burning on terrain which has been radioactively contaminated by nuclear weapons tests and technical accidents or disasters are highlighted in paragraph. 4.1 of this report.

3. FIRE STATISTICS

Within the northern hemisphere, the most complete set of data on forest fires is periodically collected and published for the member states of the Economic Commission for Europe (ECE). It includes all Western and Eastern European countries, countries of the former Soviet Union, the U.S.A. and Canada. The last set of data covers the period 1994-96 (ECE/FAO 1997). In the European Union a Community Information System on Forest Fires has been created on the basis of information collected on every fire in national databases. The collection of data on forest fires (the common core) has become systematic with the adoption of a Commission Regulation in 1994. The Community Information System on Forest Fires currently covers 319 provinces (departments, states) of Portugal, Spain, France, Italy, Germany and Greece (European Commission 1996; Lemasson 1997). It contains information on 460,000 fires recorded between 1January 1985 and 31 December 1995 involving a total of six million hectares. Other countries from outside the ECE/EU region report fire statistics in the pages of International Forest Fire News or are included in the FAO report on global wildland fires (FAO 1992).

In 1995 an ECE/FAO meeting on fire statistics, held in Geneva, concluded that the approach pioneered in the EU (European Commission 1996) is very valuable and should be extended within the framework of Resolution S3 of the First Ministerial Conference on the Protection of Forests in Europe, Strasbourg 1990 to other countries, chiefly in Europe and around the Mediterranean, but also in other regions where institutions and resources made it possible to collect fire-by-fire data. Countries starting to collect this information should use the "common core" ("socle minimum") already developed in the EU as a starting point, in order to promote comparability between data for different regions. The Commission of the European Communities offered to provide technical support to this work and to process data for new countries (including non-EU countries and non-signatories of Resolution S3) in its existing structure. The FAO/*Silva Mediterranea* forest fire network would also contribute to establishing contacts, encouraging the setting up of such systems and ensuring international comparability.

At the 1995 Geneva meeting it was pointed out that the research community needed geo-referenced data (although not at a very fine degree of resolution). If possible the coordinates of the starting fire location (or those of the commune) should be collected, in addition to the parameters already collected, which included information on the commune of the fire.

However, it may take many years before all countries, even in Europe, will be able to supply the type of detailed information required by the fire-by-fire approach. In order to avoid a short term reduction in the coverage of forest fire information, the meeting considered that it was essential to maintain the existing (FAO/ECE) system of data collection at the national level, until a more comprehensive and detailed system with a wide a geographic coverage was operational. Indeed the terms and definition, and the questionnaire itself, could be used as the basis for data collection in other regions.

At the global level, for the time being, all those involved should share information acquired, notably through International Forest Fire News, in order to build up a more accurate picture of the situation over time. Countries outside Europe and the Mediterranean area might consider adopting an approach along the lines of the one at present in place for the EU. The fire statistics meeting in Geneva also recommended that the FAO and the Global Vegetation Fire Inventory (GVFI) closely cooperate and share information of a fire data base covering countries which are not members of ECE or FAO/*Silva Mediterranea*.

Meanwhile, the Global Fire Monitoring Centre (GFMC) has been established as an initiative within the UN International Decade for Natural Disaster Reduction (IDNDR). The GFMC collects global fire statistics and encourages countries to provide their national fire databases to the GVFI on a voluntary base. More information can be found on the GFMC homepage <http://www.uni-freiburg.de/fireglobe> (see paragraph 4.5 of this report).

For this report the current state of fire statistical information of the European and temperate-boreal Asian countries (Tab.1) is attached in **Annex I**.

3.1 Overview by countries

3.1.1 Western European countries characterized by Atlantic Climate: Belgium, Ireland, Luxembourg, Netherlands, United Kingdom

The western European countries bordering the Atlantic Ocean, the English Channel and the North Sea have less wildfire problems as compared to the Central-Eastern countries of Europe. They only occasionally experience large wildfires.

Forest fires in Belgium usually do not exceed 100 ha per year. Extreme years such as 1996 (1,113 ha burned) have driven the 1980-1996 average to 152 ha/year.

With an average burned forest area of 4 ha/year between 1980 and 1996 Luxembourg is the country with the lowest fire risk in Europe.

In the Netherlands the magnitude of forest fire occurrence is similar to Belgium. In the same period 1980-1996 an average of 172 ha/year of wildfires was recorded.

Fire statistical data of the United Kingdom show an average annual area burned of 428 ha between 1980 and 1996.

In Ireland some 600 ha of forest were burned annually during the same period.

3.1.2 Southern/south Eastern European countries: Austria, Bulgaria, Czech Republic, Hungary, Slovak Republic, Switzerland

The Alpine countries: Austria and Switzerland

Wildfire risk in the Southern/South-eastern part of Europe that is covered in this report is determined by the characteristics of either mountain mixed deciduous-conifer forest or lowland broad-leaved forest.

Both in Austria (1980-96 average area burned annually: 105 ha) and in Switzerland (average area burned annually in the same period: 407 ha) a high proportion of forest fires is caused by lightning, mainly at higher elevations. In Austria and Switzerland, 27 and 33 percent respectively of all fires were started by lightning in 1994.

Forest fires in Switzerland occur mainly in the southern part, a small region of 4,000 km^2 (9.8 percent of the total national area) with a forest cover of 44 percent (176,000 ha). The main fire occurrence is during the dry winter period, but recently also during the summer seasons (Conedera *et al.* 1996). The southern part of Switzerland is situated in a small basin, closed towards the north and the west (Alps) and open toward the south and the east (Po Valley). The climate therefore is characterized by dry and sunny winters with periods of north-foehn (main time of forest fires) but also by occasionally strong snowfalls, by wet springs and autumns and by sunny summers with very heavy rainfalls (thunderstorms). The typical vegetation types under the climatic conditions in this region are chestnut forests on acid soils, deciduous broad-leaved mixed forests on limestone and beech forests at altitudes between 800 and 1300 m a.s.l.. The winter fires usually burn as surface fires in the chestnut leaf litter layer. Surface fires of low to medium intensity damage the chestnut tree layer and often lead to severe erosion and land-/mudslides causing serious damage to infrastructures and private property.

Bulgaria, Czech Republic, Hungary, Romania, Slovak Republic

The long-term fire statistics of Bulgaria for the period 1980-96 show an average annually burned forest area of ca. 3,000 ha. There are discrepancies, however, between officially reported numbers to the ECE and otherwise reported figures. For instance, the ECE/FAO statistics for 1996 indicate a total area burned of 2,516 ha, while other sources provide the number 21,500 ha for the same year (Kurpanov 1998). In 1997 the burned forest area reached 860 ha with a total number of 167 forest fires, most of which burned in May and September. Most 1997 fire incidents (133, affecting 555 ha of forest) took place in the south of Bulgaria were the vegetation consists predominantly of conifers.

During the period 1980-96, the forest area burned annually in the neighbouring countries reached 512 ha in the Czech Republic, 1,066 ha in Hungary, 244 ha in Romania, and 134 ha in the Slovak Republic.

3.1.3 Baltic and Central-Eastern European countries: Belarus, Estonia, Germany, Latvia, Lithuania, Poland

The fire problem zones in the countries bordering the Southern Baltic Sea (Estonia, Germany, Latvia, Lithuania, Poland) and Belarus are dominated by pine forests which are favoured by the continental climate.

The Baltic States

The Republic of Estonia is covered by ca. 2 million ha of forest, with the dominant tree species being Scots pine (38 percent), Norway spruce (24 percent), and birch (30 percent). Since 1949 an annual average of 215 fires affected a forested area of 210 ha. Large forest fires (>50 ha) occur, on average, once in every five years. The largest fires in recent years have taken place at Vihterpalu in 1992 and 1997. In both cases the fire damaged an area of approximately 800 hectares (Talijärv 1998).

In the neighbouring Republic of Lithuania forests cover ca. 1.8 million ha. pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*) dominate the forested area with 40 percent and 20 percent respectively. Lithuania typically has a spring fire season (April). Zabrauskas (1995) reports that most fires are caused by people while burning pastures, or through carelessness and arson. The area burned annually was 202 ha during the period 1984-96.

Forests in Latvia cover 45 percent of the surface of the country, mainly located in the Western regional districts of the country. The age structure is predominantly young and middle-aged (63 percent), and conifers are the dominating species (Scots pine 40 percent, Norway spruce 20 percent, birch 28 percent). Forest fire control in Latvia is organized by 35 Regional Forest Districts with 262 subordinated Forest Districts (Gertners 1998). The average area burned between 1991 and 1996 was 1295 ha/year.

Belarus

In Belarus ca. 5,000 ha forests are affected by wildfires annually, predominantly young to middle-aged pine stands. The main fire problem in Belarus arises on forest lands contaminated by radionuclides from the Chernobyl nuclear power plant accident in 1996 (for details see Section 4).

Germany

In Germany, the main fire problem areas are located in the northern portion of the country where predominantly poor soils are associated with continental climate features. In this region, the forests between Lower Saxony in the West and Brandenburg in the East (bordering Poland) are dominated by pine stands with relatively high fire hazard. Before the unification of Germany the annual average forested area burned in the former Federal Republic of Germany between 1980 and 1990 was 578 ha. Between 1991 and 1997, the average area burned in re-united Germany was 1,572 ha/year.

Poland

Similar site and forest conditions are more common in Poland where fires predominantly occur in pine forests. The average annual area burned between 1980 and 1996 was 5,170 ha. New fire problems arise in those forested regions which are affected by severe industrial pollution (see Section 4).

3.1.4 Nordic countries: Denmark, Finland, Norway, Sweden

Denmark

With an annually burned area of 38 ha forest fires constitute a minor problem in Denmark.

Finland

In Finland forests cover 26 million ha, corresponding to 74 percent of the total land area. Most of the Finnish forests are privately owned (63 percent). The majority of the forest is in the boreal zone and is dominated by conifers (Scots pine, Norway spruce) and birch. Only a small part of Northern Finland is mountainous. More than 30 percent of the forest land is dried swamp and peatland. Roughly 60,000 hectares of swamp is managed for peat production.

The summer season is relatively short (May-September), but may often include several warm and dry spells with high forest fire risk. In Finland, forest fire statistics are available since 1868. The worst forest fire years in this century were 1959 and1960. The total area burned was highest in 1960, with the most severe forest fire of this century which burned an area of more than 3,000 ha in Lapland. The fire had originated and spread from Russia (Frelander 1998).

Since the 1950s, the average burned area has decreased every decade, although the number of fires has remained about the same. In the last decade, the number of forest fires and total area burned has significantly increased. During the last four years (1994-97) the average area burned was 1,253 ha/year. The number of fires during the FAO/ECE reference period 1980-1996 is 524 ha/year.

Norway

In Norway the oceanic climate determines the composition and fire hazard of forests. Boreal coniferous forests stretch from the east towards the Scandinavian mountain range and its alpine ecosystems. The coastal area has been classified as a boreonemoral zone characterized by temperate coastal forests. In the south, there are smaller areas in a nemoral zone which today are strongly influenced by human activity. Lightning is frequent in Norway, but high precipitation and prevailing high humidity in the Western and Central part of the country do not allow ignition by lightning. The highest frequency of natural fires occurs in the boreal forests of the country's eastern lowlands, south-westward to the divide, and in the most continental part of central Norway (Mysterud *et al.* 1998). The forested area burned between 1986 and 1996 was 564 ha/year.

Sweden

Most of the territory of Sweden lies within the boreal and hemiboreal zone, with most of the terrain covered by a fairly flammable vegetation of coniferous trees, ericaceous dwarf-shrubs and mosses. During the mid-1970s fire was not considered a serious problem and the collection of fire statistics was abandoned temporarily in 1975 but resumed in 1992 (Granström 1998). The average area burned between 1992 and 1996 was 2,500 ha/year, with exceptionally high number of fires and area burned in 1992 and 1994. Most fires are caused by people, directly or indirectly. Investigations reveal that in 1994 arson was assumed to have caused 6 percent of the fires while lightning accounted for 35 percent of the fires, which is a very high figure in comparison with statistics from the period 1945-1975.

3.1.5 Central-eastern Asia: Russian Federation and other countries of the Former Soviet Union

After the break-up of the former Soviet Union (FSU) the Russian Federation inherited most of the forest cover. Thus, forest fires play only a limited role on the non-Russian territories of the FSU. No statistical data are available from Azerbeijan, Kirgizia, Tajikistan, and Uzbekistan. Kazhakstan reports 12,753 ha burned annually between 1994 and 1996 and Turkmenistan 522 ha/year for the same period. Thus, the focus of this section is on the Russian Federation.

Russian Federation

The official fire statistical information to this report was provided by the Federal Forest Service of the Russian Federation in August 1998 and covers the decade 1988-1997. No final information of the severe fire situation in the Russian Far East during the months August to October 1998 is available at the stage of preparation of this report. Daily satellite image updates and archived data can be found through the homepage of the Global Fire Monitoring Centre (see Section 4.5 of this report).

The information provided in Table 2 (**Annex I**) shows that in the course of the last 10 years the number of forest fires fluctuated from 17,600 to nearly 33,000. The highest intensity of fires was recorded in 1996, when 32,833 fires burnt an area of 1.3 million ha.

However, referring to Section 2.2 of this report it must be observed that these numbers cover only fires which are monitored and controlled on protected forest and pasture lands. Satellite-derived observations suggest that the real figures on areas affected by fire in the territory of the Russian Federation is much higher, e.g. the figure of 14.5 million ha for the year 1987 (Cahoon *et al.* 1994). Currently a complete study of archived NOAA AVHRR satellite observations for the 1980s is under way (Cahoon *et al.*, in prep.).

3.1.6 Central-south-eastern Asia: Bhutan, People's Republic of China, Japan, Korea, Mongolia, Nepal

The report includes temperate and boreal zone of the Central-South-eastern Asian countries which are outside of the tropical zone (which is covered by the Asia-Pacific report).

Bhutan

Bhutan is a mountainous country located in the Himalayas between 26°45' and 28°30'N and 88°45' and 92°10'E. The total territory of the country is 46,500 $km^{2,}$ of which 26,338 km^2 (i.e. 56.6 percent) is covered by forest. The south-west monsoon, starting in June and lasting four months, accounts for 86 to 97 percent of the annual precipitation. Precipitation varies with the exposure of valleys to the rain-bearing monsoon winds. Parts of the valleys located in the rain shadow are dry. On the higher mountains the little precipitation during winter comes mainly in the form of snow, beginning at the end of November. The country has been divided into three different zones of fires risk which are in accordance with the distinctly different climatic features throughout the country (Chhetri 1994).

Blue and chir pine (*Pinus griffithii, P.roxburghii*), mixed conifer, and mixed broad-leaved and conifer plantations and degraded forests, which cover approximately 40 percent of the total forest area, are most susceptible to frequent forest fires (Goldammer 1993). Repeated forest fires, often associated with heavy grazing pressure, are responsible for the degradation of the vegetation cover. Forest fire incidence is high during the dry winter months. Freezing temperatures and lack of rainfall are responsible for drying of perennial grasses, and increasing wind velocity quickens the drying process thereby making the grass covered area inflammable. Every year 20 to 75 (average 50) forest fires are reported. Most forest fires are caused by escaped fires from agricultural land and orchards. Some years like 1979, 1981, 1982, 1983 and 1989 were comparatively dry and in most parts of the country pre-monsoon rains were delayed and very much limited. As a result the number of fire cases increased. The GVFI database shows an average of 7,379 ha burned per year in the period 1980-84.

People's Republic of China

In the northern part of the People's Republic of China the temperate-boreal forests and steppes are the most fire-affected vegetation types. The mountain-boreal forest of the Daxinganling mountain range, Heilongjiang Province, Northeast China, is dominated by pines (*Pinus sylvestris* var. *mongolica*) and larches (*Larix gmelinii*) which are favoured by the continental climate. About 70 percent of the annual precipitation of 350 to 500 mm occurs between May and August. The months of March to May, and September/October are the months with the highest fire danger. Forest ecosystem dynamics and species composition of the mountain-boreal forest are characterized by regular natural and - more recently - human-caused fires (Goldammer and Di 1990). The forests in Inner Mongolia are dominated by larch, Mongolian oak and birch. Larch is the original vegetation type, but would be replaced by oak and birch or poplar (in wet areas) if fires burned over the same area frequently in a short time.

The largest fire in the recent history occurred in the Daxinganling region during the exceptionally dry months of May-June 1987. The fire affected a total land area of 1.2 million ha, of which 1.14 million ha was forest. These fires had an exceptionally high intensity and spread rate. For instance, the main fire front travelled 100 km within 5 hours and burned a total of 400,000 ha of forests within 32 hours on 7 and 8 May 1987. More than 200 people were killed by the fire, 56,000 people lost their homes, and 850,000 m^3 processed wood, and additionally infrastructures (bridges, railroad tracks, electricity and telephone lines) were burned (Zheng *et al.* 1988, Di and Ju 1990, Goldammer and Di 1990). Evaluation of long-term statistical data reveal that between 1950 and 1990 a total of 4,137 people were killed in forest fires in the Peoples Republic of China (Goldammer 1994).

Further evaluation of fire data archived in the Jiagedaqui fire station revealed that between 1966 and 1987 recurrent fires burned a total of 5.6 million hectares of forest and non-forest land in Heilongjiang Province which has a forest cover of 5.26 million ha. Thus, this number includes repeatedly burned-over areas. In 1966 10.4 percent of the forested area was burned, and in 1987 17.4 percent of the forest area was affected by fire (Goldammer 1993). In the period 1966-86 more than one- third of all fires were started by lightning. In recent years, the number of fires due to natural causes has decreased in comparison to fires started by people. This is reflected in the official data for 1997 where less than 10 percent of all fires were started by lightning.

In preparation for this study Wang Dong (1998) reports that in the decade 1986-96 the annually burned area in Heilongjiang Province and in the Inner Mongolia Autonomous Region was 95,000 ha and 31,000 ha respectively.

Japan

The forest area of Japan covers ca. 2.3 million ha. Limited information is available in the GVFI database on forest fire occurrence in the country. Fire statistical data for the period 1981-1990 indicate an average of 4,000 ha burned per year.

Already in 1994 the Japan International Research Centre for Agricultural Sciences on request from the GVFI compared the emissions from forest fires vs. husked rice hull and straw burning in Japan. The findings indicate that carbon and methane emissions from rice harvest residual burning was 10 times higher than those from forest fires (Minami 1994).

Korea

In the Republic of Korea (South Korea) 6.46 million ha of forests occupy 65 percent of the total land area. Coniferous forests account for 45 percent, hardwood forests 25 percent, mixed forest 27 percent, and unstocked areas 3 percent. In 1973 the first of two successive 10-year forest development plans was initiated. As a result, 2 million ha were reforested, which is approximately 34 percent of total forest land. Thereafter, the risk of forest fires increased due to increasing fuel availability and number of visitors (Lee 1995).

According to the official statistics collected since 1987, there is no record of fire from natural causes. All fires have been caused by humans, especially by careless burning by local people. Major causes of forest fire were careless weed burning in the spring season, activities of people visiting their ancestors' graves, etc. The majority of forest fires (>80 percent) occur in the spring (March-May) and fall (November-December). According to the forest fire statistics for the years 1987 to 1991, fires in the Republic of Korea annually affect 665 ha of forests.

No figures on forest fires are available from North Korea.

Mongolia

In Mongolia, fire is a major factor which determines spatial and temporal dynamics of forest and steppe ecosystems (Wingard and Naidansuren 1998, Valendik et. al 1998). It also drives the trend of forest formation, varying with altitude. Out of the total of ca. 17.5 million ha of forest land (corresponding to ca. 8.1 percent of the territory of Mongolia) ca. 75 percent are coniferous (predominantly larch [*Larix sibirica*] and pine [*Pinus sylvestris*]) and deciduous forest (with extended occurrence of birch [*Betula platyphylla*]). More than 4 million ha are disturbed to different levels either by fire (95 percent) or by logging (5 percent). Logged areas have increased drastically in the past 20-25 years. 600,000 ha of felled over areas have not yet recovered.

The steppe zone covers approximately 40 percent of the Mongolian territory and serves as main pasture resource for ca. 30 million animals . It is assumed that most of today's steppe vegetation is on fire-degraded former forest sites (Naidansuren 1998).

The highest forest fire danger is characteristic of low-mountain pine and larch stands growing on seasonally freezing soils. These stands are distributed in the Khentey, East Khentey and Khubsugul foothills which are characterized by an extremely continental climate. During a year, air temperature fluctuations can amount to 90°C, with the summer maximum being +40°C. Annual precipitation ranges 250 to 350 mm. In exceptionally dry years, this value does not exceed 200 mm in forest regions. The majority of forest fires occur within the central and eastern parts of the forested area. This can be attributed to the predominance of highly fire susceptible (highly flammable) pine and larch stands, and also to much higher economic activity compared with other parts of the region. In Mongolian forests, fire seasons are usually discontinuous, i.e. they have two peaks of fire danger. One peak is observed during long dry spring (from March to mid June) and accounts for 80 percent of all fires. The other fire danger peak falls within a short period in autumn (September-October) and accounts for 5-8 percent of fires. In summer, fires occur very rarely (only 2-5 percent of the total).

In one of the most sparsely populated countries in the world, it is difficult to obtain accurate information on fire history and causes. First fire history studies conducted by Valendik *et al.* (1998) indicate that most forest fires are induced by steppe fires invading adjacent forest stands. Lightning fires are common in the mountain *taiga* belt because of increasing storm activity in late May and early June. Extreme fire seasons occur every three years in Mongolia. These seasons account for almost half the number of fires and 1/3 of the total area burned over the past decade. The mean fire interval varies from 9 to 22 years depending on forest type, slope aspect, and human ignition sources.

The first attempts to manage fire did not begin until 1921 and remained limited to local town fire departments until the 1950s. Relatively accurate records are available after 1981.

It is clear, however, that Mongolia is experiencing a dangerous increase in wildfires. From 1981 to 1995, forest and steppe fires burned an average of 1.74 million ha annually. In 1996 and 1997, the area affected by fire was 10.7 and 12.4 million ha respectively – an increase of more than sixfold. The areas hardest hit by these increases have been the forested regions. The typical forest fire season (1981-95) swept through some 140 thousand ha (on average 8 percent of the total area burned), already a large area. However in 1996 and 1997, this figure radically increased to nearly 18 times the previous average – some 2.5 million ha annually, corresponding to ca. 22 percent of the total land area affected by fire. In these two years alone more forested areas burned than were harvested over the last 65 years (for detailed references see Naidansuren [1996] and Wingard and Naidansuren [1998]).

Nepal

Forest fires are very common in the mixed forest of sal (*Shorea robusta*) in the lowland zone of Nepal (Terai). During the dry season (March to May) most tree species in the Terai shed their leaves. High surface fuel loads consist of dry leaves and small twigs, accompanied by grass and undergrowth species which turn dry during that period and serve as additional fuel to carry surface forest fires. Although detailed statistical data are lacking, both national (Sharma 1996) and international (Goldammer 1993) observations agree that fires are common between March and May and may burn the forests up to three times within one single fire season.

4. SOCIO-ECONOMIC BACKGROUND AND ENVIRONMENTAL IMPACTS OF FIRE: IMPLICATIONS ON FIRE MANAGEMENT STRATEGIES AND PUBLIC POLICIES

In this section selected examples are given of specific fire phenomena and fire problems in various countries in Europe and temperate-boreal Asia. Statements or problem descriptions were provided either by government agencies or individual analysts. The problem definitions or solutions proposed do not necessarily reflect official policies or programmes.

4.1 Fires in radioactively contaminated terrain: Belarus, Russia, and Kazakhstan

According to Dusha-Gudym (1996) the following territories in the Russian Federation were contaminated by radionuclides between 1949-1993:

Nuclear weapons test sites

Nuclear weapons testing in the atmosphere began on Semipalatinsk Nuclear Testing Ground (now Republic of Kazakhstan) in 1949. After these tests the radioactive material was transported by air currents over considerable distances. The forests of Altai Area adjacent to Semipalatinsk Region, particularly the unique Lentochnyie Groves were contaminated by radioactive precipitation which included dozens of different radionuclides. In 1950-1963 a total of 1,977 fires were recorded in Lentochnyie Groves; the total area of fires was 46,946 ha. Information concerning radioactive contamination of forests was not available in the 1950s and 60s, thus no measurements were made regarding the rate and density of soil contamination by radionuclides, and concerning specific contamination of fuels and products of their combustion by radionuclides. Radiation and pyrogenic conditions can only be reconstructed by calculating and modelling the processes of decay and migration of radionuclides that took place in the forests during those years.

Industrial accidents

Technical failures occurred at the "Mayak" Industrial Corporation (Chelyabinsk Region) in 1949-1956, 1957 and 1967. The Mayak Industrial Corporation is located east of Kyshtym town, Chernobyl Region. The first accident occurred in 1949-1956, when radioactive waste was dropped into the river system of Techa - Iset - Tobol. The second failure took place on 29 September 1957 when an explosion in the radioactive waste storehouse released a cloud of radionuclides which crossed the territory of Chelyabinsk, Cverdlovsk and Tyumen Regions. The area of the territory with a density of soil contamination by Sr-90 over 0.1 $Ci{\cdot}km^{-2}$ was greater than 23,000 km^2. The third failure in spring of 1968 was due to the fact that radionuclides had been spread by wind from the Karachai Lake banks exposed to erosion as a result of drought. The terrain affected by radioactive deposits were conifer and hardwood forests of the Southern Urals and the Zayralskaya Plain.

On the Siberian Chemical Complex Tomsk-7 a tank containing about 20 m^3 of low-active liquid uranium and 500 g of plutonium exploded on 6 April 1993. A mixture of radioactive gases was released to the atmosphere and formed a cloud. Radioactive precipitation was monitored over the area of approximately 200 km^2 covered by forests. Radioactive traces were observed in the southern *taiga* region of the Western Siberian Plain.

The Chernobyl Nuclear Power Plant accident

The Chernobyl Nuclear Power Plant accident of 26 April 1986 is considered as one of the greatest technogenic disasters of the 20th century. Chernobyl radioactive fallouts took place mainly over the zones of broad-leaved and mixed forests. The highest level of soil contamination by radionuclides (mostly by Cs-137, also by Sr-90 and Pu 239) was in the Dneprosvko-Pripyatsky, Bryansky and Central Districts of the broad-leaved forests zone. The major Chernobyl radioactive traces are found in the forests around Melekhov-Mokeev where the fire season lasts 160 to 180 days between April and early October. Within the 30-km zone around Chernobyl and in some areas into which the former inhabitants migrated forest fires occur regularly. Moreover, in the above territories, fires take place on vast areas of abandoned (evacuated) lands, e.g. meadows, pastures, kitchen gardens and farmsteads which are covered with thick grass that becomes highly flammable. By 1994-1995 fires were observed on 955 ha of abandoned lands. In the 30-km protection zone around the Chernobyl power plant fires occurred over the forest area of 17,000 ha in the years following the disaster. A forest fire on an area of 1 ha can generate 0.5-1 to 2-3 t of radioactive ash and incomplete combustion. Ash and partially burnt fuels represent open sources of ionizing radiation, and the level of contamination often equals that of radioactive wastes.

Fire-generated transport of radioactive materials

Dusha-Gudym (1996) reports that the fuels burnt in forest fires contain radioactive caesium, strontium and often other long-life elements such as plutonium. In the products of fuel combustion, i.e. in ash and partially burnt fuels, the concentration of radionuclides sharply increases. A part of the radioactive ash remains on the fire site, and the other part is released in smoke aerosols and transported over various distances.

In August 1992 in the region of Novozybkov, where multiple forest and peat fires took place, the Cs-137 content in atmospheric air was $70x10^{-5}$ $Bq{\cdot}m^{-3}$ (for comparison: in August 1992 the Cs-137 average content in atmospheric air over the whole zone of Russia contaminated by radionuclides from Chernobyl was $1.75x10^{-5}$ $Bq{\cdot}m^{-3}$, i.e. it was by 40 times lower).

These fires alone were not severe enough to explain such sharp increase of radio-active cesium content in the air. The sources of huge smoke plumes were located at a considerable distance from Novozybkov, on the territory of the adjacent regions where forest fires covered thousands of hectares. Besides Cs-137, both strontium-90 and plutonium were found in smokes of the above fire. Research work carried out in 1993 confirmed the results of our investigations of 1992 that proved the presence of plutonium-239 in aerosols of smokes in forest fire in the region of Zlynki town.

Two recent major international conferences underscored the priority of programmes to address the problems arising from wildfires on radioactively contaminated terrain (Annexes II and III).

4.2 Bhutan

In Bhutan, the occurrence of forest fires is normally highest during the dry winter months. Land preparation for agricultural, horticultural and shifting cultivation purposes is done during or at the end of the winter months. Fire is used as the cheapest tool for cleaning such land by the villagers and shifting cultivators. As a result, uncontrolled use of fire in or adjacent to the forest occurs frequently. Often such fires escape to the forest accidentally. In some cases, fires are set intentionally by cattle grazers to obtain new flush of good grasses. So far, there is no report on forest fire incidence caused by lightning. Analysis reveals that in Bhutan all fire incidences are human-caused, on purpose or accidentally (Tab.3, Annex I).

Chhetri (1994) suggests that the number of escaped fires can be reduced by adapting appropriate controlled burning techniques in agricultural land and orchards. "Uncontrolled use of fire as a tool to improve pasture land should not be considered in any part of the country. If it is a necessity for the survival of livestock, appropriate techniques for burning of pasture land should be developed so as to ensure the protection of surrounding vegetation. Similarly, the number of fires escaping from camp fires, cooking fires etc. can be reduced by adopting more restrictions through rules and regulations. Appropriate prevention modules for different types of target groups, such as agriculturists, orchard owners, herders etc. should be designed. Various target groups should be made aware of the value of the forests. Only then would we be going in the right direction towards obtaining the goodwill of the people. Prevention is better than cure. Therefore every effort should be made to prevent forest fires. If there is honour with our people in preventing forest fires, then the fire incidence could be avoided. On the other hand, nowadays more land is brought under utilization for various purposes. As such, there is every likelihood of increasing the numbers of escaped fires. Therefore, it is time to consider prevention approaches through various media and the enrolment of villagers in forestry programmes (social, community and agroforestry) which play a vital role in educating people in the importance of forests and developing goodwill to minimize the destruction of the forest."

4.3 People's Republic of China

In the People's Republic of China, wildfires are caused mainly by people: fires escaping from agricultural maintenance burning, camp fires lit by hunters, mining operations, collectors of non-wood forest products, and fires started alongside roads and railways. Lightning is a frequent fire cause at the end of spring fire season in the northern forest region, especially along the border with Russia.

Wang Dong (1998) reports that in accordance with the "Forest Fire Prevention Act" a series of measures are carried out to prevent human-caused fires. Every year during the last decade the local government announces the starting date of the fire season and period of the fire ban. At the start of the fire season, at almost every entrance to forest regions fire prevention checkpoints are set up which control permits and inspect matchboxes and lighters carried by people. Spark arresters of automobiles are also checked. During the fire season, each train travelling through a forested region must have a look-out in the end carriage. In some places of high fire risk, e.g. along down-slope railway tracks where braking trains often produce sparks, ground patrols prevent fire ignitions. Any uncontrolled fire use is not allowed during the fire-ban period. A lightning detection system has been established in the Daxinganling mountain forest region.

Forest fire management policies

In China, the local government is responsible for fire prevention and suppression in accordance with the "Forest Fire Prevention Act". The Act also regulates details of the right of governments to declare fire season restrictions, establish fire control organization, construct wildfire control facilities, approve the use of prescribed fire, and conduct public education. The responsibilities of other agencies involved in wildfire control, e.g. communication, transport, weather forecasting, and medical treatment, are also regulated by the Act. The Act also regulates the role of the armed forces in fire emergency cases.

After the fire episode of 1987, forest fire prevention programmes were enforced, particularly in the northern provinces Heilongjiang and Inner Mongolia. Forest fire control offices were established by the provincial governments at local administration level and forest bureaux to implement the Act. In this region, a very important element for fire control is the forest police and the professional fire brigades established 50 years ago. Adequately trained and equipped with advanced transport means, e.g. all-terrain vehicles and helicopters, most wild fires are put out by quick response. Aerial fire-fighting is absolutely necessary in the large, remote forest zones.

In Heilongjiang and Inner Mongolia ten airfields are operated for fire-fighting, and about 30 aeroplanes are employed each year. In recent years, air tankers and helibuckets were developed for aerial fire suppression in addition to their tasks in fire detection and personnel transport.

A national fire information system based on a computer network and intranet software is in use, and fire images received from NOAA weather satellites can be transmitted from the national office to over 300 terminals throughout the country including the two provinces mentioned above.

Fires occurring along the border zone are considered as a serious problem. Therefore a special fund has been provided by central government each year to build firebreaks along the border. The use of prescribed fire is one of the methods for firebreak construction.

The expenditures for fire prevention and control are given in Table 4 (Annex I). The total costs of 185 million RMB are equivalent of approximately US$ 30 million .

National long-term programmes

As an important long-term strategy, plans have been made for the construction of "greenbelts" acting as fuelbreak network integrated into reforestation throughout China. The goal of this fuelbreak network is to limit the size of wildfire-affected areas to a maximum of 100 hectares which corresponds to the designed forest space surrounded by the greenbelt network (see also Shu Lifu 1998).

One of the recent programmes is the national forest fire danger rating system and broadcasting network, which will be developed and put into use before year 2001. To promote use of high technologies is another task in recent years, e.g. the use of infrared scanner, helirappel attack, large air tankers and helibuckets. All of these will increase the efficiency of both fire detection and suppression.

4.4 Finland

In Finland the between the 1950s and 80s the average burned area per decade decreased although the number of forest fires had been more or less constant (ca. 500 per year). In the last decade, however, both the number of forest fires and the total area burned has significantly increased. During the last four years (1994-97) an average of 1,253 forest fires burned 1,034 ha per year. During the last twenty years the burned area has been less than 1.0 ha per fire on average, except for 1992 and 1994.

The main socio-economic causes of forest fires and measures/actions adopted to prevent and reduce impacts

The main causes of forest fires are human negligence and carelessness. About 10 percent of all fires were started by lightning (6 percent during the last four years).

According to the report of the government of Finland (Frelander 1998), the following factors had positive effects on forest fire protection over the last decades:

Efficient forest fire warning system - Citizens living in areas of higher risk of fire are informed via mass media and nowadays also via the Internet

Sufficient regulation - Positive attitude of people towards the regulations on restriction of open fires

Education, information and prevention - Efficient and continuous work has been carried out by fire chiefs and foresters

Efficient fire detection - All forests are monitored by aerial patrols. Under high risk conditions, regular airborne surveys are carried out by the state fire officials over extensive inhabited areas

Forest road network - Increase of overall forest road network by several thousands of kilometres during the last decades

Increased resources - Better equipment of municipal rescue services, especially in areas with higher risk of fire

Airborne fire suppression technologies - Use of helicopters equipped with "Bambi Buckets" provided by the state.

By Finnish law everybody is allowed to enter all forests. To light an open fire in the forests, one needs to obtain the permission of the land owner. At the time of official forest fire warning, lighting of campfires is prohibited in the forest and nearby forests.

Legal instruments and local fire organization

The Fire and Rescue Service Act (559/75) and Fire and Rescue Service Decree (1089/75) provide regulations about forest fire protection and lighting open fires during forest fire warning. The Ministry of the Interior is responsible for forest fire control at the governmental level. At the regional level, the five provinces are coordinating forest fire control activities. At the local level, the municipal rescue services have the responsibility for all fire control within the municipal area.

In Finland, there are 60 professional fire brigades with about 4,500 fire-fighters, 180 semi-professional fire brigades (personnel: 5,000), 630 voluntary (personnel: >10,000), and village fire units (personnel: 3,000).

The district emergency centres receive all smoke and alarm calls and check information on forest fires, and dispatch the rescue services. The Forest Service (state and private) is responsible for assisting rescue authorities in forest fire prevention and suppression.

Educational programmes

After the large forest fires of 1970, an effective and continuous education and prevention work was carried out by fire chiefs and foresters during the rest of the decade . The authorities (municipal fire authorities, the provincial governments and the Ministry of the interior) usually inform about the coming forest fire risk in the beginning of the season, before midsummer and when there is extreme risks for forest fires.

The Finnish Meteorological Institution calculates twice a day a Forest Fire Risk Index. If the Risk Index is 4 or more, a forest fire warning is given in the area in question via radio, TV, newspapers and nowadays also via the Internet. When a forest fire warning is given, open fires are prohibited in forests and nearby forests.

During the forest fire season air patrols cover the whole country with 25 flight routes. Such patrols are organized by the provincial governments with directives and funding from the Ministry of the Interior. The actual patrolling is done by flight clubs. Detection towers are no longer used in fire control.

The state supports the municipalities with helicopters equipped with helibuckets ("Bambi"). The helicopters are private and state owned. The Ministry of the Interior has funded all helibuckets. During the fire season the Forest Service has foresters on duty to assist fire authorities in forest fire control. The costs are covered by the Ministry of the Interior.

Use of prescribed burning

The prescribed burning of forest floor is, in the boreal zone, an efficient method for site preparation after clear felling to facilitate forest regeneration. Although Finland has a long tradition in the use of prescribed burning, this practice had been decreasing during the last few decades. However, during the last few years the silvicultural and ecological advantages of prescribed burning have been discussed, and more attention is given to this technique. It is expected that prescribed burning in forestry will increase in the future.

Currently the Forest Research Institute, the National Board of Forestry and the University of Joensuu conduct research on the use and impacts of prescribed burning.

National costs and implication of forest fires

Damage caused by forest fires has been assessed between 0.3-2.7 million FIM annually in 1994-97. The costs for the state fire services were between 1.0-2.8 millions annually during the same period. The government estimates that 8 percent of the costs for municipal fire and rescue services (totalling 2 billion FIM per year) are spent for forest fire protection, equalling ca. 16 to 20 million FIM per year.

4.5 Germany

Prescribed burning

While forest fire management in Germany has no exceptional fire problems, changing paradigms of the role of fire in nature conservation can be observed during the past couple of years. At present, new initiatives are being taken to restore fire as a dynamic and vital element to maintain biodiversity and the cultural and ecological characteristics of landscapes.

Target of these initiatives are those ecosystems and landscapes that had been treated with fire historically. Changes in many vegetation types have been observed as a consequence of abandoned traditional land-use practices. Ecologically important disturbances by land-use include grazing, mowing, biofuel utilization, and burning. Traditionally fire was used to keep vegetation open and at successional stages, to regenerate grass, heath and brush, and to clear land from weeds and harvest residues. Since 1975, a vegetation burning ban has been imposed in all German states.

Between 1996 and 1997 four scientific workshops were held at the State Academies for Nature Conservation in Lower Saxony, Hesse, and Baden-Württemberg, and the Federal German Nature Conservation Academy. In these workshops the importance of fire as a cyclic recurrent disturbance factor was highlighted. Recommendations were made to include prescribed burning into nature conservation and landscape management programmes.

In 1997, the first large prescribed burning research programme began in the State of Baden-Württemberg. It aims to investigate the use of prescribed burning in the management of hedge and slope terrain in the viticulture region of Southwest Germany. The use of fire to maintain or restore grass cover which provides habitats for endangered flora and fauna is the objective of this programme. The project was requested by the State Ministry for Rural Space of Baden-Württemberg because of the dramatically increasing subsidies necessary to mow and mulch those sites on which biodiversity is lost due to succession towards bush and forest cover. Detailed references on the historic role of fire in European land-use systems and strategic concepts on the use of fire in modern nature conservation and landscape management are provided by Goldammer *et al.* (1997a,b,c). The use of prescribed fire inside forest stands for wildfire hazard reduction, however, has not been further discussed after the first proposals and pilot experiments in the 1970s (Goldammer 1979).

Regional and international initiatives

The state of fire science (fundamental fire research, fire ecology) in most vegetation types, and the results of biogeochemical and atmospheric sciences research of the last decade provides sufficient knowledge for supporting decision making at fire policy and management levels.

However, it is evident that in many developing countries advances in scientific and technical knowledge are either not known or readily accessible for developing adequate measures in fire policies and management. The fire and smoke episode of 1997-98 in South East Asia was a good example that existing fire information systems or fire management expertise was utilized to a limited extent only. These circumstances led to confusion at national and international decision-making levels and led to the delay of response by a series of national and international projects, some of them even missing the targets. This can be explained by the lack of an information system which is accessible globally.

Consequently, an information and monitoring system was needed which national and international agencies involved in land-use planning, disaster management or in other fire-related tasks can utilize for planning and decision making.

The Global Fire Monitoring Centre (GFMC) was established in Freiburg (Germany) in 1998 in accordance with

- the objectives of the UN International Decade of Natural Disaster Reduction (IDNDR),
- the recommendations of the ITTO Guidelines on Fire Management in Tropical Forests, and

- the recommendations of various scientific and policy conferences in the field of fire, e.g. the FAO/ECE/ILO Conference "Forest, Fire and Global Change" (Russia 1996).

Following the principles which were developed for a scientific Global Vegetation Fire Information System in the early 1990s, the Global Fire Monitoring Centre will document archived and provide real-time or near-real time information related to fire. This will include the interlinking with other national, regional and international information systems.

For its first phase the GMFC is sponsored by the government of Germany, Ministry of Foreign Affairs, as a German contribution to the IDNDR. The fire documentation, information and monitoring system is accessible through the Internet: **<http://www.uni-freiburg.de/fireglobe>.**

The GFMC is established at the Fire Ecology and Biomass Burning Research Group of the Max Planck Institute of Chemistry, Germany. Since the beginning of the 1990s, the Max Planck Institute has been responsible for designing, coordinating, organizing and partially implementing several international fire research campaigns under the umbrella of the International Geosphere-Biosphere Programme (IGBP). The institute is chairing the scientific steering committee of the fire science component within the IGBP (the Biomass Burning Experiment [BIBEX]) and hosts the BIBEX Secretariat, located at the GFMC. Since the early 1990s the Fire Ecology Research Group in addition has taken a leading role in the UN system through its role as coordinating unit of the UN-FAO/ECE/ILO Team of Specialists on Forest Fire.

Furthermore, the Fire Ecology Research Group is convenor of the IDNDR Early Warning Programme Working Group "Fire and Related Environmental Hazards".

The GFMC is co-sponsored by several international and national organizations and programmes:

- UN: IDNDR, UNESCO, UN-ECE Trade Division,
- The World Bank,
- The International Union of Forestry Research Organizations (IUFRO), Subject Group S8.05-00,
- The International Boreal Forest Research Association (IBFRA), Fire Working Group,
- The International Geosphere-Biosphere Programme (IGBP),
- International Global Atmospheric Chemistry IGAC) Project,
- the Biomass Burning Experiment (BIBEX).

4.6 Mongolia

Except evidence by tree ring records, no information is available on wildfires in Mongolia in archived and historic documents before 1921. Naidansuren (1998) explains this with the fact that by Mongolian tradition nature has been treated sensibly due to the high dependence of nomadic people and livestock on well-preserved grazing resources.

Increasing amounts of wildfires occurred during the period of rapid social-economic development in the 1950s and 60s. The reason was an increase of population and agricultural machinery and equipment, the construction of the first railway, and the increasing forest use construction materials, timber trade and fuel supply. As a consequence of increasing fire occurrence, the Government of Mongolia established an aerial fire guard service in the provinces of Khubsugul, Selenge, Arkhangai, Dornod and Khentii. These services were equipped with helicopters and smokejumpers. Today the Forest and Steppe Fire Prevention Department (SFPD) is under the jurisdiction of State Civil Defence Department (SCDD). Each of the 21 Mongolian provinces has a local civil defence department responsible for wildfire suppression.

Fire causes

In an investigation of wildfire-causes Naidansuren (1998) explains the missing or less reliable fire statistical data during the periods of the presence of foreign military troops on the territory of Mongolia and the transition to market economy. As already stated in this report (Section 3.1.6), the majority of fires (60-90 percent) start in spring when warm, windy and dry weeks coincide with the beginning of human activities in the forests and steppes after the winter break, e.g. hunting, antler collection, logging, and fruit gathering. The overall main fire causes in Mongolia which have led to an increasing occurrence of wildfires are:

Escaped campfires - Campfires are common in forests or steppe for cooking and warming (day temperatures of +10 to 25°C drop at night to 0 to -10°C). Many additional escaped campfires are caused alongside roads by people affected from transport breakdowns and car accidents.

Antler collectors - The high demand for deer antlers (both naturally shed "bone" antlers and live antlers taken from hunted animals are expensive raw material for medicine) on the Chinese and South East Asian markets drives illegal antler collectors and hunters into the forests. These people are a major source of starting wildfires (campfires, smoking).

Military - In the past Soviet/Russian troops (1966-1992) and nowadays the Mongolian army cause extensive fires by military activities (field exercises, artillery, mining, tanks pipes, open fire, smoking).

Railways - Mainly caused by sparks from train exhaust pipes and brakes, cigarettes thrown by passengers.

Tractor exhaust pipes - Agricultural machinery and equipment, particularly crawler tractors, are mostly used in the agricultural and animal husbandry sectors.

Plantation cleaning - After the harvest, all residues (straw, stalks) are gathered and burned. Fires often escape if these burns are not controlled sufficiently.

Spark from ger chimneys - Most of Mongolian rural people uses chimneys from which sparks can be transported to the surrounding dry grasslands.

Children - The rate of Mongolian population increase is 2.5 percent, which is the highest in Asia, and 34 percent of the total population is in the age range between 2 and 14 years (according to the demographic statistics of 1996).

Stove ash - Nomadic families in the steppe pasture lands live in yurts and use common stoves in which dried cattle dung (argal) is burned. Glowing embers are a major source of steppe fire ignitions.

Powerlines - Extremely high windspeed in Mongolia often damage powerlines and cause ignition by electric sparks.

Lightning - Lightning storms of 40-60 hours per year were recorded in Central and Northern Mongolia and represent a source of natural ignition.

New developments in forest fire management

Immediately following the 1996 fires, Mongolia received assistance from international organizations to help local people recover from the losses. Besides the advice and training on disaster fire management received through the U.S. Office of Foreign Disaster Assistance (OFDA) (Shulman 1996, 1997), the German government contributed to these efforts in the form of an Emergency Fire Aid project carried out in the northern and eastern parts of the country (October-December 1996). Since then, the government has been working to find long-term solutions to the problem of fire management. As a first step, the parliament passed of a law designed to organize and improve fire-fighting efforts at all levels.

In February of 1998, the German and Mongolian governments signed an agreement to start an Integrated Fire Management Project to be implemented over the next three years (1997-2000). The GTZ, responsible for the German contribution, will provide long and short-term experts, support staff, training and equipment (Wingard and Naidansuren 1998).

The integrated fire management project concept

The project region selected by the Integrated Fire Management Project is the Khan Khentii Strictly Protected Area and its buffer zones – one of the harder hit areas during the 1996 fires. A primary task will be the establishment of a fire management plan compatible both with the protected area goals and the responsibilities of the local communities. Fire Management Units in the local communities will receive professional training and basic hand tools suitable for the regional conditions. Information and Training Centres will provide the necessary infrastructure for fire prevention activities, management information, training exercises, dispatch and field organization.

Project components

The IFM project supports Mongolia by strengthening local capacities effectively to address the issues of fire prevention, pre-suppression, and suppression. It will do this by helping to organize the cooperation between protected area, local and national administrations responsible for fire management; by establishing the necessary infrastructure, providing training both in-country and abroad; and, by including all stakeholders in the planning and implementation of fire management activities. A socio-economic study is under way which will provide the design of a community-based fire management approach (Ing 1998).

4.7 Nepal

The fire problems as highlighted in the country brief have not yet been addressed by a national fire management policy or strategy. Although there are fire control plans within some

District Forest Offices in the Terai region, most are considered insufficient and not effective (Sharma 1996). The main reasons are:

- lack of resources,
- lack of extension education for the local people,
- lack of specific fire control rules and regulations,
- lack of specific fire control organizations.

There are no statistics on fire in Nepal yet. The lists of ignition causes as described by Sharma (1996) and Goldammer (1993) clearly indicate the potential target groups of extension and public information and education. The main causes for wildfires in the Terai of Nepal are:

- Cattle grazing: burning for stimulation of new grass,
- Illegal loggers: burning of stumps to hide evidence,
- Collecting non-wood (minor) forest products, e.g. honey, trophies, etc.,
- Torches: burning of wood or rubber, for travelling by night.

Fires set by cattle graziers for stimulating new grass growth and careless smokers alone account for about 45 percent of all known causes of forest fires. Natural causes (e.g. thunderstorms) of fires are not reported. About 64 percent of fires are caused by people intentionally, about 32 percent by accident or carelessness, and about 4 percent by unknown causes. Preventive measures could be the solution for a fire control programme.

Sharma (1996) recommended that the Department of Forests of Nepal should immediately prepare district-level Forest Fire Management Plans (FFMP). More than 90 percent of the activities should be based on fire prevention activities and the rest on fire suppression activities, research and accounting of fire.

Within the Forest Department a functional organization should be established. The organization should be responsible for fire prevention, human resource development, law enforcement, and fire research. Collection of fire statistics should include:

- number of fires and area burned (yearly),
- number of fires by each cause,

- area burned by each cause,
- fire distribution by forest vegetation zones,
- size distribution of forest fires,
- duration of forest fires,
- monthly distribution of forest fire incidents throughout the year.

Because of the limited resources and poor communication infrastructures, prevention activities, which are the most economic way of reducing fire damages and losses, could be the most important function of fire control services for Nepal. The most important elements of fire prevention would be:

- Primary school education,
- Extension programmes - general public education,
- Workshops among political leaders and members of administrations,
- Enforcement of laws, regulations, rules, and restriction for fires and their communication through sign boards and warning notice boards,
- Fuel management - fire line construction and control burning along the firelines and forest tracts and roads, and
- Clear demarcation of forests.

Sharma (1996) also recommends that local NGOs and other groups should be utilized for extension activities. Village Fire Control Group (VFCG) should be formed and motivated by a responsible organization.

4.8 Poland

One of the examples of fire problems in industrially polluted regions is located in Poland. The Rudy Raciborskie Forestry Administration Area includes 17,780 ha of forest (89 percent pine forest) out of which 14,215 ha are in the heavily damaged zone (Zone II). Additionally this area is affected by water table depression due to sand pit exploitation. A large fire in 1992 burned more than 9,000 ha in the superintendency. The complete consumption of the humus layer by fire and the subsequent loss of ash by strong winds together with the pollution impacts led to a severe increase of soil acidity of <3.0 pH. The rehabilitation of such burned areas will require a complicate system of planting including successive steps from pioneer stands towards a more species-rich climax stand (Anonymous 1998).

4.9 Russia

In general, forest fires occur as a result of human activities. The local population alone accounts for 60-80 percent of the total number of fires. According to a report of the Federal Forest Fire Service of Russia (Rosleskhoz 1998), a series of measures were launched for the prevention of human-caused fires, e.g. construction of firebreak systems, special access roads, water sources, and recreation areas for the public. Propaganda against fires and for nature protection is becoming more important in Russia with the purpose of involving various levels of the society, especially young people.

In accordance with the needs to strengthen forest fire protection, the forest legislation has also been changed. In 1997 the new Forest Code of the Russian Federation was approved and a number of decrees and regulation were adopted.

In accordance with the Code, the responsibilities for fire management and disaster management in emergency situations connected with forest fires, and the state fire supervision in the Forest Fund were given to the Federal Forest Fire Service of Russia (Rosleskhoz). Protection of forests from fires is being implemented by the special agencies of Rosleskhoz, consisting of the ground and aviation subdivisions, which constitute a single system for prevention, detection, warning and suppression of fires. All the activities are financed from the federal budget.

For raising the level of forest fire protection, stabilization and gradual reduction of forest fire intensity and the size of direct and indirect damage from forest fires, the Government of the Russian Federation adopted the State Programme "Forest Fire Protection for 1993-1998". The draft federal programme "Forest Fire Protection for 1999-2005" has also been prepared.

Research and development is under way to improve forest fire danger forecast, to develop new technical means of fire detection and suppression of the forest fires, including airborne technologies, and to create advanced communication systems. A programme to reduce forest fire risk is under way. It includes the planning of preventive prescribed burning in forests. The adoption of the special programmes by the Russian Government emphasises the significance of implementing the work in the general strategy of the nation on protection of the environment and promotes the implementation of the planned work.

Constraints in implementing the programme has been influenced by the current economic crisis in Russia. In a report on the 1996 fire season in Russia, the unfavourable situation in the Eastern part of the country (Krasnoyarsk, Baikal, Far East regions and Yakutiya) was explained as a consequence of lowering the level of forest fire protection by cutting down the number of fire-fighting crews, reduction of aircraft flying time, etc. (Davidenko 1997). The flying hours of aircraft involved in fire observation was reduced to 40,000 hours in 1996, while the necessary time (according to proven norms) should be 150,000 hours.

The average percentage of fire detection by aviation during the last five years was reduced to a level of about 41 percent of the average during the 1980s. Also the number of smoke jumper and helirappeller crews was reduced: only about 4,000 aerial fire suppression specialists were employed in 1996-97 as compared with 8,000 people in the early 1990s. Aerial fire suppression operations involving transport of smoke jumper and helirappeller teams decreased sharply: while in 1991, 2,598 aerial fire-fighters were transported in 98 operations, only 28 transport operations ferrying 745 fire-fighters were performed in 1996.

The 1998 fire season was extremely severe in the Far East of Russia. According to the Aerial Forest Fire Protection Branch (Avialesookhrana) of the Federal Forest Service of Russia, a total of 21,341 fires were recorded in Russia up to 20 October 1998, burning a total area of approximately 2,063,821 ha. In the Russian Far East (Khabarovsk region), 1,261 fires were recorded burning 1,502,750 ha. On Sakhalin Island 311 fires burned, affecting 28,428 ha of forest. According to the 1998 fire database of Avialesookhrana the Far East suffered more than 10 times the average area burned as compared to the average of the last 10 years (Source: Avialesookhrana 20 October 1998).

Lack of fire-fighting resources was one of the major impediments to appropriate response to the forest fires. According to a report by the UN Office for the Coordination of Humanitarian Affairs (OCHA) the Far East Forest Protection Air Base in Khabarovsk in 1998 operated only 8 are serviceable AN-24 aircraft for fire detection and fire suppression deliveries, whereas in 1998 the number of AN-24 was 60 (OCHA 1998).

4.10 Sweden

Dendrochronological (fire history) studies reveal that the forest fire occurrence in Sweden in historical times was much different from today (Granström 1998). As late as in the mid 1800s, on average more than 1 percent of the forested area in northern Sweden burned per year. Probably the situation was much the same further south, although less is known from there. The annually burnt area dropped steeply over the last decades of the 19th century. The decrease in area burnt coincides with the expansion of modern forestry. It is assumed that the rural people gradually abandoned old fire practices (such as burning for improving grazing conditions in the forest) and started to suppress fires ignited by lightning as well. The contribution of humans to the fire regime of the old days is not fully clear, but it most certainly varied from region to region and over time. The interior of northern Sweden was settled by farmers (mainly depending on cattle) only since the late 1600s. There is evidence that prior to this, fires were relatively few but some of them covered many thousand of hectares. With an increased number of settlements, the number of fires increased but their size went down. Therefore, the resulting area burned did not increase as much as might be expected. Instead, the most substantial change in the fire regime came with forestry towards the late 1800s, as outlined above.

Today there is a consensus among environmentalists and forestry people that the present fire situation is historically unprecedented and possibly unhealthy for biodiversity in the long run (cf. also Page *et al.* 1997). Therefore some measures have been taken to increase the amount of fire in the landscape. Many forest companies have resumed the old tradition of burning felled areas. This is then used as an alternative to mechanical soil scarification. Still the area treated with fire is small (probably less than 2,000 hectares during the last year) but it is increasing. On these areas there is often a residual stand which serves as seed source for stand regeneration and increase of the structural diversity of the future stand (dead wood, old living trees). There also have been some efforts to use fire in the management of forest reserves, although very little has been accomplished so far (Page *et al.* 1997).

5. FIRE SCIENCE PROGRAMMES WITH RELEVANT TO REGIONAL FIRE MANAGEMENT AND POLICY DEVELOPMENT

5.1 International fire research programmes

5.1.1 International Geosphere-Biosphere Programme (IGBP)

The international vegetation fire research community has organized itself through various mechanisms. The International Geosphere-Biosphere Programme (IGBP) is the most interactive platform on which several major international and interdisciplinary fire research programmes have been designed and implemented.

One of the operational IGBP core projects is the International Global Atmospheric Chemistry (IGAC) Project. One of the activities of its foci is oriented towards investigating the impact of biomass burning on the biosphere and atmosphere (Biomass Burning Experiment [BIBEX]). Since 1990 several research campaigns have been conducted. For the boreal Asian region the "Fire Research Campaign Asia-North" (FIRESCAN) began in 1992 FIRESCAN addresses the role of fire in boreal ecosystems and the consequences for the global atmosphere and climate (FIRESCAN Science Team 1996).

IGBP-IGAC-BIBEX closely cooperates with the research programmes mentioned in the following paragraphs. One of the major expected impacts of all programmes is to stimulate exchange in research and development between the countries formerly divided by the Cold War (Goldammer and Furyaev 1995).

IGBP Northern Eurasia Study

Additional fire experiments will be conducted jointly with scientists collaborating in the IGBP Northern Eurasia Study. It will be a joint effort of scientists representing several IGBP Core Projects, the Biospheric Aspects of the Hydrological Cycle (BAHC), International Global Atmospheric Chemistry (IGAC), and Global Change and Terrestrial Ecosystems (GCTE) Projects. The unifying theme of the IGBP Northern Eurasia Study is the terrestrial carbon cycle and its controlling factors, and the study's overall most important objective is to determine how these will change under the rapidly changing environmental conditions projected under global change (Steffen and Shvidenko 1996). The IGBP Northern Eurasia Study will consist of an integrated set of experimental and observational studies at a number of scales, modelling and aggregation activities, and supporting databases and GIS capabilities. The major elements are transects and network sites, a water, energy, and carbon flux study, and detailed studies of disturbance regimes.

The fire component of the IGBP Northern Eurasia Study will have four components: (i) fire manipulations at individual forest sites; (ii) a series of campaigns based on aerial and spaceborne research platforms; (iii) the construction of a fire database, relating the frequency, extent, and intensity of fires to vegetation and climatic conditions for present and historical conditions; and (iv) development of aggregated models of forest fire frequency and extent, responsive to global change variables.

5.1.2 International Boreal Forest Research Association (IBFRA)

The International Boreal Forest Research Association (IBFRA) was founded in 1991 after a meeting of the International Panel on Boreal Forests in Arkhangelsk, Russia. The Fire Working Group (originally called "Stand Replacement Fire Working Group [SRFWG]) was one of the first working groups created under the IBFRA, and to date it has been the most active. Following an organizational meeting in Siberia in 1992, the Fire Working Group has strongly promoted and facilitated cooperative international and multi-disciplinary boreal forest fire research between Russia and western boreal countries of Europe and North America (Fosberg 1992, Stocks *et al.* 1996a). A number of collaborative studies dealing with global change/fire issues, remote sensing, fire behaviour, fire danger rating, fire history and fire ecology and effects have been initiated. A major conference and field campaign was carried out in central Siberia in 1993 in cooperation with FIRESCAN, with follow-up research activities planned beyond the year 2000. The "International Crown Fire Modelling Experiment" (Ft. Providence, Northwest Territories, Canada) began in 1997-98 with a cooperative involvement of European and Russian scientists and will continue in 1999 (see http://www.nofc.forestry.ca/fire/fmn/nwt/). A major fire research programme involving scientists from the U.S.A., Poland and Russia is under way at present in Poland and Russia. It is designed to look at fires of various intensities in European and boreal Asian pine forest ecosystems.

5.1.3 International Union of Forestry Research Organizations (IUFRO)

Until the early 1990s the IUFRO Fire Research Section 8.05 (former Subject Group S 1.09) was dormant except when acting as co-sponsor of several fire conferences. When the group was activated in 1994 it was recognized that several international organizations had developed focused forest fire research programmes, such as the aforementioned IGBP and the IBFRA. At the IUFRO XX World Congress in Finland it was agreed to keep the group alive as a liaison node between IUFRO and the other fire research programmes. The XX World Congress was utilized as a forum in which boreal fire scientists evaluated the FIRESCAN Bor Forest Island Fire Experiment (IUFRO 1995). IUFRO continues to cosponsor UN-FAO/ECE International Forest Fire News and the Global Fire Monitoring Centre. At the XXI World Congress (Malaysia 2000) the fire group will organize a sub-plenary session “Forest and Fire.” Considering the fact that fire science is most advanced in the ECE region, IUFRO supports the concepts of the FAO/ECE/ILO Team of Specialists on Forest Fire and the fire science projects under the IGBP to share expertise with other regions of the world.

5.2 National fire research programmes

5.2.1 Finland

Thanks to extensive forest fire control and efficient fire-fighting operations, there have been no large forest fires in Finland during the last decades. However, a few threatening forest and peatland fires showed that the authorities are not sufficiently prepared for large forest fires. With the decrease of large forest fires and prescribed burning, the practical experience and the fire controlling skills, especially management and leadership for big forest fires are disappearing.

The risk of outbreak of extremely large forest fires increases as well because of changing weather condition. The average wind speed and number of storms is increasing. The Meteorological Institution predicts that the dry spring weather will be longer and warmer in the future. Thus, the risk of forest fires in April and May will be higher.

The Ministry of Interior has initiated some research projects on forest fire control. The essential objectives of the research is to develop:

- more detailed information on causes, impacts, and behaviour of forest fires,
- methods to predict more exactly the forest fire risk on different areas and to inform the general public more efficiently,

- more cost-effective measures to monitor forest fires,
- optimal ways to use aircraft in forest fire suppression, and
- to identify the possibilities of using retardants and other additives for improving efficiency of fire extinguishing operations.

The Ministry of the Interior has initiated several projects to face the increasing risk of large forest fires:

- Publication of a new book and training materials, organization of courses in forest fire protection for fire authorities, and launch of an education programme for safety measures for prescribed burning for fire authorities and foresters.
- A physically based operational and more reliable method for estimation of forest fire risk. It has been developed in the Finnish Meteorological Institution. The final results will be issued at the end of 1998.
- A fully automatic satellite-based forest fire detection and alert system has been developed to detect forest fires using data from the meteorological NOAA satellites. The system has been tested in four pilot experiments 1994-97 in Finland and its neighbouring countries Estonia, Latvia, Russian Karelia, Sweden and Norway. The project is funded by the Ministry of the Interior (see section 6.3 of this report).

In 1997, the Ministry of the Interior and the Provincial Government of Lapland agreed to develop new forest fire control methods (use of aircraft and helicopters, water additives), investigate fire behaviour and survey the possibilities and the cost-efficiency of proactive fire-fighting. In future the Ministry of the Interior will propose to put into practice:

- Procurement of tanks and accompanying supplies to use additives in the extinguishing tanks of helicopters,
- Purchase of additives for tests at all forest fire air bases,
- Intensive training and application of fixed-wing aircraft in forest fire suppression, including the use of additives,
- Establishment of a post-fire evaluation and reporting on forest fires larger than 100 ha,
- Development of a forest fire prognosis and behaviour model for the various field and weather conditions,
- Revision of the ONTI follow-up and reporting system,
- Improvement of training in fire-fighting tactics and technologies,
- Enlargement of a network of fire specialists, including international cooperation.

5.2.2 Germany

Fire science in Germany has a traditional focus on fire ecology, fire management and fire policies at Freiburg University. The Fire Ecology Research Group concentrated its efforts on the tropics and the boreal zone, and on the role of fire in the global environment. However, the series of International Fire Ecology Conferences which were convened in Freiburg between 1977 and 1993 also provided a European platform. In 1990 the Fire Ecology Research Group was integrated into the Max Planck Institute for Chemistry. Since then the institute conducts interdisciplinary fire research in support of biogeochemistry and atmospheric chemistry studies.

Research and development of spaceborne sensing systems for detection, monitoring and characterization of fire and fire effects is a major focus of the German Institute for Aeronautical and Space Research DLR, Institutes for Space Sensor Technology and Optoelectronics (Berlin and Oberpfaffenhofen).

After it has been recognized that currently orbiting meteorological satellites are not satisfying the demands for information of the fire science and management community, it was decided to develop several dedicated instruments and research satellites. The fire research satellite BIRD is a pilot system which is currently built by the DLR Institute of Space Sensor Technology and will be launched in 2000.

The DLR Intelligent Infrared Sensor System FOCUS is designed to perform a prototype function for a globally operating high temperature environmental disaster recognition system. FOCUS is a candidate instrument for the International Space Station and is currently in Phase A.

A new project proposal has been submitted to ESA's "Earth Explorer Opportunity Missions" by the DLR, jointly with the Max Planck Institute of Chemistry, the Space Research Institute (Moscow), and VVT Automation (Finland) to develop the Satellite FIRESCAR-S (Fire Events, Scars, and Atmosphere Reconnaissance Satellite).

5.2.3 Poland

The Forest Research Institute of Poland hosts the main forest fire research facility in Europe. The Forest Fire Control Section was established in 1963. Current research foci of the institute are:

- Utilization of satellite data for fire hazard assessment, fire detection and monitoring,
- Use of television and infrared techniques for fire detection,
- Forest fire hazard assessment by weather forecasts,
- Fire extinguishers,
- Ecological and environmental impacts of forest fires.

5.2.4 Russia

In Russia, several facilities of the state research organization the Academy of Sciences, and the universities conduct research in basic questions of fire ecology, fire behaviour, and technology development for fire intelligence and management:

The Sukachev Institute of Forest of the Russian Academy of Sciences, Siberian Branch, Krasnoyarsk, is Russia's Centre of Excellence in fire research. The main foci are in fire ecology, biogeochemistry (carbon cycling), fire history, fire and fuel mapping, prescribed burning, use of remote sensing in fire management and fire impact assessment. The institute was host of the first international fire conference and fire experiment in modern Russia (Goldammer and Furyaev 1996, FIRESCAN Science Team 1996). The institute also hosts the International Laboratory of Forest Fire Ecology of the International Forestry Institute (IFI) in which several non-Russian scientists are members. The IFI Headquarters in Moscow has a focus on fire database management, remote sensing of fires, and the development of a Geographic Information System (GIS) for forest fires (Korovin 1996).

State forest research institutes involved in fire research are located in Krasnoyarsk, Ivanteevka (Moscow Region), and St. Peterburg. Focus of work of the Research Institute for Forest Fire Protection and Forestry Mechanization (VNIIPOMleskhoz), Krasnoyarsk, is mechanical equipment for fighting forest fires on the ground (Yakovlev 1992). The Forest Research Institute St. Petersburg has specialized on spaceborne detection of fires and particularly the development of airborne fire suppression technologies, including additives (retardants).

The Far East Forestry Research Institute (FEFRI) in Khabarovsk has a research focus on fire problems in the Far East of the Russian Federation. The institute will host the 1999 International Conference on "The World's Natural Forests and Their Role in Global Processes" (15-20 August 1999). The in-tandem workshop "Fire on Ice" (14-15 August 1999) 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 Centre (Max Planck Institute for

Chemistry, Biogeochemistry Department). Workshop participants will be fire and permafrost scientists actively involved in northern circumpolar research.

Laboratory of Forest Pyrology of the Research Institute of Forest Chemistry (VNIIHLeskhoz), Ivanteevka, Moscow Region, is the leading fire laboratory which investigates the effects of fire on radioactively contaminated terrain (see para.4.1).

At university level, international cooperative efforts in the area of forest fire behaviour modelling were initiated in 1994. The Canadian government translated a comprehensive Russian monograph on "Mathematical Modelling of Forest Fires and New Methods of Fighting Them" by A.Grishin, Centre on Reactive Media Mechanics and Ecology, Tomsk State University. An international conference "Mathematical and Physical Modelling of Forest Fire and Ecology Problems", was held in Tomsk in July 1995. A number of North American fire modellers participated, and the conference proceedings are published (Grishin and Goldammer 1996).

5.2.5 Sweden

Research on forest fire has been conducted since the early 1900s. The first questions concerned the influence of fire on forest regeneration and soil productivity. Hardly anything was done on fire behaviour or risk assessment, probably because fires were no longer a significant threat (Granström 1998). Fire history research was conducted sporadically starting in the 1930s, but more systematically since the 1970s. Today, research is motivated largely by the concern for forest biodiversity, but, as Granström (1998) underscores, some of the old questions are being dealt with again: what is the role of fire for the maintenance of site productivity in the long run? There have also been some research trying to connect fire history, fire behaviour and fire effects, with the aim to understanding the role of fire in earlier times at the landscape level.

6. INTRA-REGIONAL AND INTERNATIONAL FIRE MANAGEMENT AND POLICY PROGRAMMES

6.1 Economic Commission for Europe (ECE)

One of the main activities of the ECE in the field of forest fires in the periodic collection and publication of fire statistics of the member states (for details: see Section 3 of this report). The FAO/ECE/ILO Team of Specialists on Forest Fire operates under the UN-ECE Trade Division. The team's main task is to provide a critical link in communication and cooperation between fire scientists, managers and policy makers. The main activities embrace (1) the production of International Forest Fire News (IFFN), (2) organization of seminars, and (3) promotion of synergistic collaboration between individuals and institutions. An ECE-wide study "Legislation and regulations related to forest fire prevention and control" was conducted in the mid 1980s (Goldammer 1986).

FAO/ECE International Forest Fire News

The international community of fire specialists started to organize itself in the late 1980s. Starting with the first issue of FAO/ECE International Forest Fire News (IFFN) in 1988, a bi-annual publication of the Timber Section, UN-Trade Division, a steadily increasing communication process in international fire matters was initiated. Since then IFFN provides an international information platform on which advances in fire research, technology and policy development are reported and disseminated. Currently the printed version of IFFN is subscribed to by ca. 1,000 agencies, research laboratories and individuals all over the world. Starting with its 19th issue (August 1998) the IFFN is available on the Internet homepage of the "Global Fire Monitoring Centre". This includes all past issues (since 1988) which are organized into 48 country files.

The UN-ECE/FAO/ILO Team of Specialists on Forest Fire

The seminars conducted by the FAO/ECE/ILO Team of Specialists on Forest Fire were devoted to fire suppression technologies (Poland 1981), fire prevention (Spain 1986), the socio-economic environment of fire (Greece 1991), and on fire issues related to global change (Russian Federation 1996).

The international seminar on Forest, Fire, and Global Change was held in Shushenskoe, at the invitation of the government of the Russian Federation from 4 to 9 August 1996 (Goldammer 1996a). The seminar focus was on:

- Assessments of the extent of land areas affected by fire (forest and other land);
- Assessment of damages caused by wildfires;
- Clarification of the role of forest fires in:
  (a) land-use and land cover changes,
  (b) ecosystems and in maintaining biodiversity,
  (c) global carbon nutrient and water cycles,
  (d) forests affected by industrial and radionuclide pollution,
  (e) ecosystems affected by climate change.
- Forest fire management, fire intelligence and equipment;
- New spaceborne fire sensors.

The recommendations of the seminar, addressing fire in a globally changing environment are presented in Appendix II of this report.

A new Baltic Fire Focus: Contribution to BALTIC 21

The nations bordering the Baltic Basin are now showing increasing interest to promote fire management systems in forests and open landscapes. Such management systems must be based on advanced fire science and technology development. The need has been recognized to create a forum in the Central-Northern European region in which the fire problems are entirely different from the Mediterranean region. Consequently, the UN-FAO/ECE/ILO Team of Specialists on Forest Fire initiated the First Baltic Forest Fire Conference in May 1998 (Poland). The conference brought together scientists, managers and representatives from administrations of the host country (Poland), the Baltic States (Estonia, Latvia, Lithuania), Russia, the Nordic countries (Denmark, Finland, Norway, Sweden), and Germany.

The UN-FAO/ECE/ILO Team of Specialists on Forest Fire is promoting a cooperative approach of the nations bordering the Baltic Basin to share fire management expertise and resources (Goldammer 1998c). It is proposed to set up pan-Baltic programmes and exchange mechanisms encompassing fire research, fire management training, the use of prescribed fire (in forestry, nature conservation, and landscape management), and mutual fire emergency assistance. In its periodic working session, the Team decided to create a Baltic Subgroup of the UN-ECE/FAO/ILO fire team which is now chaired by Finland (H.Frelander). The Team has proposed a follow-up process to the first Baltic fire conference, starting with a pan-Baltic forest fire exercise BALTEX FIRE 2000 (the Baltic Exercise in Forest Fire Information and Resources Exchange) to be held in Finland in 2000 (Goldammer 1998d).

With the Baltic fire forum the UN-FAO/ECE/ILO Team of Specialists on Forest Fire intends to provide inputs from the community of fire scientists, managers, and policy makers into the BALTIC 21 Action Programme which is an initiative for the application of the Agenda 21 in the Baltic Sea Region. The recommendations of the Baltic fire conference are given in Annex III of this report.

A controversial debate was held on the applicability of prescribed fire in vegetation management. The discussion revealed that there was no common and equal state of knowledge in some Baltic countries on fire ecology and the use of prescribed fire in forest and landscape management and in nature conservation. It was recommended that the team of specialists should organize a seminar on fire ecology and prescribed burning in the countries neighbouring the Baltic Sea. In the sequence of planned pan-Baltic fire activities it seems reasonable to organize such seminar in the year 2001 (host: Sweden or Germany).

Joint ECE-ASEAN Initiatives

Transboundary pollution problems within the ECE region are exclusively linked to emissions from industry, traffic and other technogenic pollutants. In the region of the Association of South East Asian Nations (ASEAN) the transboundary pollution problems currently are dominated by smoke from vegetation burning. In May 1998 the Germany-Singapore Environmental Technology Agency (GSETA) organized the Asia-Pacific Regional Workshop on Transboundary Atmospheric Pollution in order to explore jointly whether the UN-ECE Convention in the abatement of long range transboundary air pollution would be applicable to the ASEAN region. While it became clear that the Convention is not directly applicable in ASEAN, it was recommended to continue to exchange expertise between the regions.

6.2 European Union

Specific schemes of the European Union aim to contribute to the efforts of the Members States to prevent forest fires. This scheme has been recently extended for a new period of five years. Although the main fire problem areas of Europe are in the Mediterranean region (see FAO Regional Mediterranean Study by Alexandrian [1998]) some basic information on the EU activities in fire protection must be mentioned because they are open to all EU member countries. The following summary is taken from Lemasson (1997).

The aim of the scheme, established in 1992 by the Council Regulation No.2158/92, is to contribute to the efforts of the Member States to prevent forest fires while at the same time ensuring that forestry measures financed by the Community in areas at risk from fire are consistent. The scheme also provides for the development of close cooperation between the Member States and the Commission of the European Communities within the Standing Forestry Committee, and for the creation of a Community system of information on forest fires to permit a better evaluation of measures in protecting forests against fire. After five years, the results of the implementation of this measure are the following:

Areas at fire risk

The Commission has approved the lists of areas of high and medium risk submitted by Portugal, Spain, France, Italy, Greece and Germany, making a total of 60 million hectares at risk from fire (nearly one half of the Community's forests), of which 60 percent is privately owned and 40 percent publicly owned.

Forest fire protection plans

The Commission has issued favourable opinions on 79 of the forest-fire protection plans submitted by the Member States. These plans, covering almost all the areas of high and medium risk, are particularly important tools, describing the measures taken by the Member States to protect their forests, thus giving improved guarantees of the success of forestry measures co-financed by the European Union.

Preventive measures

For the period 1992-96, 480 projects submitted by the Member States were approved, involving a total of ECU 63 million. Table 5 (Annex I) gives information about the categories of measures approved over the period concerned.

Quantitative details on a number of measures funded are as follows:

- 254 information campaigns, 11,437 ha of fire breaks, 13,534 ha of shrub clearance, 12,005 km of tracks, 1152 water supply points, 8,848 communication posts, 151 watch towers, 5,226 persons trained;
- 97 percent of the assistance was granted in areas of high risk and 3 percent in areas of medium risk;
- 5 percent of the assistance was granted for publicly owned forests, 10 percent for privately owned forests and 85 percent in mixed areas (public/private).

There seems to have been a fairly even regional distribution and this reflected the applications made by the Member States. Several studies into the causes of fires were carried out in Portugal, Spain, Greece and France (13 percent of the appropriations allocated for the Regulation). The projects are high added-value projects. The cost is small but their potential multiplier effect is considerable. A total of 48 percent of the appropriations were allocated to prevention infrastructures and 30 percent to monitoring operations. These two types of measure are of vital importance for increasing the effectiveness of fire-fighting measures once a fire breaks out.

In giving consideration to the whole system of protection, i.e. studies of the causes, improving preventive measures, monitoring and measures to fight fires, it is therefore essential to achieve a more effective use of national and Community funding.

The Community Information System on Forest Fires

Since 1990, the Commission and the Member States' experts on the Standing Forestry Committee requested an instrument at their disposal for ongoing monitoring and evaluation, comprizing information on forest fires and allowing a contribution to be made to the greater effectiveness of national and Community protective measures. A Community Information System on Forest Fires has therefore been created on the basis of information collected on every fire in national databases. The collection of data on forest fires (the common core) has become systematic with the adoption of a Commission Regulation in 1994. The Community Information System on Forest Fires currently covers 319 provinces/departments of Portugal, Spain, France, Italy, Germany and Greece. It contains information on 460,000 fires recorded between 1January 1985 and 31 December 1995 involving a total of six million hectares.

An analysis of the information collected therefore shows that the exchange of information, the evaluation of protection measures and risk periods, and the development of protection strategies can be achieved by implementing the Community information system, especially when extended over a longer period of time.

The following strategies could be developed:

- identification of the kind of priority protection measures to be reinforced (controlling the causes, prevention, surveillance or fire-fighting) on the basis of the characteristics of each region;
- strengthening inter-regional cooperation between geographically distant zones sharing the same forest fire characteristics;
- comparison of fire data with socio-economic information, such as rural out-migration, type of farming, tourism, etc., to make the analysis of the causes of fire more extensive;
- identification of periods of the year and hours of the day at which the risk of fire is at its greatest, allowing for a more effective use of surveillance and fire-fighting media, etc.

At an international level, the common core has also been used as the basis for the creation of a pan-European network of local databases, adopted at the 1990 ministerial conference in Strasbourg on the protection of forests in Europe. It also becomes a tool for international cooperation in the States of the Mediterranean basin.

Conclusions

The Community measures, complementing those of the Member States, have helped to improve measures to prevent forest fires and provide better guarantees and better direct Community funding for forest areas at risk from fire. At the end of the five years of application, nearly one half of Community forests have been classified as areas at risk from fires. The Member States concerned have submitted their forest-fire protection plans for the areas at risk. Assistance of ECU 63 million has been granted for more than 480 fire-prevention projects provided for in the protection plans. Community-wide cooperation has been established to analyze the causes of fires and to improve protection systems. The results of the Community system of information on forest fires show that this is an excellent tool for the evaluation of measures, which becomes also an interesting tool for international cooperation.

In February 1997, the Council has adopted the extension of this specific scheme for a new period of five years (1997-2001).

Training courses

Training and education are important parts of the accompanying measures of the European Union Research Programmes. Advanced study courses on selected relevant topics of the Environment and Climate RTD programme form an important part of training and education activities. They are solicited through a call for proposals launched annually and published in the Official Journal of the European Communities. The main objectives of those courses are:

- to further advance the education on specific topics at the forefront of scientific and technological development in Europe,
- to exploit the wide-ranging teaching capacities of European institutions for transnational education, and
- to improve communication between students and scientists at a European level.

In the field of forest fire protection an advanced course on Wildfire Management had been selected and was held in Athens (Greece) from 6 to 14 October 1997 (Eftichidis 1997). The course was focusing on:

- Behaviour and modelling,
- Prevention plan,
- Suppression and management,
- Fire effects,
- Management technology.

The course was attended by graduating, graduate or post-graduate students already involved in research in the area. The participants came mainly from Mediterranean Europe but also several participants were included from Central and Northern European countries.

6.3 Mutual border-crossing agreements

Baltic Region

An agreement signed on 9 August 1994 between the Republic of Finland and the Russian Federation was considered necessary in view of increasing trade and tourism between the two countries. This agreement concerns collaboration in the prevention of accidents, in information to the public and in reduction of the negative consequences in the case of emergencies. The agreement further includes procedures for bringing equipment and supplies across the border in case of a major accident. Mutual assistance in forest fire disasters is also part of the agreement. The agreement further recommends the two countries to intensify the organization of joint training in various fields of Fire and Rescue

(F&R) activities. As one of the first joint activities, a course on forest fire control was held between 10-13 October 1995 at the Evo Forest College (Paasiluoto and Jurvélius 1995).

The F&R Departments of the region have formed a special emergency unit in the case of needs outside of Finland. This Unit is called FINN-RESCUE-FORCES (FRF). Participating countries are: Estonia, Finland, Latvia, Russia, and Ukraine (Paasiluoto and Jurvélius 1995).

A fully automatic system has been developed to detect forest fires in the Baltic region using data from the meteorological NOAA satellites (Kelhä 1998). The system has been developed in Finland and tested in four experiments in 1994-1997 in Finland and its neighbouring countries Estonia, Latvia, Russian Karelia, Sweden and Norway. For each detected fire, a telefax including data on the location of the fire, the observation time and a map showing the location, is sent directly to the local fire authorities.

In summer 1997 the experimental area was enlarged from the original (approximately 1,150 km by 1,150 km) to cover the whole area of Norway, Sweden, Finland, Estonia, Latvia, and Russian Karelia, approximately 1,690 km by 1,690 km. Between 5 May and 15 September 1997 a total of 1,013 hot areas were detected, most of them in Russia and in Lithuania outside of the project area. 363 fires were located in the area of Norway, Sweden, Finland, Estonia, Latvia, and Russian Karelia and the corresponding alerts were sent automatically. Verifications were received from local authorities in 162 cases. 83 percent of the alerts were real fires, most of them forest fires. The amount of detected building fires was six. 17 percent of the alerts were false alerts or unknown fires.

Border cooperation between Poland and Germany

The cooperation in forest management and the solution of fire control issues in forest areas along the common borders began in the early 1970s (Wiler 1998). This cooperation was implemented directly by fire brigades and the Polish Forest Research Institute. In recent years, Euroregions were formed, involving working groups engaged in environmental issues, including forest fire control. The following position was adopted at the III Forum of Polish Border Regions which took place in Lagow, 25-26 January 1996:

> "The Euroregions jointly advocate and find well-advised the mutual support given to projects related to afforestation, fire control, protection against pests etc. Forestry problems are very essential for the whole of the Polish-German borderlands and their solution should be considered a priority because of the large degree of afforestation in these areas".

In compliance with the objectives of the UN Decade for Natural Hazard Reduction (IDNDR), the Republic of Poland and the Federal Republic of Germany signed in 1995 an agreement on mutual assistance in the course of catastrophes and natural disasters or other serious accidents. The states (Länder) of the Federal Republic of Germany and the borderland provinces of the Republic of Poland continue and expand all the possible forms of cooperation related to this issue.

Border-crossing fire suppression assistance was successfully conducted between the two countries in 1992 and 1994, accompanied by joint exercises and seminars.

The Joint Committee for Programming and Monitoring of Transboundary Cooperation between Poland and Germany approved the Project "EUROLAS - Forest Fire Control". EUROLAS funding was granted by the CEC through the funding mechanisms of PHARE (Poland and Hungary Assistance to the Reconstruction of the Economy).

People's Republic of China - Russian Federation - Mongolia

China and Russia have signed an agreement on cooperation in forest fire prevention and suppression. This agreement includes exchange of delegations of forest fire protection personnel (Davidenko 1997). The Chinese central government has allocated special funds to build fire breaks along the border with Russia and Mongolia (Wang Dong 1998).

6.4 International exchange programmes

International exchange programmes with countries outside the Europe and temperate boreal Asian region are conducted between the U.S.A., the Russian Federation, Norway, and Germany.

After the "Wildland Fire Exchange 1997" the Bureau of Land Management (BLM) in the United States Department of the Interior strengthened its multilateral partnerships (Vickery 1997).

On 9 June 1997 a Letter of Common Understanding between the Bureau of Land Management and the Russian National Aerial Forest Fire Protection Service Avialesookhrana was signed (Rosenkrance and Andreev 1997). The letter envisages cooperation in sharing information, fire suppression technologies, personnel, training, and mutual aid. The programme became fully operational in mutual field exchanges during the 1998 forest fire season (Vickery 1998).

The BLM and Norway agreed to exchange fire management personnel (Vickery 1998). A joint fire research programme is under way between the BLM and the German Max Planck Institute for Chemistry, Fire Ecology Research Group, since 1998.

Since 1997 the BLM is financial co-sponsor of the UN-FAO/ECE International Forest Fire News (Goldammer 1998a).

An exchange programme between fire management personnel and the U.S. Forest Service and the Russian Federal Forest Service is under way since the mid-1990s.

6.5 Overseas technical cooperation programmes

In the recent years an increase of bi- and multilateral technical development projects is noted in which expertise in fire science, management and fire policy development from Europe is transferred to developing countries. Some examples may underscore the importance and range of such projects:

- German Agency for Technical Cooperation GTZ: Integrated (Forest) Fire Management Projects in Indonesia and Mongolia. Fire components in numerous bilateral forestry projects, e.g. Algeria, Argentina, and Sudan.
- Namibia-Finland Forestry Programme conducted by FTP: Integrated Forest Fire Management Project (Caprivi). Numerous fire management training programmes have been conducted world-wide.
- The Natural Resources Institute in the United Kingdom: Installation of satellite fire detection and monitoring technologies in numerous developing countries
- European Union: Forest Fire Prevention and Control Project in Indonesia.

It must be noted that this is not a complete list of technology transfer projects. An increase of technical cooperation projects is expected in future. It shows that problems related to management of wildfires and land-use fires in the developing countries have been identified.

7. CONCLUSIONS

Causes and impacts of fire in the temperate-boreal Asian region are multi-facetted due to rich cultural diversity and a broad range of socio-economic and environmental conditions. Thus, it is prohibitive to draw any generalized conclusion or develop recommendations which would lead to unified responses or to generally valid fire management strategies and public policies.

However, the country cases which were reported in detail reveal that appropriate public policy responses to wildfires in forest and other vegetation, e.g. steppe fires, mainly address people as the most important fire source. Prevention has been recognized most important in designing policies and fire management strategies.

Main fire problems have been identified (1) on terrain affected by industrial pollution or radioactive contamination, (2) in sparsely populated boreal forests of central Asia where fire management is limited by the lack of fire management resources, and (3) in regions where increasing burning activities lead to severe degradation in mountain forests, steppe, and steppe-forest ecotones in the transition zone between the tropics/subtropics and the boreal zone at the southern edge of the region.

New challenges in fire management are arising from the debate to use prescribed burning in forest fire management in Russia and in nature conservation and landscape management in Western Europe. Advanced technology developments are under way, e.g. spaceborne remote sensing of fire and fire impacts.

International cooperation in the field of fire management is increasing, e.g. transboundary mutual assistance agreements for wildfire disaster situations, exchange of fire management expertise, and international fire research programmes, both inside the region and in exchange with other regions.

Although the magnitude of the fire problem in the Baltic region is smaller than in Mediterranean Europe or elsewhere in the world, new initiatives in international collaboration in fire management are being established.

Public policies at national and international levels increasingly build on synergistic efforts, especially within the European Community and the ECE region.

It could be concluded that, at political level, both internationally and nationally, fire management as part of sustainable forest management has been advanced. However, implementation of fire management still calls for further actions.

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ANNEX I - FIRE STATISTICS

Table1. Forest fire statistics for Europe (without Southern Europe) and temperate-boreal Asia for the period 1980-1996. Note: Data on fire causes do not always refer to the period indicated. Sources: ECE/FAO and country reports contained in the pages of International Forest Fire News (IFFN) and the database of the Global Fire Monitoring Centre (GFMC)

Country	*Period*	*Average Annual Area Burned (ha)*	*Average No. of Fires*	*Causes of fires (%)*		*Total number of fires by known causes*	*Thereof caused by (%)*		
				Unknown	*Known*		*Neglicence*	*Arson*	*Lightning*
Afghanistan	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"
Austria	1980-1996	104	150	22	78	1,705	63	8	29
Azerbaijan	1991-1994	39	5	"~"	"~"	"~"	"~"	"~"	"~"
Belarus	1990-1996	5,003	3,597	22	78	15,828	100	0	0
Belgium	1980-1996	152	68	31	69	613	80	17	2
Bulgaria	1980-1996	3,009	245	53	47	1,867	81	15	4
Inner Mongolia (PR China)	1986-1996	31,022	75	"~"	"~"	"~"	"~"	"~"	"~"
Heilongjiang Province (PR China)	1986-1996	94,198	38	"~"	"~"	"~"	"~"	"~"	"~"
Czech Republic *	1980-1996	512	943	19	81	7,703	96	2	2
Denmark	1980-1996	38	10	36	64	65	83	14	3
Estonia	1990-1996	327	139	16	84	1,249	83	15	2
Finland	1980-1996	504	608	20	80	5,340	76	4	20
Georgia	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"
Germany	1980-1996	1,265	1,612	40	60	12,523	63	33	4
Hungary	1980-1994	1,066	266	19	81	512	99	1	0
Iceland	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"
Ireland	1980-1994	619	465	85	15	632	88	12	0
Japan	1981-1989	3,783	3,695	"~"	"~"	"~"	"~"	"~"	"~"
Kazakhstan	1994-1996	12,753	1,068	20	80	2,579	100	0	0
Korea (South)	1987-1991	665	172	"~"	"~"	"~"	"~"	"~"	"~"
Kyrgyzstan	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"
Latvia	1991-1996	1,295	1,001	0	100	5,006	83	17	1
Lithuania	1984-1996	202	669	6	94	3,536	80	19	1
Luxembourg	1980-1996	4	9	36	64	76	91	8	1

Country	*Period*	*Average Annual Area*	*Average No. of Fires*	*Causes of fires (%)*		*Total number of fires by known*	*Thereof caused by (%)*		
		Burned (ha)		*Unknown*	*Known*	*causes*	*Neglicence*	*Arson*	*Lightning*
Republic Of Moldovia	1991-1995	24	14	0	100	51	100	0	0
Mongolia **	1980-1996	337,347	151	0	0		0	0	0
Netherlands	1980-1996	172	114	57	43	795	34	62	4
Norway	1980-1996	961	487	27	73	3,926	74	6	21
Poland	1980-1996	5,170	3,525	29	71	42,829	69	30	1
Pakistan	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"
Romania	1980-1996	244	78	27	73	729	90	6	3
Russian Federation	1980-1996	920,713	17,499	42	58	135,283	79	0	21
Slovakia	1994-1996	134	488	7	93	1,197	99	0	1
Slovenia	1991-1996	643	89	40	60	279	75	11	14
Sweden	1992-1996	2,498	3,280	40	60	5,620	77	4	18
Switzerland	1980-1996	407	108	31	69	1,233	81	9	10
Tajikistan	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"
Turkmenistan	1994-1996	522	9	4	96	1,238	80	20	0
Ukraine	1990-1996	21,605	4,617	0	100	30,016	100	0	0
United Kingdom	1980-1995	428	532	26	74	3,923	47	52	0
Uzbekistan	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"	"~"
Yugoslavia	1992-1996	2,985	"~"	"~"	"~"	"~"	"~"	"~"	"~"

* = Czechosolovakia '1980-1994' ** = Area burned in Mongolia 1996-98: 9,000,000 ha; **"~" =** no data available

Table 2. Forest fire statistics for the Russian Federation 1988-1997. Source: Roslesk hoz (1998)

Indices	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*
Forest land burnt by fires (in 1000 ha)	786.9	1,627.9	1,366.3	682.0	691.5	748.6	536.8	360,1	1,853.5	726.7
including crown fires	143.8	247.4	23.9	116.0	56.0	104.1	61.4	23,6	204.9	127.2
Non forested land burned (in 1000 ha)	224.4	412.4	303.3	444.1	451.3	451.8	186.3	102,7	458.4	257.0
Total number of forest fires	18,573	21,934	17,672	17,965	25,777	18,428	20,287	25,951	32,833	31,300
caused by:										
agricultural burnings	1,046	1,067	1,313	1,441	1,204	1,094	1,387	1,140	2,924	2,530
logging operations	586	400	209	274	377	219	249	192	335	138
investigation and research groups	222	109	69	41	41	47	36	30	10	16
other organizations	1,273	1,086	728	990	643	568	497	413	729	564
local population	11,241	13,265	10,710	11,083	20,608	13,010	15,467	21,034	25,682	26,074
lightning	3,661	5,273	3,809	3,620	2,523	2,804	1,957	2,653	2,290	1,538
other reasons	544	734	834	516	381	686	694	489	863	440
Total loss caused do forestry by fires in million rubles (without counting inflation)	88.6	201.8	111.6	95.6	81.5	24,225.7	94,952	283,524.1	1,456,100.3	1,301,181.2
Burned and damaged:										
- standing forest (million m^3)	37.0	65.2	23.4	10.0	11.1	22.3	10.2	8.5	55.9	21.8
- logged wood production (1000 m^3)	83.7	87.4	87.6	5.1	127.5	35.6	12.7	3.5	6.1	15.1

Table 3. Causes of fire starts in Bhutan. Source: Chhetri (1994)

Cause	*%*
Debris burning (i.e. escaping from field)	40
Cattle grazing (burning for new grass)	30
Uncontrolled camp fire, cooking fire, Warming fire and road maintenance	25
Smokers	5
Human-made fires	100

Table 4. National expenditures for fire management in the People's Republic of China in 1997. Source: Wang Dong 1998)

Year 1997 Total(RMB)	*Aerial fire fighting*	*Fire breaks*	*Fire-fighting Crews*	*Facilities*
185,000,000	20,000,000	10,000,000	80,000,000	55,000,000

Table 5. Categories of fire management measures approved for Member States of the European Union over the period 1992-96. Source: Lemasson (1997)

Measures	*Assistance granted (x million ECU)*	*%*
Information campaigns and projects to combat causes	8.0	13.0
Prevention projects	30.3	48.0
Monitoring projects	18.6	30.0
Information-system projects, etc	6.0	9.0
Total	62.9	100

ANNEX II - CONCLUSIONS AND RECOMMENDATIONS OF THE SEMINAR ON "FOREST, FIRE, AND GLOBAL CHANGE", SHUSHENSKOE (RUSSIAN FEDERATION), 4-9 AUGUST 1996. EXTRACTS FROM THE CONFERENCE REPORT (ECE/FAO/ILO 1996)

1. General statement on the role of fire in the global environment

I. Both anthropogenic and natural fires are an important phenomenon in all vegetation zones of the globe. Their impacts, however, are not uniform. Fires may lead to the temporary damage of forest ecosystems, to long-term site degradation and to alteration of hydrological regimes which may have detrimental impacts on economies, human health and safety.

II. As a consequence of global population growth and land-use changes, the cumulative effects of anthropogenic disturbances, and the over-use of vegetation resources, many forest types, which over evolutionary time periods became adapted to fire, are now becoming more vulnerable to fire.

III. On the other hand, in many vegetation types, of the temperate, boreal and tropical ecosystems, fire plays a central role in maintaining the natural dynamics, biodiversity, carrying capacity and productivity of these ecosystems. In many parts of the world sustainable forestry and agricultural practices as well as pastoralism depend on the use of fire.

IV. Vegetation fires produce gaseous and particle emissions that have significant impacts on the composition and functioning of the global atmosphere. These emissions interact with those from fossil fuel burning and other technological sources which are the major cause for anthropogenic climate forcing.

V. Global climate change is expected to affect fire regimes and lead to an increase of occurrence and destructiveness of wildfires, particularly in the boreal regions of continental North America and Eurasia.

VI. Fire control has been the traditional fire policy in many parts of the world. An increasing number of countries have adopted fire management policies instead, in order to maintain the function of fire in removing the accumulation of fuel loads that would otherwise lead to damaging wildfires, and in order to arrest succession at stages that are more productive to humans than are forests and brushlands that would predominate in the absence of fire.

VII. In many countries, however, inappropriate choices are made - often because the responsible authorities and managers are not provided adequately with basic fire information, training, technologies and infrastructures. Large-scale wildfire disasters which occurred in the past years, especially in the less developed countries, may have been less severe and extended if national fire management capabilities had been developed and assistance through the international community provided.

VIII. Although the global fire science community has made considerable progress to investigate global impacts of fire, using available and developing new technologies, no international mechanisms exist for systematically collecting, evaluating and sharing global fire information. There are also no established mechanisms at the international level to provide fire disaster management, support and relief.

IX. Therefore the participants of the FAO/ECE/ILO Seminar on "Forest, Fire and Global Change" adopted the following conclusions and recommendations:

A. Conclusions

1. The economic and ecological impact of wildland fire at local to global levels has been demonstrated at this seminar. The possibility of major world disasters, such as the transfer of radioactive materials in wildland fire smoke, and the substantial loss of human life in recent fires, has been scientifically documented. The lack of, and need for, a global statistical fire database, by which the economic and ecological impact of fires could be spatially and temporally quantified, was identified. Such a reliable database is essential, under current global change conditions, to serve sustainable development and the

urgent needs of fire management agencies, policy makers, international initiatives, and the global modelling community.

2. Similarities in wildfire problems throughout the world are evident, particularly increasing fire incidence and impact coupled with declining financial resources for fire management, underlying the urgent need to coordinate resources at the international/global level in order to deal effectively with impending major wildland fire disasters.

3. As climate change is a virtual reality, with predicted significant impacts at northern latitudes, seminar participants recognize that boreal and temperate zone fire activity will increase significantly in the future, with resulting impacts on biodiversity, forest age-class distribution, forest migration, sustainability, and the terrestrial carbon budget. It is essential that future fire regimes in these regions be accurately predicted, so informed fire management decisions can be made.

B. Recommendations

1. Quantifiable information on the spatial and temporal distribution of global vegetation fires is urgently needed relative to both global change and disaster management issues. Considering the recent various initiatives of the UN system in favour of global environmental protection and sustainable development, the ECE/FAO/ILO Seminar on Forest, Fire and Global Change strongly urges the formation of a dedicated United Nations unit specifically designed to use the most modern means available to develop a global fire inventory, producing a first-order product in the very near future, and subsequently improving this product over the next decade. This fire inventory data will provide the basic inputs into the development of a Global Vegetation Fire Information System.

The FAO should take the initiative and coordinate a forum with other UN and non-UN organizations working in this field, e.g. various scientific activities of the International Geosphere-Biosphere Programme (IGBP), to ensure the realization of this recommendation.

The information given in the Annexes I to III (Draft Proposals for the Development of a Standardized Fire Inventory System) to these recommendations describe the information requirements (classes of information, information use), the establishment of mechanisms to collect and distribute fire inventory data on a global scale.

2. The development of a satellite dedicated to quantifying the geographical extent and environmental impact of vegetation fires is strongly supported. Such an initiative is currently being evaluated by NASA, and this seminar strongly recommends that this and similar initiatives (e.g., NOMOS sensor on MIR space station) be encouraged and supported.

3. A timely process to gather and share information on ongoing wildfire situations across the globe is required. The creation of a WWW Home Page to handle this information flow is recommended. This could be coordinated with an ongoing G7 initiative, the Global Emergency Management Information Network Initiative (GEMINI), which includes a proposal to develop a Global Fire Information Network using the World Wide Web.

4. Mechanisms should be established that promote community self reliance for mitigating wildfire damages and would also permit rapid and effective resource-sharing between countries as wildfire disasters develop. Since the United Nations Disaster Relief Organization (UNDRO) is an organization recognized and established to coordinate and respond to emergency situations, including wildfires, it is recommended to entrust this organization, in collaboration with the United Nations Educational, Scientific and Cultural Organization (UNESCO), to prepare the necessary steps[14]. The measures taken should follow the objectives and principles of the International Decade for Natural Disaster Reduction (IDNDR).

[14] UNDRO does not exist any longer. Its tasks were taken over by the UN Department of Humanitarian Affairs (DHA) which is under reorganization at the time of writing this report. DHA's Relief Coordination Branch, through its Joint UNEP/DHA Environment Unit, operates through United Nations Disaster Assessment and Coordination Teams (UNDAC) which are dispatched to disaster regions.

5. The unprecedented threat of consequences of fires burning in radioactively contaminated vegetation and the lack of experience and technologies of radioactive fire management requires a special, internationally concerted research, prevention and control programme. Such programme should be implemented under the auspices of the FAO/ECE/ILO.

6. The Wildland Fire 97 International Conference in Canada should be used as a forum to further promote the recommendations of this seminar. This can be realised through co-sponsorship of this conference by the FAO, UNDRO, UNESCO, IDNDR and the ECE/FAO/ILO Team of Specialists on Forest Fire.

The Annexes to the recommendations of the conference give details on proposed standardized fire inventory system. They are published in the pages 45-47 of No. 15 of International Forest Fire News.

Annex I: Draft Proposals for the Development of a Standardized Fire Inventory System
Annex II: Information Requirements
Annex III: Establishment of Mechanisms to Collect and Distribute Global Fire Data

ANNEX III - FIRST BALTIC CONFERENCE ON FOREST FIRE, 5-8 MAY 1998, RADOM-KATOWICE, POLAND

General recommendations

1. Forest fires constitute one of the main threats to sustainability of forest ecosystems and the continuity of their multifunctional role.

2. Countries bordering the Baltic Sea (Denmark, Estonia, Finland, Germany, Lithuania, Latvia, Norway, Poland, Russia and Sweden) hereinafter referred to as Baltic States, are one of the regions in Europe with high fire risk and significant level of environmental contamination. Forests of that region are very valuable for nature as well as in economic and social terms. Great majority of forest fires break out as a result of direct or indirect human activities. Due to global environmental changes and ever increasing pressure imposed on the forest by the societies we should expect further increase of fire risk in that region.

3. To solve current and future problems regarding forest fire protection it is necessary constantly to enhance and standardize forecasting, detection and extinguishing activities and improve legal regulations.

4. The prerequisite for the effectiveness of those activities is development of comprehensive cooperation in the field of science, technology and organizational aspects with the contribution from the public on international, national and local level.

5. The Conference recognizes that forests in the Baltic States should be managed in compliance with biodiversity principles. Considering the above factors, we find it necessary to create an international programme for fire protection in the Baltic states. Protection of woodlands against elemental disasters should be included in cooperation agreements especially in transboundary areas.

6. The Conference recommends that the problem of forest fires should be handled in compliance with the Action Plan Baltic 21, regional activities of the International Decade for Natural Disaster Reduction (IDNDR), as well as other programmes.

Specific recommendations

I. Prevention

1. Forest management should encompass the need to strengthen natural resistance of forests to damaging forces, including fires. The tasks to be undertaken in this field are in particular: adaptation of tree stands composition to habitat conditions, protection of biodiversity, improvement of water retaining capacity in woodlands and enhancement of infrastructure.

2. Prevention activities should be particularly intensified in highly contaminated areas, especially with radioactive substances, where, besides economic losses, fires cause re-occurrence of contamination.

3. Fire protection problems should always be considered with regard to drafting spatial management plans which include, among others, increase of afforestation rate, spatial order in woodlands and development of infrastructure.

4. It is necessary to develop cooperation to enhance training programmes for forest and fire control services.

5. It is recommended to expand further informational and promotional activities to raise social awareness, in particular on the local level.

II. Forecasting, detection and extinguishing activities

1. Fire protection in woodlands should constitute an integral part of national rescue programmes.

2. With regard to exchange of information and resources among the Baltic States we recommend to develop Baltic programs and exchange mechanisms which would include scientific research connected with fires, impact of global environmental changes and use prescribed fire (in forestry, nature conservation and landscape management), training on fire protection and mutual assistance.

3. It is necessary to undertake steps to improve legal regulations which refer to the establishment of forest rescue systems and financing methods as well as oblige businesses imposing fire risk for woodlands to protect them and remove damages.

4. We should aim at enhancing transborder cooperation in the field of early warning, monitoring, detection, fire suppression, exchange of information and undertaking joint initiatives.

5. For the purpose of fire control all forests should receive the same treatment regardless of their ownership structure, in particular in those countries in which forests are re-privatized.

6. We should improve telecommunication systems and ensure their compatibility and reliability, especially in transboundary areas.

7. We should undertake initiatives to remove barriers among Baltic States with custom reliefs and subsidies which enable transfer of technical resources used in forest protection.

III. Post-fire activities

1. Re-cultivation of burned forests should be treated as a separate problem in science and in forest practice and be a subject of international exchange in this field.

2. Baltic states should render mutual assistance in the area of availing technical resources and consultancy.

3. It is recommended to develop an advanced system of collecting fire statistic at international level, particularly including damages of forest stands affected by fire.

IV. Within further development of international cooperation in the field of fire control among the Baltic States we recommend to:

1. Initiate a tradition to hold biannual working meetings of representatives from Baltic States.

2. Unify systematic legal solutions regarding fire prevention in Baltic States.

ANNEX IV - BOREAL FOREST FIRES, ATMOSPHERE AND CLIMATE

1. Fire - a natural cyclic source of greenhouse gases

Natural fire intervals in boreal forest ecosystems range between several years, decades, and centuries, and are an important factor in maintaining a dynamic equilibrium between vegetation and climate. In cyclic pulses boreal forest fires are releasing carbon in the form of the radiatively active trace gases ("greenhouse gases"), e.g. carbon dioxide (CO_2), carbon monoxide (CO), or methane (CH_4).

Theoretically there are no fire-induced net fluxes of carbon to the atmosphere in the present interglacial as long as the carbon released by fire will be sequestered by new growth, at varying time scales. However, past climate fluctuations, as established by dendrochronological and densitometric analyzes in the boreal zone, suggest that decadal and centennial periods warmer or cooler than the long-term average must have changed carbon fluxes periodically.

2. Characteristics of gaseous emissions

Certain radiatively active trace gases, e.g. incompletely oxidized reactive combustion products such as carbon monoxide (CO) and methane (CH_4) are emitted from boreal fires in a larger proportion (emission ratio as compared to other ecosystems, e.g. the tropical and subtropical savannas, which represent the most extended fire landscapes of the globe. A large fire experiment conducted in Krasnoyarsk Region in 1993 revealed that the quantities of chemically/photochemically active combustion products produced per unit of fuel burned in boreal fires are consistently higher than those resulting from fires in other major global ecosystems (FIRESCAN Science Team 1996, Cofer *et al.* 1996 a,b, 1998).

Some boreal fires are characterized by specific behaviour, e.g. high-intensity stand replacement fires producing strong convective activity and injecting smoke emissions into higher altitudes of the troposphere from where they even might be transported into the stratosphere. One of the major objectives of the large Siberian fire experiment in 1993 was the sampling of emissions for specific analyzes of methyl bromide (CH_3Br) and methyl chloride (CH_3Cl). Decay products of these compounds are, like the longer-lived chloro-fluoro-carbons (CFCs), known to induce depletion of stratospheric ozone. It should be noted here that bromine is much more efficient on a per atom basis than chlorine in breaking down ozone (by a factor of about 40; WMO 1992). The emission ratios of CH_3Br and CH_3Cl measured in the Bor Forest Island Fire were much higher than those found in other vegetation fires (Manö and Andreae 1994).

3. Fire - an atmospheric carbon sink?

A close look at soils and organic layers in boreal forests and other organic terrain (raw humus, peat) reveal the abundance of charcoal. Most of the charcoal basically consists of black carbon (BC, also called elemental carbon) which is formed during pyrolysis. BC is biologically non-degradable, chemically inert and not available for uptake by plants. In addition to the deposition of larger BC-containing charcoal particles, BC is also emitted in small fractions and transported as aerosol; quantitative data are not yet available.

In general, most boreal forest fires do not destabilize the ecosystem (e.g. towards a lower phytomass productivity or lower biomass carrying capacity) in the long term, regardless of the sustainable fire return interval. Thus, the formation of BC represents a net atmospheric carbon sink because the cycling uptake of atmospheric carbon (through photosynthesis) remains constant, and the deposition of ground and soil charcoal as well as the aerosol BC deposited in sites distant from the fire are not available for plant life and are not subjected to degradation.

The fire science community is still in the beginning of quantifying this global carbon sink through BC formation and deposition, and much work needs to be done to collect pan-boreal charcoal storage data. However, the present state of knowledge allows to conclude that fires in "sustainable fire ecosystems" in general, and boreal fires in particular, may help to explain at least a part of the "missing sink" for carbon (Kuhlbusch and Crutzen 1995, Kuhlbusch *et al.* 1996).

4. Global climate change: Boreal forest in possible transition from carbon sink to carbon source

4.1 Present global boreal carbon storage

Estimates of carbon stored at present in living and dead plant biomass (without soil organic matter) above- and below-ground in the global boreal forest area range between 66 and 98 billion tons (US Department of Energy 1983, Apps *et al.* 1993). Additional large amounts of carbon are stored in the boreal forest soils (ca. 200 billion tons) and in the boreal peatlands (ca. 420 billion tons).

4.2 Greenhouse climate, global warming, and vegetation changes

Expected global warming over the next 30-50 years, as projected by GCMs for a doubled carbon dioxide equivalent greenhouse gas forcing scenario ("2xCO_2 climate"), will be most evident in the northern circumpolar regions. According to these models it is assumed that zonal warming may lead to the shift of vegetation belts, e.g. causing the boreal forest to shift north. The shift of ecosystems is projected to have a considerable impact on the distribution of phytomass. Zonal warming will also affect the balance of the pan-boreal carbon pool. The processes involved, however, are rather complex and should not be generalized.

A recently developed model shows that in a 2xCO_2 climate 72 percent of today's boreal forest area would be covered by temperate mixed-deciduous forests (Smith *et al.* 1992). Based on the assumption that mixed-deciduous forests in the region will have ca. 43 percent more carbon in living biomass than do *taiga* forests (Kolchugina and Vinson 1993), the total carbon in living biomass in the region occupied by today's boreal forests would increase by approximately one-third over the long term (Kasischke *et al.* 1995).

Climate-induced changes in carbon stored in the ground layer, however, are different. The predicted increase of average temperatures in the boreal zone will increase the decomposition rate of dead and dissolved organic matter in the ground and mineral soil layers, thus reducing the amounts of carbon stored.

4.3 Climate change and fire regimes

The prediction of increasing occurrence of extreme droughts in a 2xCO_2 climate indicates that fire regimes will undergo considerable changes (Flannigan and van Wagner 1991, Stocks 1993, Wein and de Groot 1995, Stocks *et al.* 1996b, Fosberg *et al.* 1996). An increase in the length of the fire season will lead to a higher occurrence of large, high-intensity wildfires (Wotton and Flannigan 1993). The GCM of the Canadian Climate Centre projects a global mean temperature increase of 3.5°C for a 2xCO_2 climate scenario. Regional warming during winter will be as follows: Continental regions of Siberia and Canada: + 6-8°C, Alaska + 2-4°C, and Scandinavia little change. Spring temperatures are projected to be uniformly 2-6°C warmer and spring precipitation 8-30 percent greater than at present. Early fire season temperature changes show up to +6°C in western Siberia, with precipitation greater than at present. While mid and late fire season temperatures will be nearly the same as present, the precipitation is projected to decrease. Canadian scientists predict an increase of the length of the fire season in Canada by an average of ca. 30 days in a 2xCO_2 climate, resulting in an additional 20 percent increase in the annual area burned in Canadian boreal forests.

Most critical will be the impact of increased fire activity on the continental regions of Eastern Siberia where the presence of extended larch forests, e.g. in Yakutia, is dependant on water supply from continuous permafrost during the summer drought. Forest fires are known to affect the active layer and to lead to thermokarst formation and the loss of forest cover. In brief : It is expected that increasing fire activity will result in large-scale loss of forests in Eastern Siberia (Goldammer 1998b).

Comments on the Situation in Europe and Boreal/Temperate Asia

Eduard Davidenko[15]

In spite of continuous modernization of the means and methods of fighting forest fires, the number of fires is on the increase and the damage caused to ecology and economy as a whole is very high. Annually, fires in different parts of the world create extreme situations which are transformed into disasters. We have fresh examples such as those in Russia presented yesterday by Mr. Harcharik (1998, Far East and Sakhalin, where in the village of "Gorki" 146 houses were burnt, 680 people were left without a roof over their heads and 3 villagers were killed).

In 1950, the number of forest fires in the world was calculated to be about 200,000. Recently, according to official statistics about 400,000 fires are recorded annually. Even in Western Europe, the number of fires has increased by 40 percent in comparison with 1980. In Russia, the incidence of fires has increased by 20 percent in the last 20 years.

Specialists point out that forest fires are becoming much more destructive and that there is a need to consider how efforts may be combined at international level to manage fires more effectively. In 1995, the FAO/ECE Team of Specialists on Forest Fire drew attention to the necessity of creating an international forest fire-fighting centre to deal with complicated forest fire situations around the world. In my opinion, this idea deserves attention and discussion. However, thus far we have not heard any comments, assessment or practical suggestions on this idea. Perhaps it is time to convene an international forum to discuss the possibility of material ng this idea in detail.

Throughout the world fire-fighting involves large numbers of people, many of whom do not have the necessary skills or experience, and lead to huge losses of financial and technical resources. A great deal of work has been done by speakers in preparing their regional presentations. We have had an opportunity to be acquainted with the deep comprehensive analysis of the situation in the whole world. But very few suggestions have been made as to what should be done? The number of fires continue to rise as do the damage and losses caused by them. The forecasts are not favourable for humankind. The costs of fire-fighting activities go on increasing.

I consider that, among other measures, the creation of well trained international forces would be of great value. For example, a UN force of about 100 well trained professional fire-fighters equipped with state-of-the-art tools could be dispatched rapidly to crisis areas by special aircraft.

The Russian Federation has an enormous forest area. The boreal forests are the most prone to fires. The lack of roads in inaccessible *taiga* areas has conditioned the use and development of aerial (aviation) detection and suppression of forest fires. At present, aerial protection of forests from fires in Russia is carried out on the area of 685.3 million ha or 47.3 percent the whole forest area. The reindeer pastures are protected by aviation on 83.0 million ha. On 10.4 percent of forest land we have only aerial patrols without making use of active means. 25.8 percent of Russian forests are unprotected they are being monitored by satellites.

The aerial forest fire protection organization, or *Avialesookhrana* as we call it, includes 20 air bases and 2 air wings. In order to fulfil the work for this year, it was planned to use about 400 planes and helicopters, 3,700 regular *rappellers* and smoke-jumpers. Due to the well known crisis in the Russian economy, many subdivisions of the civil aviation organization became incapable of maintaining light aerial surveillance because of its unprofitability. That is why we had some problems in attracting light planes and helicopters for forest protection. *Avialesookhrana* had to create its own air subdivisions. At present it owns 73 aircraft.

[15] Aerial Forest Fires Centre, Pushkino, Russian Federation.

The uncertain character of the origin and spread of forest fires conditions the behaviour of fires in different forest areas and in different seasons. 80–90 percent of the forest area burnt annually is in 3-4 regions of Russia with unfavourable dry weather conditions. The share of forest territory burnt by fire in the boreal zone is, as a rule, 70 percent of the total area and 20–25 percent of the number of fires.

During last decade, a rising trend was observed in the number of forest fires in the aviation protected zone. The growth in the number of forest fires escaping control (>200 ha) is also evident. The number and area of forest fires for the period 1978-1997 on the territory protected by aviation are shown below.

Years	*Number of fires*	*Burnt forest area 1000 ha*
1	*2*	*3*
Average for a year: 1978-1979	13,297	208,3
1980	13,280	161.20
1981	14,821	206.51
1982	13,165	325.30
1983	10,141	151.45
1984	12,953	309.90
1985	10,200	483.05
1986	14,272	696.03
1987	11,304	502.68
1988	16,432	732.50
1989	18,751	1,425.25
1990	14,867	1,351.72
1991	14,181	661.1
1992	19,600	545.1
1993	14,509	719.4
1994	14,796	488.4
1995	17,681	322.8
1996	22,623	1,789.5
1997	20,134	640

On the whole, statistical data indicate that the increase in the number of fires in Russia in the regions of aerial protection is about 20 percent in the period 1988-1997 against the period 1978–1987. Large fires during the three years 1995–1997 increased by up to 3.4 percent of the total number of fires, in comparison with the annual average of 1.3 percent during the period 1971–1983.

The causes of forest fire occurrence, on the basis of many years' data, are as follows:

About
50 percent - local population
19 percent - lightning
5 percent - agricultural burning
5 percent - logging operations
3 percent - railway, field expeditions
18 percent - unknown.

In some regions of Siberia and the Far East, the share of forest fires caused by lightning reaches 70 percent. These are, as a rule, distant and inaccessible places where fire-fighting is very complicated and very costly. The deepening economic crisis in Russia impacts very unfavourably on the aerial protection of forests. The intensity of aerial patrols have decreased by as much as 5 times. The main personnel (smoke-jumpers and *rappallers*) was reduced by more than two times. The material supply of the aviation service is now at an extremely low level, the movement of forces and means having been reduced by many times. And all this has not taken long to affect the quality of aerial forest fire protection. As a result, a considerable number of forest fires go out of control and spread over large areas (80 percent).

Recently, fire-fighting technology making use of aircraft has been introduced. Benefiting from the long practical experience of the employment of airtankers in the USA and Canada, we in Russia have worked out, and are using, various modifications of aeroplanes and helicopters equipped with systems for water drops on fire. Aircraft deployed are: first, a light aeroplane (AN - 2P) with a water (retardant) carrying capacity of 1,200 litres and then an amphibian aircraft (BE - 12P) with a capacity of 6,000 litres, an aeroplane (AN – 26P) with a carrying capacity of 4,000 litres and, finally, a heavy strategic aeroplane (IL – 76P) with a capacity of 42 tons of retardant.

The development, in accordance with the technical requirements of *Avialesookhrana,* of the system for retardant drops VSU – 5 with a capacity of up to 4,000 litres for helicopter MI-8, is considered a great success. The system was designed and produced at a high scientific and technical level. In some respects, it surpasses the well known Canadian “Bambi Bucket”. One indubitable achievement in solving the problem of fire suppression from the air is the joint development of retardants on the basis of polymeric thickeners by *Avialesookhrana* and branch research institutes (SPBNIILH and VNIIH leshoz). The polymeric thickeners provide the necessary parameters of viscosity for concentration 0.05–0.2 percent. These are polyacrylamides, plastigel and polyethylonoxide. Laboratory studies and field testing in 1997 showed that polymer-based retardants help increase the length of fire – break belts by 2-3 times in comparison with pure water drops, and this is of practical interest. We are planning to carry out a practical check in 1999 on the efficacy of the new retardants on real forest fires. It is very important to take into account the fact that the polymers mentioned above are used on an industrial scale and are safe for flora and fauna.

Avialesookhrana has accumulated a positive experience in the application of modern information technologies for support of fire-fighting activities implemented by the federal and regional services.

Avialesookhrana, jointly with the International Forest Institute and Institute of Space Investigations started setting up in 1995 the geo-information system of forest fire monitoring (GIS MLP) that uses the data from ground, aviation and space sources. And the space means of observation are not considered as an alternative but as a useful addition to aviation and ground means for forest fires monitoring. The geo-information system that is under development will have to provide the conjugate processing of cartographic information and data of remote sensing, special recording of lightning discharges, operative registration of forest fires and weather conditions. The system must function in the interests of both aviation and ground forest protection services.

During the 1997 fire season, special software was developed and used to make maps reflecting the fire situation in different regions in Russia. The software is based on daily operative data on forest fires and weather conditions. The information on current weather conditions and forecast over the whole forest area is received every day from the Hydromet Centre of the Russian Federation. The space imageries of the total forest territory and areas of large fire occurrences come from the receiving stations installed in Moscow and Siberia (Irkutsk) through Institute of Space Investigations. The processed results of the information received are given to the users of the INTERNET-server of *Avialesookhrana* and includes the following:

- daily reports on forest fires and suppression of large forest fires;
- maps of fire activity and large fire sites;
- maps of current and forecast fire danger in forests depending on weather conditions;
- space imageries of the forest territory and regions of large fires.

The first experience is acquired concerning the operative use of lightning activity data from the System of Registration of Lightning Discharges (SRMR) together with AVHRR data from the dispatching point of management of aviation forest protection activity within the zones of control of Irkutsk , Krasnoyarsk and Tomsk airbases.

It is known that the boreal forests play a decisive role in the maintenance of oxygen-carbon balance in the world. Therefore, their protection has an international dimension. I hope that after this meeting resolution of the problems connected with the protection of *taiga* forest from destructive fires will be pursued more actively.

Thank you for your attention!

REPORT OF THE WORKING GROUP ON EUROPE AND BOREAL/TEMPERATE ASIA

MEMBERS OF THE WORKING GROUP

Mr. Shingo Shibata (Japan) – Chairperson
Mr. Wang Dong (China) - Secretary
Mr. Leo Lintu (FAO) - Technical Secretary
Mr. Harry Frelander (Finland)
Ms. Saldan Enkhtuya (Mongolia)
Mr. Bayartsogt Sangajav (Mongolia)
Mr. Eduard Davidenko (Russian Federation)
Mr. Felix Kogan (NOAA)
Mr. Johann G. Goldammer (Germany)
Mr. Jorge Najera (UN-ECE)
Mr. Zhou Feng (China)

MAIN POINTS RAISED IN THE DISCUSSION

The main points highlighted in the regional background paper and raised in the discussions at the inter-regional panel and the regional working group were as follows:

Regional issues:

- Humans as the main source of forest fires;
- Fires in industrially and radioactively contaminated areas;
- Fire management in sparsely populated lands;
- Forest fires in countries in transition to market economies;
- Problems arising from decentralization of government structures;
- Integrated fire management (use of prescribed burning; community-based, [social], fire management).

Global issues:

- Standardized global fire inventory;
- Standardized fire terminology ("language");
- Impact of climate change on fire severity;
- Improvement of global fire information system;
- International mechanisms for resource sharing in fire management;
- National and international coordination.

CONCLUSIONS REACHED CONCERNING POLICIES AFFECTING FOREST FIRES

The discussions resulted in the identification of following national, regional and international policies of relevance to forest and other vegetation fire management:

- ***Integrated fire management policies***. In all countries of the region a strict fire exclusion policy is practised. In the boreal zone fire exclusion may lead to fuel build- up and consequently to an increase of fire hazard and severity. The integration of natural fires and prescribed burning allows reduction of fuels and potential wildfire severity. In some countries, e.g. in the Nordic countries, the re-introduction of traditional silvicultural burning methods is being considered but not yet fully restored. Integrated fire management, which allows the use of prescribed fire needs to be further developed in order to reduce future problems and increased damages and costs involved.

- Some landscape types, which include nature reserves and areas of high biodiversity value, require the control of succession by traditional land-use practices, e.g. grazing, mowing, and burning. The loss of traditional land treatment methods has led to an increasing loss of biodiversity. Prescribed burning in nature conservation and landscape management offer alternative methods to preserve or restore these ecosystems.
- ***Forest management policies***. In some countries forest management, planning and silvicultural practices still favour the establishment of even-aged monocultures of conifers, often involving large clear cuts. Large reforested or otherwise regenerated young forest is highly susceptible to wildfire damage. Alternative silvicultural and forest planning policies would reduce the damage of forest or a large scale.
- ***Community-based policies***. Communities play an important role in fire management, especially in fire prevention. Thus, if communities are owners of forest or have the right of forest utilization their interest and responsibilities to protect forest from fire can be increased. Sustainable forest and fire management at community level can be increased by incentive programmes.
- ***Inter-sectoral policies***. Fire management often requires the involvement of various national authorities including their planning responsibilities and instruments. Thus, the development of inter-sectoral policies are mandatory for successful fire management programmes at all levels (local, provincial, national/central).
- ***International policies***. Fires often affect border regions between two or more nations. The development of regional resource protection policies must involve collaboration between the countries concerned. In Europe and temperate-boreal Asia, two regional cooperation programmes are proposed in the Baltic and the Central Asia region.

RECOMMENDATIONS ADDRESSED TO COUNTRIES, FAO OR OTHER INSTITUTIONS

- Currently available fire reporting systems and statistical databases are inadequate in providing relevant, accurate and timely information for various users (fire policy, management, science). The FAO is encouraged to design and implement a global fire inventory or reporting system in close collaboration with the fire science community and other end-users, particularly the ECE/FAO, EU, IGBP and IPCC.
- There is an urgent need for an internationally harmonized fire management terminology. Additional support is needed for updating the FAO glossary.
- 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 programmes, increase preparedness and respond to fires. The FAO is encouraged to consider the support of the currently existing information center (Global Fire Monitoring Center).
- Fire research needs to be strengthened in order to support development of fire policies and fire management capabilities, especially related to socio-economic and cultural aspects.
- The FAO is encouraged to support the development of criteria for assessing economic, social and ecological losses caused by forest fires.
- Following the example of the ITTO Guidelines of Fire Management in Tropical Forests, the FAO is encouraged to support the development of similar guidelines for the boreal and temperate regions.
- The development of coordinated support programmes for fire management between international, regional, and national public and private organizations is needed.
- Countries in transition to market economies require assistance in designing and implementation of fire management policies and programmes which should be supported by technical assistance.
- Transboundary or regional agreements for collaboration in fire management need to be developed, preferably strengthening the role of ECE and partnerships between ECE and neighbour countries such as Mongolia, People's Republic of China and other countries.
- 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

and Belarus with high priority. This would include also careful recording of data and experience for any future similar emergency.

- In some countries of the region, capacity building in fire management and preparedness in coping with extreme wildfires must be supported through technical assistance.
- The FAO and other international organizations should draw attention to the need for development of new dedicated space-borne remote sensing technologies which are required for improving decision support in fire management. This includes sensor technologies for fire detection and early warning of fire.
- Consideration needs to be given to the establishment of fire emergency response teams, which would operate internationally and assist countries in extreme fire disaster situations on request.
- FAO together with other organizations should support the development of programmes in public information and education for fire prevention.
- The FAO, in cooperation with other programmes and agencies, should develop a strategic concept, which addresses the impact of climate change on fire regimes and fire severity.

PUBLIC POLICIES AFFECTING FOREST FIRES IN THE AFRICAN REGION

Abdoulaye Kane[16]

1. SUMMARY

For some people, forest fires are thought to a destructive phenomenon that should be totally prevented whereas for others they are regarded a useful management tool. Experience has, however, shown that in fragile ecosystems fires can cause profound damage to soil, vegetation and ultimately to human populations. On the other hand, it has been shown that in other ecosystems, mainly in Sudan dry and humid savannahs, controlled early burning is necessary to prevent damaging fires from occurring late in the dry season.

After reviewing the main causes and consequences of forest fires in the Africa region, this paper analyzes the policy options and stresses the lessons learnt from experience and suggests that fire management with regard to social aspects and ecological requirements underlies recent policies.

2. INTRODUCTION

Forest fires have played an important role in transforming the original types of vegetation all over the world and they are one of the most critical factors of forest degradation in Africa.

The use of fire in land clearing and hunting is a very old practice in Africa. 2,500 years ago Hanon, King of Carthage, whilst on a journey to the Guinean Gulf, described the wildfires he witnessed along the coast, as follows "we were navigating alongside a blazing country filled with scents, where streams of flames were flowing into the ocean:"

Given that wild animals where abundant in that period, the description suggests that the forest fires were set more for land clearing than for hunting. In traditional agricultural and pastoral systems, fire was and is still extensively used.

As long as the climate was "normal." the rate of degradation was generally slow. However droughts and the decrease in rainfall have accelerated the process.

Even though forest fires are identified as one the most, if not the most important factor of forest and land degradation, how to solve the problem is still debatable, even within a country.

The effectiveness of policies regarding forest fires depend basically on how the fires affect the day-to-day life of rural populations and, subsequently, how these impacts are perceived.

Causes and consequences of forest fires

Whether fires occur in dry zones or in humid zones, forest fires in the Africa region are seldom due to natural causes. Cases due to lightning and biomass fermentation reported respectively by Lebrun (1947) and Sillans (1958) are rather exceptional. The most common causes are accidental (Schmitz *et al.* reported 75 percent for Burkina Faso) and those purposely started.

[16] Forestry Service, Dakar, Senegal.

A fire can accidentally be set by peasants clearing brushwood or preparing their land for cultivation, by herders or careless people. It can also be set purposely for hunting, for renewing pasturelands, for security or for religious reasons.

Whatever the cause, local populations are generally not likely to interfere with a running fire unless their lives or their belongings are threatened. M. Terrible (1984) concluded from a study conducted in Burkina Faso that behaviour is a consequence of the following perceptions and beliefs related to the forest:

- Even if a fire occurs every year, the vegetation regenerates vigorously during the rainy season and degradation is so gradual that it is hard for the peasant to relate degradation to the occurrences of fires.
- After a forest fire, the benefits such as temporary elimination of insects, unwanted animals and plants; renewed pastureland, possibility to crop more easily some non- wood product such as honey, appear to be much greater than the disadvantages.

Studies conducted in Nigeria (J. Ramsey and R. Rose Innes, 1963) and Côte d'Ivoire (A. Aubréville,1936), among others, have shown that fires are less detrimental to the ligneous vegetation and to the soil when they occur at the beginning of the dry season, when the grass is not yet totally dry. Fires set by local populations are generally in that category while accidental fires occur when the grass is completely dry. The Sahelian and Sudan zones are characterized by a herbaceous layer which can be continuous and very thick at the end of a good rainy season. In these conditions fires are very intense particularly when they are accelerated by the "Harmattan " (a very dry, hot wind).

The subhumid and humid zones are characterized by ecological conditions which are not favourable to fires.

Comparison of 28 years old plots at Olokomeji (Nigeria)

	Late burning		*Early burning*		*Protected*	
	Number	*%*	*Number*	*%*	*Number*	*%*
Number of stems	98	-	163	-	433	-
Fire tolerant species	14	87.5	21	63.6	17	39.5
Fire sensitive species	-	-	8	24.2	20	46.5
Exotic species	2	12.5	4	12.1	6	14.0
Total number of species	16	100.0	33	99.9	43	100.0

2.1. Accidental causes

Fires set by peasants while clearing land for cultivation usually occur towards the end of the dry season, thus they do not burn very large areas. The herbaceous layer at that time is discontinuous. However, the effect on ligneous vegetation is very detrimental because the trees are at the most critical period of their annual cycle.

2.2. Purposely set forest fires

In addition to fires set to induce new grass shoots and for hunting, in Senegal, Mali and Chad it has been reported that when they there is conflict between herders, peasants can set bushfires to force them to move farther away.

Other noteworthy cases reported by foresters are fires set:

- for customary or religious reasons (mostly to exorcise unwanted events);
- to induce higher non wood production (honey, fruits, gums);
- to destroy snakes, insects and vectors of diseases.

2.3. Consequences

Forest fires are an important means of deforestation. It is estimated that, during the last 30 years, slash and burn practices for cultivation and forest fires have depleted more than 120 million hectares of Africa's tropical forest. In West Africa, principally in the savannah strip, more than 60 percent of the forested area are reported to be burned every dry season.

In the semi arid zones, frequent bushfires occurring late in the dry season result in gradual changes in the grass species composition, favouring less desirable species such as *Cenchrus biflorus*.

Usually, in the sub-humid zones, there is no important accumulation of combustible fuels susceptible to intense burning. The woody vegetation and the grasses are too sparse to dry up. However, a series of droughts experienced since the seventies combined with overcutting, has caused wildfires to become more common in these zones.

Year after year, fires progressively burn off the bark of trees and affect the trunks so trees are either killed or fall down. The natural regeneration is also often offset.

The phenomena accelerates the deforestation process and ends up destroying wildlife habitats.

There are many records attributing the loss of tropical forest to savannah by fire. As a consequence, wildlife whose habitats are destroyed by periodic forest fires and fire intolerant species disappear affecting adversely the biological diversity of the burned areas.

In the semi-arid zones, the ecosystems are generally more tolerant of fires. However, fires occurring during the late dry season are destructive to trees and shrubs except the most fire resistant species and can progressively lead to changes in species composition. When fires occur early in the dry season, there are limited degrading effects. Instead, fires may induce the growth of new grass, flowering of some species, gum production, etc. In general, shrubs with low sprouting capacity are more tolerant of fires than those which have abundant sprouting capacity.

In addition to their effects in the various ecosystems, forest fires cause a lot of damage to production systems in rural areas. Throughout West Africa, every year, loss of lives, crops and homes are reported. In the pastoral areas, populations are obliged to move elsewhere with their cattle after a fire runs through their pasturelands.

3. POLICIES AND ACTIONS

Policies concerning forest fires reflect, in general, the physical impact, the social beliefs, and the economic effects on the local populations.

Where physical impact is spectacular and the effects on the rural production systems (mainly rangelands) destructive as in the Sahelo-Sudanian zone, policies tend towards totally preventing fires. Where the impact is less spectacular and the overall effects are considered to be positive, policies aim at managing fires rather than preventing them.

3.1. Policies aiming to prevent forest fires

In West Africa, policies aimed at preventing forest fires are a legacy left by French foresters. These policies are aimed exclusively at the Sahelian and Sahelo-Sudanian zones with the main objective of protecting rangelands. However, despite repressive legislation, which underlies the policies, fires are always frequent and by the end of the dry season few areas are left unburned.

As customs and local knowledge were not properly taken into account in the beginning by the legislator, forestry legislation has led, in general, to adverse effects. By forbidding burning early in the dry season, there has been an increase in the number, intensity and the spread of fires occurring late in the dry season. It is a quite widely shared belief that the present behaviour of local populations regarding forest fires results from that legislation.

From various areas, experience has shown that forest fires cannot be prevented on a long term basis and that total prevention can end up causing more damage to the forest than through the wise use of fire as a management tool.

An experiment conducted near Lubumbashi (RDC) has shown that after six years of total protection of a plot, a late fire killed 72 percent of the stems in the 29 cm circumference class and 25 percent in the 90 cm circumference class.

In general, except in the Sahelian zone, early burning has been subsequently authorized and regulated by legislation.

Up to the mid-eighties, Senegal represented a special case where almost all the Sahelian part of the country was covered by a network of firebreaks. Between the 1950s and the early 1970s the network, of about 4,500 km, was implemented in the northern silvi-pastoral zone. At the end of every rainy season, the entire network was cleared using motor graders. The network was backed by fire brigades distributed throughout the area and equipped with fire engines and radios. Local committees composed of volunteers were organized for combating wildfires within the territory of every village. That protection system, though relatively efficient in keeping out extensive fires, did not actually prevent the area from burning every dry season. It was mostly meant to suppress fires as soon as they started. Elsewhere, there were no firebreaks but equipped fire brigades and local committees were well distributed but were less successful at suppressing fires than in the silvi-pastoral zone.

In addition to the above-mentioned protection system, the laws concerning bushfires have always been very repressive.

The main lesson derived from the Senegalese experience is that legislation, even when it is extremely repressive, cannot prevent bushfires.

In fact, it is now well accepted that in zones with a long dry season a policy aimed at preventing bushfires cannot be effectively implemented. In subsumed areas, on the other hand, the measures would be efficient as long as the grass and brush are kept sparse.

Forest fire management measures

Firebreaks: Except in intensively managed forests, parks, plantation and ranches, firebreaks are known to be used extensively only in Senegal.

Firebreaks can stop bushfires only if the grass is short and if there is no wind blowing. Most of the time they are used to set counter fires and as convenient roads for fire engines to reach the fire front.

With the economic difficulties experienced by the country since the 1970s, the cost of maintaining the infrastructure became such a financial burden that the forest service could no longer maintain it and no other partner was interested in supporting its maintenance. This situation has in fact made the problem worse as in firebreaks left without maintenance the herbaceous layer and shrubs are thicker providing substantial fuel for fires.

In conclusion, if firebreaks are a useful tool in combating bushfires, but the burden of maintenance is too heavy, then it seems to be more rational to limit them to areas where there is an absolute necessity to preserve the vegetation (i.e. ranches, fragile ecosystems, etc.).

The use of heavy equipment: Heavy equipment includes fire engines, trucks equipped with water tanks, motor graders, radio networks, etc. Use of such equipment is more efficient when combined with firebreaks.

In Africa, except Senegal, this type of equipment is mainly confined to managed areas (ranches, national parks, managed forest)

Well distributed water points and technical bases are required. The cost of acquiring, properly running and maintaining this equipment is probably not affordable to most African countries.

Fire-fighting local committees: These committees are organized in villages under the sponsorship of the forestry services or forest conservation projects. When the committees are well formed, equipped with light tools and monitored they are quite efficient in combating fires in their territory. To encourage their members and somehow reward them, the food-for-work programme was extended in some areas to cover the action of such committees. However, cases have been reported that in order to draw the attention of officials to their actions and eventually to obtain rewards in the form of food, committees have actually set fires themselves.

A significant increase of the yearly reported cases of fires set by local populations in order to get increased food rations has convinced the authorities to end the scheme.

Education: A better understanding of the origin and the underlying reasons for traditional practices has recently resulted in more tolerant attitudes regarding forest fires. Dialogue has thus replaced repression.

Most of the studies and observations have led to the conclusion that in all zones, fire is traditionally viewed more as a management tool and a normal element than a destructive force. It is regarded as destructive phenomenon only when it runs outside the boundaries within which its effects are perceived as positive.

This change in view has led to the implementation of education programmes. Many of those programmes integrate modern techniques such as “multi-media communication’’ strategy, involving audio, visual and scriptural means. A study conducted in 1996 in Guinea Conakry by the Ecological Monitoring Centre of Dakar has clearly shown the impact of education using broadcasts.

3.2. Fire management policies

It has long been recognized that man’s activities combined with fire resulted in steppe and savanna type vegetation. Moreover, fire is traditionally considered as a tool in clearing land for cultivation and managing pasturelands. It is regarded by most ethnic groups as a natural and unavoidable phenomenon. Hence, in almost all countries located in the semi arid and subhumid zones, the policy adopted aims mainly to manage fires in order to use their positive effect where needed and to lessen the adverse effect where the ecosystems are too sensitive to burning.

In general, species of tropical forest are not tolerant of fires. A fire running through young seedlings destroys them irremediably and the yearly occurrence of the phenomenon ends up with the destruction of the forest itself. On the other hand, it has been observed that important changes in the environment resulting from fires may lead to a loss in annual increment of trees.

From his studies in Côte d’Ivoire, J. Bertault (1985) states that in the tropical forest stand, nearly one-third of small diameter stems were killed by a fire running through. In addition, the flora structure was modified due to differences in tolerance to fires shown by the species inventoried.

Entandrophragma cylindricum and *Morus mesozygia*, for example, were more fire tolerant than all other species. On the other hand, wildlife associated with tropical forest habitats (*Cephalophus sp*, *Philantomba sp*,) are also endangered by forest fires.

In tropical forests and savannah ecosystems, it is proven by various studies (West,1965) that fires occurring early in the dry season have little effect on the vegetation, whereas those occurring late have adverse effects on grasses, on brush, on trees and on the soil. This finding has led foresters and rangers to set controlled early fires to reduce fuels and to prevent detrimental late fires.

However, if in the past this method could be practised without a significant risk of the fire getting out of hand and causing damage in contiguous dryer areas, nowadays changes in the climate and vegetation have brought about a new situation. Erratic rainfall creates more or less large patches of dryer areas where a fire set in a contiguous area can produce the same effects as a late fire. To face this situation, the period for early burning should no longer be determined by the legislation. Rather, it should be decided locally.

Results of an experiment conducted by the Ecological Monitoring Centre in Guinea

This experiment presents major innovations due to it participatory and multidisciplinary character. People were involved through village meetings conducted by professionals of communication. During these meetings, local know-how on fire-fighting techniques was collected, which allowed understanding of practices and behaviour towards wildfire and adapting the message to be circulated through local radios.

A major advantage of this approach is its replicability in the African context in which investments needed to run a local radio station are very few, due to low management cost and spontaneous participation of people, which is quite different from the classical administrative approach. The involvement favoured by the sociological approach used is a guarantee for sustainability because the option of fire-fighting techniques would be defined and put into action by the people themselves.

Under certain conditions, local radio stations may be a powerful tool towards finding a local solution, against degradation of natural resources. A multidisciplinary approach has been applied in forest fire management for the first time in Africa, and a solution has been found through direct and frank exchanges between three partners: the people, the national resource managers and the media professionals. Last, the efficiency of a new technology, remote sensing in monitoring and orientation of actions against forest fires has been demonstrated and used at a local level

The major lessons learned from this experience may be summarized as follows:

- Local radio represents an excellent tool for forest fire management;
- Synergy between population, technicians and media specialists is both necessary and possible,
- Remote sensing technique can be used as a tool for monitoring the environment and for controlling resources.

This experience, to be effective, should be extended to other African countries. Young people and women are considered to be the most receptive targets.

The success of this research action opens a promising perspective for a sub-regional programme.

Wildfires are probably the most complex issue that faces communicators, public authorities, and people in charge of development. Among the challenges would be how to explain to rural dwellers the relationship that exists between forest fires and the long distance they have to travel in search of water; how to convince them to reduce ritual fires; how to convert hunters who do not hesitate to set fire to one hundred of hectares just to collect one “agouti” into friends of the environment.

The experiment has shown that local radios may succeed where until now, politicians, foresters, extension agents and policemen have failed. With no little difficulty, we can all accept that careful listening to the keepers of tradition is often the key to success. In oral traditions, when people are well informed, have the opportunity to express themselves and listen to each other (what local radio can easily facilitate), they seldom reject innovative actions towards their interest in the short or long run.

In the steppes of the Sahelian zone, the herbaceous layer is essentially composed of annual species which do not regenerate after early fires. Since the main rural activity is livestock raising, the aim of the policies is to prevent even very early fires. In Senegal, to achieve this goal, the measures taken were very costly and were hence difficult to sustain. The important firebreak network of the silvi-pastoral zone did not survive long after the beginning of the country’s economic difficulties. All the fire extinguishing equipment is out of order or too old to be reliable.

If the policy is well accepted by the local communities, the means of achieving it effectively are out of their reach. Hence alternative measure should be sought.

4. LESSONS FROM EXPERIENCE

Because they are highly destructive and adversely affect human and animal lives even when they occur early in the dry season, fires should be totally prevented in the Sahelian zone.

Fires should also be totally prevented in tropical forests where they may lead to an irreversible degradation of the ecosystems.

Elsewhere, periodic controlled early burning should be used extensively as a tool to combat forest fires.

Appropriate education programmes involving local communities and technicians using multi-media communication strategies can lead to more cooperative interactive contributions of the rural population.

Repressive legislation has no effect in keeping people from setting forest fires.

5. CONCLUSION

Despite a lack of recent studies and statistics on the extent of forest fires in Africa, it is widely recognized that their contribution to forest degradation is greater than ever. However, the consideration now given to social and ecological aspects of forest conservation has influenced policies directly or indirectly affecting forest fires. In that respect, policies should now integrate the various aspects which are identified as basic to sustainable development.

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FIRE IN SOUTHERN AFRICAN WOODLANDS: ORIGINS, IMPACTS, EFFECTS AND CONTROL

Peter G.H. Frost[17]

INTRODUCTION

Biomass burning is common and widespread throughout the tropics. Wildland fires, started either by people, for various reasons, or by lightning, are frequent and extensive. Fires fuelled by wood, charcoal or agricultural residues are the main source of domestic energy for cooking and heating. Fire is also used to remove biomass from land being cleared for agriculture or, afterwards, for getting rid of unwanted agricultural residues. Together, these fires are a significant source of trace gases and particulates to the global atmosphere. Current estimates of the amount of biomass burned each year globally amount to 6,230-8,700 Tg[18] dm yr^{-1}, about 87 percent of which is calculated to occur in the tropics. Of this, almost half (49 percent) is considered to be due to savanna burning, including both wild fires and management fires. Burning of fuelwood, agricultural residues, and slash from deforestation comprise the balance, in about equal measure. Within the tropics, 42 percent of emissions are estimated to come from Africa, 29 percent from Asia, 23 percent from South America, and 6 percent from Oceania (Andreae 1991). The scale of these impacts emphasises the regional and global dimensions of the problems created by uncontrolled burning.

CONCERNS ABOUT BIOMASS BURNING

The widespread occurrence of fire prompts a number of concerns. Fire is popularly viewed as destructive of vegetation, and many present-day savanna communities in Africa are considered to be fire-maintained sub-climax formations. There is no consensus, however, on what constitutes the climax vegetation: forest, or merely a denser phase of the present vegetation (Trapnell 1959, Hopkins 1965, Fanshawe 1971, West 1972, Freson *et al.* 1974, Menaut 1977, Lawton 1978, Scholes and Walker 1993, Frost 1996). Frequent late dry season fires transform woodland into open, tall grass savanna with only isolated fire-tolerant canopy trees and scattered understorey trees and shrubs. Frequent fires also suppress the regrowth of woody plants, preventing their recruitment to the canopy. In contrast, complete protection from fire, and to a lesser extent early dry season burning, favours both the recruitment and growth of woody plants (Trapnell, 1959). Fire can also have adverse effects on soil fertility (Trapnell *et al.* 1976, Frost and Robertson 1987).

Biomass burning is considered to be a major contributor globally to emissions of greenhouse gases and precursors of tropospheric ozone. Globally, biomass burning is estimated to release about 3,460 Tg C as carbon dioxide; 350 Tg C as carbon monoxide; 38 Tg C as methane; 24 Tg C as non-methane hydrocarbons, C_2 - C_{10}; 8.5 Tg nitrogen as nitric oxide, NO; smaller, but no less important, quantities of other trace gases such as methyl chloride; and 104 Tg particulate matter (Hao *et al*., 1990; Andreae, 1991). Estimates of the amount of biomass burned annually in savanna fires, globally and in Africa, are given in Table 1. The contribution of the emissions from these fires to total global emissions is given in Table 2. The wide range in estimates of the amount of biomass burned is notable. This must lend considerable uncertainty to the calculation of emissions.

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[18] 1 teragram (Tg) = 10^{12}g = 10^6 t, 1 gigagram (Gg) = 10^9 g = 10^3 t.

Table 1. Estimates of the amount of biomass burned annually by fires in savannas (Tg DM yr^{-1})

Southern Africa	*West Africa*	*Africa*	*Global*	*Reference*
			1,190	Seiler & Crutzen, 1980
			600-3,200	Crutzen & Andreae, 1990
1,200	1,228	2,428	3,691	Hao *et al.,* 1990
			3,690	Andreae, 1991
	90-480	1,294		Menaut *et al.*, 1991
		2,520		Delmas *et al.*, 1991
		1,300-2,500	2,500-3,700	Lacaux *et al.*, 1993
561-1,743 (213-2,812)				Scholes *et al.*, 1996a (method 1)
177 (90-264)				Scholes *et al.*, 1996a (method 2)

The trace gases emitted by fires contribute both to the 'greenhouse effect' and to the chemical reactivity of the atmosphere. Savanna fires in Africa are thought to be the main cause of the pronounced peak in tropospheric ozone that extends across the Atlantic Ocean from Africa to South America annually during September-October (Fishman *et al*., 1991). Biomass burning also produces large numbers of sub-micron size particles as smoke that remain suspended in the atmosphere for long periods, reducing atmospheric quality and visibility. This problem is intensified in southern Africa by the relatively stable atmosphere during the dry season that allows strong thermal inversions to develop, thereby trapping the particles in the lower atmosphere. This is further compounded by the presence of a large sub-continental atmospheric gyre that re-circulates many of these emissions around southern Africa during the dry season (Garstang *et al.* 1996).

Set against these adverse impacts are the apparent benefits that people perceive they get from burning vegetation. These include the flush of green grass following fire in some landscapes, which is used by pastoralists to increase protein intake by their livestock; control of bush encroachment, thereby potentially increasing grass yields for livestock; cleared paths between settlements, making it easier to detect predators and other dangerous animals; and control of pests such as ticks (Acaridae). Wildland fires may also arise from poor control of fire used for clearing and preparing plots for cultivation, burning firebreaks, producing charcoal, smoking out bees during honey gathering, and burning areas to concentrate wild animals for hunting, (Trapnell, 1959; Kikula, 1986). These and other practices have probably been carried out for millennia. Stone-Age people are known to have used fire in Zambia about 55,000 years ago (Clark and Van Zinderen Bakker, 1964), and there are suggestions of even earlier use by hominids at the Swartkrans Cave, South Africa, dated at about 1.2 million years BP (Brain and Sillan 1988).

Table 2. Comparison of estimated global emissions from biomass burning with emissions from all sources, including biomass burning (Andreae 1991)

Chemical species	*Emissions (Tg element yr^{-1})*		*Contribution of biomass burning (%)*
	Biomass burning	*All sources*	
Carbon dioxide (gross)	3,460	8,700	40
(net) [1]	1,800	7,000	26
Carbon monoxide	350	1,100	32
Methane	38	380	10
Non-methane hydrocarbons [2]	24	100	24
Nitric oxide	8.5	40	21
Methyl chloride	0.5	2.3	22
Total particulate matter	104	1,530	7
Particulate organic carbon	69	180	39
Elemental carbon (black soot)	19	<22	>86

[1] Net emissions of CO_2 equal gross emissions minus that amount taken up again by regrowing plants
[2] Excluding isoprenes and terpenes

This paper first summarises the major policy concerns and the underlying scientific and technical questions that need to be answered prior to formulating policy. This is followed by a summary of some of the relevant information needed to inform policy, including a review of existing legislation governing the use of fire in two countries in south-central Africa, Zambia and Zimbabwe. Finally, some suggestions on the opportunities for, and constraints on, improving the present situation through changes in policy and practice are outlined.

Policy issues

The key policy issue is whether wildland fires in Africa pose a sufficiently serious problem to require some form of legislative or administrative response. To address this issue properly requires, first, information on the magnitude and extent of wildland fires in Africa, with details of where, when, and how these fires occur. Second, information is needed on the direct and indirect effects of these fires on the environment, natural resources, and peoples' livelihoods, and how these vary in different circumstances. Third, to avoid formulating policy for a situation that no longer pertains, it is necessary to establish whether fire regimes are changing and, if so, in what ways, at what rates, and why. Information is also required about the proximate and ultimate causes of wildland fires and, where necessary, how these interact.

A subsidiary issue, assuming that the amount of burning is considered to be excessive and should be better controlled, is what options are there for limiting the extent of wildland burning or reducing its adverse impacts, and what are the associated costs and benefits. The likely effectiveness of the various options in lessening the extent of wildland burning and mitigating the severity of its impacts need to be assessed, together with their respective costs and benefits of the different options. This includes considering what the likely long-term costs of not addressing the problem might be.

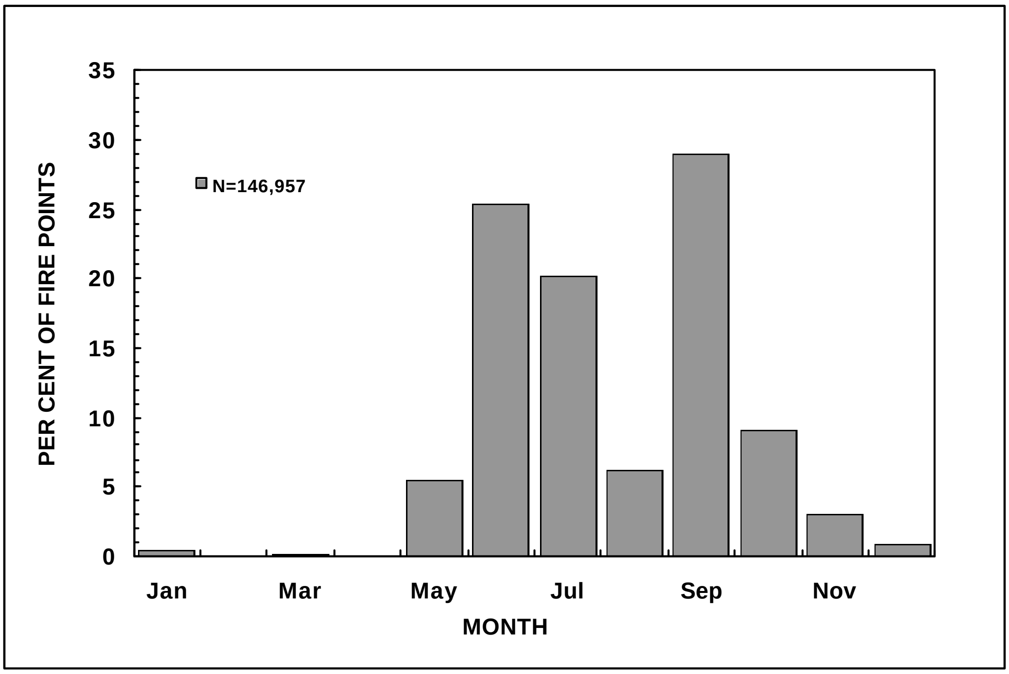
Given that most countries in the region already have laws and regulations governing the use of fire, and assuming that there is a problem of excessive wildland burning, a third issue is why current legislation, or its enforcement, is ineffective in regulating the amount of burning. The supporting scientific and technical information needed to address this issue includes questions about peoples' perceptions and understanding of the regulations; the methods of enforcement, if any, and their effectiveness; what factors constrain enforcement of, or compliance with, the regulations; and what kinds of incentives or deterrents would promote compliance.

Extent and magnitude of wildland fires in Africa

Seasonality

Although wildland fires can and do occur throughout the year in Africa, more than 90 percent of the fires and 99 percent of the area burnt is due to dry season fires. This is when the herbaceous vegetation is either dead (annual grasslands) or dormant, and when deciduous trees have shed their leaves, thereby contributing to the build up in surface fuel loads. Fires during the wet season are uncommon and localised. The seasonal distribution of fires in southern Central Africa in 1993, as determined from an analysis of 1 km data from the Advance Very High Resolution Radiometer (AVHRR) sensor on board the NOAA daily weather satellites is shown in Figure 1 (see Arino and Melinotte 1997 for details of the algorithm used to determine active fire points).

Figure 1. Monthly distribution during 1993 of active fire points in south-central Africa from 6°S, 11°E to 23°S, 43°E, as detected by the NOAA AVHRR satellite-borne sensor at 1 km resolution. Data derived from Arino and Melinotte (1997). The relatively low number of fires recorded in August is probably not typical



The data show peaks in September and June. The peak in June reflects a concentration of burning at that time in northern Angola and the Democratic Republic of Congo. The later peak reflects the widespread burning occurring further south and east in eastern Angola, Zambia, Malawi, Mozambique, and northern Zimbabwe. The relatively low percentage of fires occurring in August is probably not typical, as multi-year data for Hwange National Park in Zimbabwe shows. There the peak in fire abundance is in August (Figure 2). Although most fires occurred during the period August-October, the most significant months in terms of the proportion of total area burnt are September, October and, to a lesser extent, November. Hot, windy and extremely dry conditions during these months mean that fires spread easily and are difficult to control. They consequently burn large areas, as shown by both their larger average and maximum sizes (Figure 3).

Figure 2. Seasonal distribution of, and contribution to, total area burned by 156 fires recorded in Hwange National Park, Zimbabwe, 1968-1989

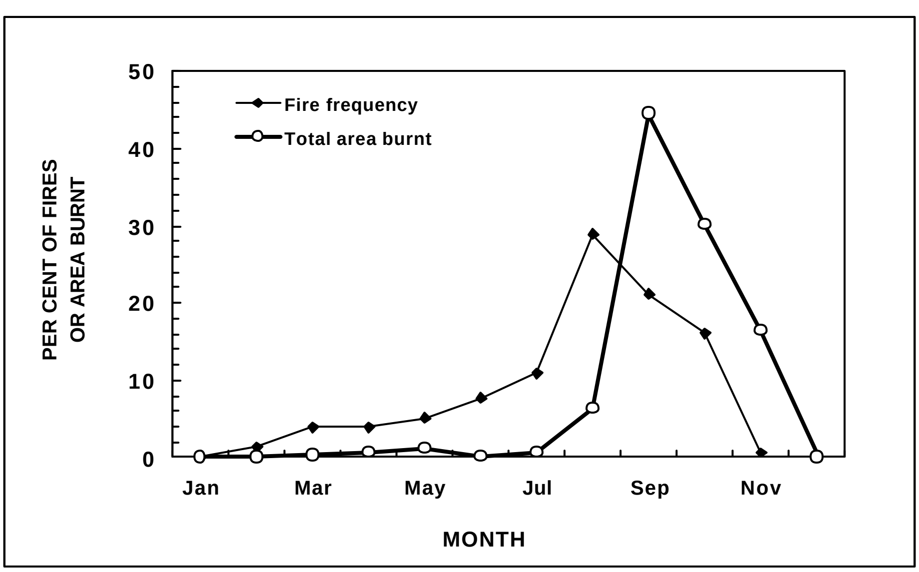
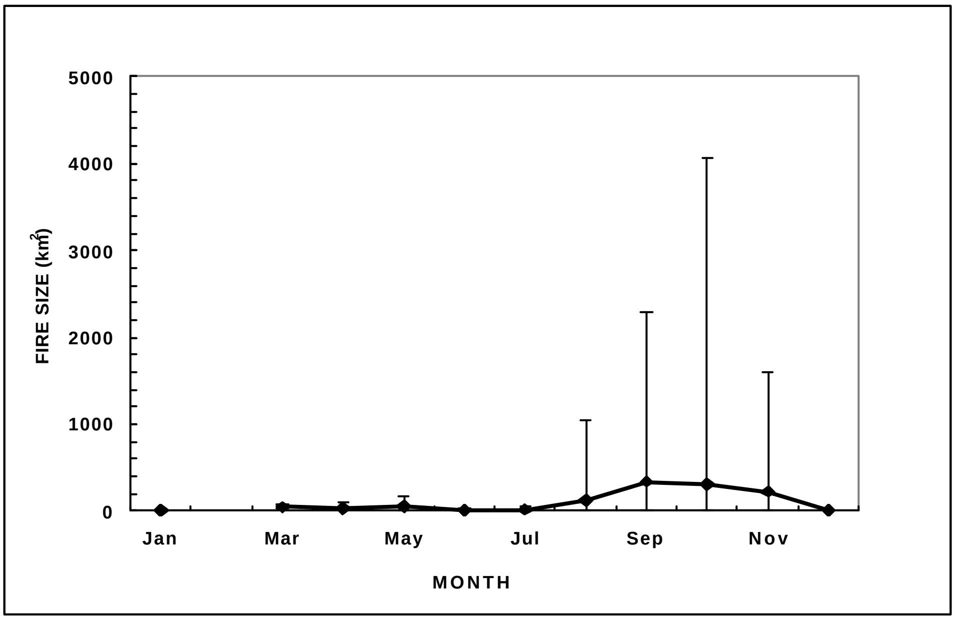


Figure 3. Monthly average fire size and range in reported sizes of 156 fires recorded in Hwange National Park, Zimbabwe, 1968-1989



The number of active fire points detected by the NOAA AVHRR sensor does not accurately reflect the area burned. Scholes *et al.* (1996a) calibrated the actual area burned, as determined from 12 stratified randomly selected Landsat MSS from across southern Africa, with the number of fire points detected by the AVHRR sensor over the same period. They showed that the actual area burnt in the arid and semi-arid zones, where fires tend to be infrequent but large, is underestimated by the AVHRR data, whereas the area burnt in the sub-humid zone, where fires are more frequent but generally smaller in size, is overestimated. Nevertheless, within a zone, there is wide variation both in the number of fires and in the area burned annually (Figures 4, 5).

Figure 4. Relationship between annual rainfall and the number of wildland fires recorded in the following dry season in Hwange National Park, Zimbabwe, 1968-1989

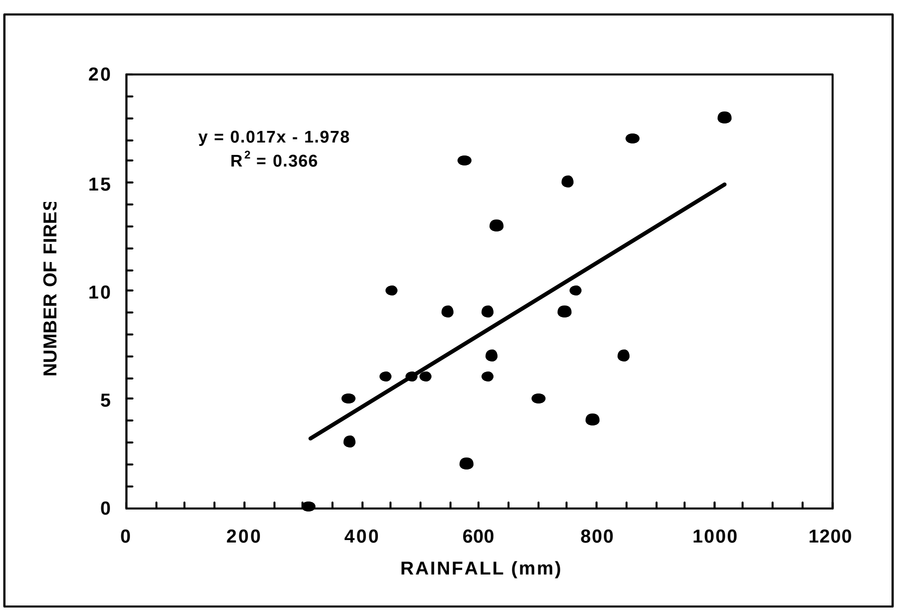
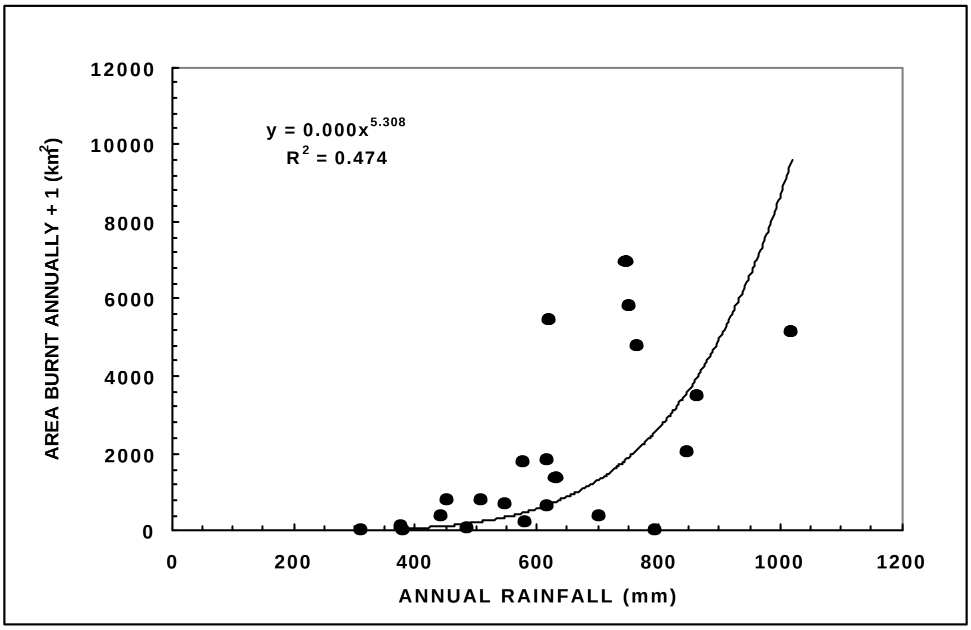


Figure 5. Relationship between annual rainfall and total area burned by wildland fires during the following dry season, Hwange National Park, Zimbabwe, 1968-1989



Distribution

Wildland fires occur throughout the seasonal tropics in Africa, primarily from November to April north of the equator and from May-October south of it (Figure 6). Within south-central Africa, extensive burning starts in May-June in the tall grasslands of the savanna-forest mosaic along the southern edge of the Congo basin and then spreads south and eastwards across the subcontinent (see data and images in Arino and Melinotte 1997). A comparison of the distribution of these active fires with the spatial distribution of Normalised Difference Vegetation Index (NDVI) values, an index of 'greenness' of the vegetation also derived from the AVHRR sensor, shows that burning closely tracks the seasonal pattern of drying out of the vegetation following end of the annual rains in the region.

These data, together with those acquired from the Operational Linescan System (OLS) on the USA Defence Military Satellite Program (DSMP) satellites (Cahoon *et al.*, 1992) and the Advanced Very High Resolution Radiometer (AVHRR) on the National Oceanographic and Atmospheric Administration (NOAA) satellites (Kendall *et al.*, 1997), also show a generally marked reduction in the number of recorded fires in Africa south of the Zambezi River. This is due to either or both to the generally drier environment and more extensive settlement and fragmentation of the natural land cover in Zimbabwe, Botswana and South Africa.

The extent of burning and the amount of biomass estimated to be burned in each of the main vegetation types of Africa south of the equator, derived from modelling plant production and the area burned, using satellite remote sensing, is shown in Table 3. In terms both of the area burned and the amount of biomass consumed by fire, the infertile savanna, mostly miombo, is by far the most important vegetation formation.

Figure 6. Seasonal distribution of burnt areas across Africa, November 1990 – October 1991, derived from analysis of NOAA AVHRR Global Area Coverage (5km) data sets using a multi-temporal, multi-threshold technique to identify fire-affected areas (P. Barbosa in IGBP-DIS 1997)

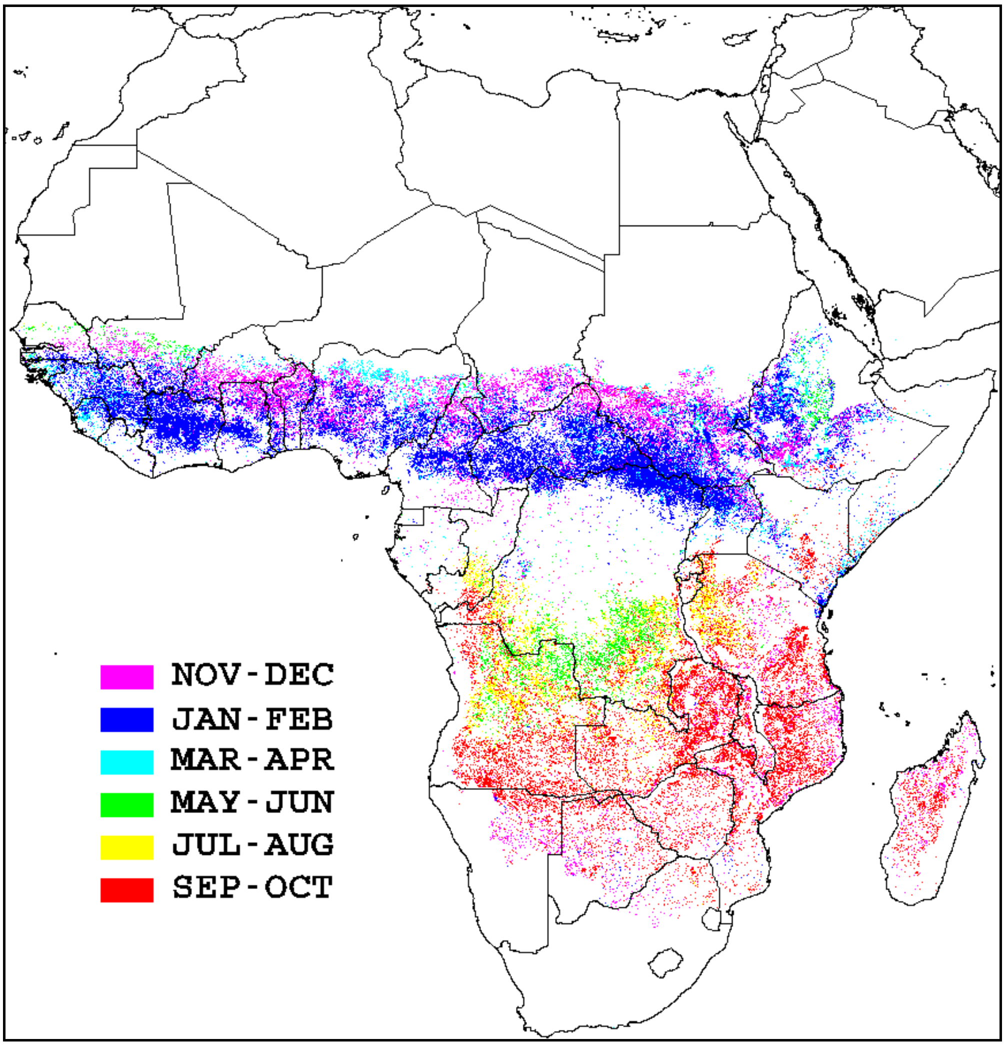


Table 3. Estimates of the total area and amount of biomass burnt by wildland fires in Africa south of the equator, based on modelling of biomass production and fire occurrence at 0.5 x 0.5 ° resolution using a correlation between the total area burnt, the cumulative normalized difference vegetation index, and cumulative number of active fire points detected by the NOAA AVHRR sensor (Scholes et al. 1996a)

Vegetation type	*Total area (10^3 km^2)*	*Fraction of area burnt*	*Total area burnt (10^3 km^2)*	*Biomass consumed (Tg)*
Evergreen forest	1,036	0.038	39.37	9.5
Dry forest	113	0.181	20.45	6.8
Forest/savanna mosaic	716	0.270	193.32	21.4
Infertile savanna	4,177	0.250	1,044.25	88.4
Fertile savanna	2,140	0.089	190.46	29.6
Arid shrubland/succulent semi-desert	534	0.011	5.87	0.4
Desert grassland	131	0.001	0.13	0.0
Fynbos	74	0.050	3.70	2.2
Infertile grassland	371	0.317	117.61	10.6
Fertile grassland	267	0.180	48.06	3.8
Wetland (*e.g.* dambos, vleis)	42	0.528	22.18	4.3
Total Error range (+/- 49 percent)	10,135	0.166	1,685.40	177.0 (90-264)

Frequency

It is widely supposed that African savannas burn every 2-3 years (Andreae, 1991; Ward *et al*., 1996) but there are almost no data to support this. The few available data suggest that intervals between successive fires are a site are longer than this (Table 4), though undoubtedly there are some sites and landscapes, particularly those close to where people live, that burn more frequently. Only in the case of the Serengeti National Park, an area of widespread grassland, and the Ruwenzori National Park, which has two wet and two dry season per year, is the commonly-held perception approximately true. The Serengeti, Kruger National Park and Matetsi Safari Area were all subject to widespread controlled burning as well as uncontrolled fires initiated both within the areas and from outside, by both people and lightning.

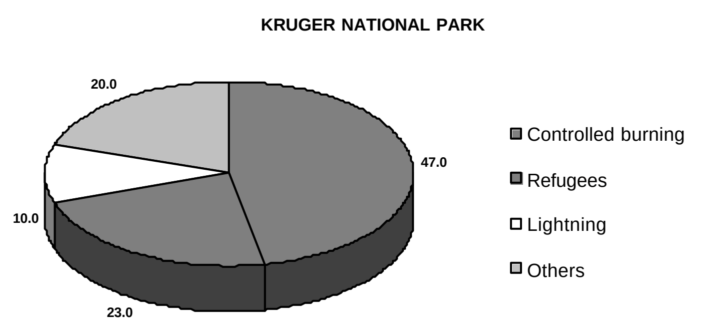
Table 4. Recorded areal fire frequencies, measured as the mean interval between fires, and calculated as the reciprocal of the mean proportion of an area burned annually, in various African ecosystems

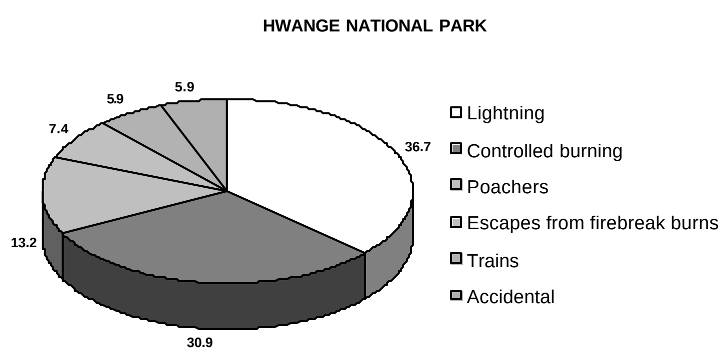
Locality (area)	*Mean annual rainfall (mm)*	*Mean proportion of area burned annually*	*Mean interval between fires (yrs)*	*Reference*
Ruwenzori National Park, Uganda (1,978 km^2)	1,010	0.36	2.8	Eltringham (1976)
Serengeti National Park, Tanzania (25,000 km^2)	600-1,150	0.62	1.6	Stronach (1989)
Matetsi Safari Area, Zimbabwe (4,720 km^2)	650	0.26	3.8	Frost (1993)
Hwange National Park, Zimbabwe (14,600 km^2)	625	0.17	5.9	Frost (1993)
Kruger National Park, South Africa (19,485 km^2)	420-630	0.13	7.7	Trollope (1993)
Etosha National Park, Namibia (22,270 km^2)	430	0.14	7.1	Siegfried (1981)

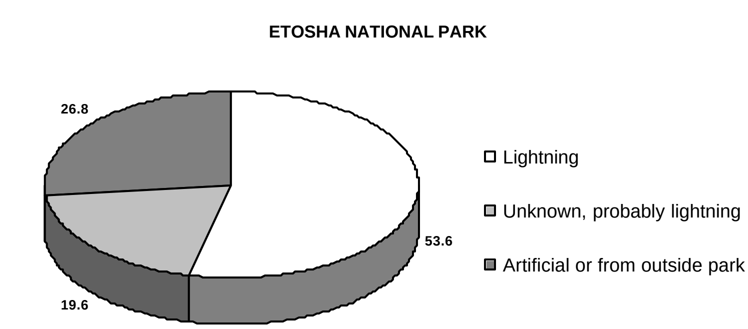
Causes of wildland fires

People are undoubtedly the main cause of fires occurring in Africa, but reliable data on this are few. The data that are available come from conservation areas to which access by people is generally limited and in which controlled burning by management staff is sometimes carried out (Figure 7). Controlled burns accounted for 47 percent of the area burned in the Kruger National Park, South Africa, in the period May 1985 - September 1992 (Trollope 1993). Fires lit by refugees from neighbouring Mozambique accounted for a further 23 percent, while fires from other unspecified sources burned 20 percent of the area. Fires originating from lightning strikes accounted for 10 percent of the area burnt.

Figure 7. Causes of fire in three southern African national parks. Data for Hwange and Etosha national parks refer to the percent of fires started by lightning; data for Kruger National Park reflect the percentage of area burnt by fires of different origins (data from Siegfried 1981, Trollope 1993 and Frost 1993)







In the more arid Etosha National Park, Namibia, about 53 percent of 56 fires recorded between 1970-1979 were started by lightning. The causes of a further 20 percent of the fires were unknown but were thought probably to be due to lightning, while only 27 percent were started artificially or originated from outside the park (Siegfried 1981). In Hwange National Park, Zimbabwe, between 1968-1989, lightning caused 37 percent of 68 fires for which the source of ignition was determined (Jones pers. comm.[19]). Controlled (management) fires accounted for 31 percent. Other causes were fires lit by poachers (13 percent); fires getting out of control during the burning of firebreaks (7 percent); fires started by trains passing along the eastern boundary of the park (6 percent); and fires started by accident (6 percent).

The incidence of fires started by people is likely to be higher in settled areas, though because of fragmentation of landscapes, reduced fuel loads, and fire control, such fires tend to be small. Nevertheless, fires started by people tend to be lit earlier in the dry season than fires started by lightning and are likely to pre-empt many potential lightning fires from igniting or spreading later in the dry season. Areas that have not been burned earlier, however, are susceptible to being ignited by lightning strikes from the numerous thunderstorms that build up during the late dry and early wet season. This is important because it makes complete protection from fire difficult to achieve. If people do not light fires, either deliberately or accidentally, then lightning sooner or later will.

The causes of anthropogenic fires are many and varied, reflecting the broad range of socio-economic, cultural and environmental conditions in countries where burning is prevalent. The most common uses are to clear land or removed unwanted debris; improve grazing for domestic livestock and, in some nature reserves, for wildlife; manage vegetation structure and composition; improve conditions for hunting; and reduce potentially hazardous fuel loads. Wild fires are also started accidentally, for example from roadside cooking or heating fires, or during charcoal production, smoking out bees during honey gathering, or burning firebreaks. Fire is also sometimes used maliciously.

Whereas these are the proximate reasons for using fire, there is a range of broader factors that influence the extent of burning. Vegetation types differ in their exposure and susceptibility to fire (van Wilgen and Scholes 1997). Some vegetation types (*e.g.* grasslands, open savannas) are spatially more homogeneous and therefore more prone to widespread and frequent burning than other more distinct vegetation formations. Other factors include the widespread traditional use of fire; continued dependence of rural people on agriculture as a means of livelihood, because of the lack of alternative economic opportunities outside the sector; the ongoing need to convert more woodland and grassland to subsistence agricultural land to accommodate the rising numbers of people; continued impoverishment of subsistence farmers, which constrains their ability to adopt alternative technologies; frequent lack of security of tenure; and weak local institutions governing access to and use of natural resources. These are compounded by policies that do not sufficiently encourage and reward sustainable land-use; a lack of both the policies and the resources to effect coherent fire management strategies in different land-use systems; and poor integration among land-use sectors in the development and implementation of such policies.

Environmental and other effects of wildland fires

Effects on vegetation composition and structure

The influence of fire on the dynamics of the savanna vegetation of southern Africa has long been recognized (Trapnell 1959, Fanshawe 1971, Kennan 1972, Lawton 1978, Booysen and Tainton 1984, Chidumayo, 1988, Frost and Robertson 1987). Fire may have little effect on some plants, damage the aboveground parts of others, and kill some outright. The effects depend partly on the timing and intensity of fire, and on the intrinsic attributes and physiological state of the plants concerned (Frost 1984). Single fires generally have less effect than a succession of fires. In this case, fire frequency is an important variable. Generally, dry season fires affect woody plants more than grasses (most of which are dormant or nearly so); among woody plants, individuals less than 2 m tall are usually more susceptible than taller individuals. Late dry season fires are almost always more destructive than early dry season fires.

Numerous experiments across the continent have shown that if fire is excluded from a site (usually at considerable cost relative to the size of the protected area) woody plant density and biomass increase and grass biomass decreases. This is well illustrated by data from a long-term fire experiment at

[19] M.A.Jones, formerly Ecologist, Department of National Parks and Wild Life Management, Zimbabwe.

Matopos Research Station, Zimbabwe (Frost unpublished data). A survey carried out in 1992 of all woody plants on plots (a) protected from fire since 1947, (b) burnt in the late dry season (mid September) at one-, two-, three- and five-yearly intervals, and (c) burnt during the early dry season (mid June) at one- and two-year intervals, showed marked differences in the density, biomass (as indexed by plant basal area), and the number of species (Figures 8 – 10). Although there is little difference among the treatments in the number of woody plants <5 cm basal diameter, the number of trees with basal diameters >5 cm is significantly greater under complete protection (Figure 8), as is the total basal area (Figure 9).

The number of woody species was also significantly greater under complete protection but differed little among any of the other treatments (Figure 10). The additional species recorded in the plots protected from fire since 1947 included species known to be sensitive to burning (*e.g. Pappea capensis*, *Olea europea* ssp. *africana*, *Rhus pyroides* (so named because of its spinescent branches, not its affinity for fire), and *Pouzolzia mixta*). All of these fire-sensitive species, however, are found in the surrounding area, which is occasionally burned, though they survive by occupying fire-protected sites such as termitaria and rocky outcrops. In contrast, in areas on the forest-savanna boundary, such as in parts of Central and West Africa, changes in species composition towards a forest flora occur when a site is protected for many years (Trapnell 1959, Hopkins 1965, Menaut 1977).

Effects on nutrient cycling

Fire is important in nutrient cycling in African savannas. Cations and much of the phosphorus are returned to the soil where the resulting rise in soil pH increases nutrient availability and decrease the solubility of elements such as iron, aluminium and manganese. Elements such as carbon, nitrogen, sulphur, and some phosphorus, are lost through volatilization or as wind-blown ash. Data from long-term experimental fire plots show lower soil nitrogen levels in areas burnt annually during the late dry season than in early burnt or protected plots, suggesting that significant losses of nitrogen can occur. Some of this may be replaced by nitrogen fixation; N-fixing legumes seem to respond positively to the higher phosphorus levels found in regularly burnt plots, but overall nutrient budgets remain to be worked out (Frost and Robertson, 1987).

Figure 8. Average number of woody plants per 0.084 ha plot (± 1 s.d.) on the Sandveld experimental fire plots, Matopos Research Station, Zimbabwe. The experiment was started in 1947 and measurements were made in 1992. EB = early dry season burn (mid June); LB = late dry season burn (mid September); CP = complete protection since 1947; 1, 2, 3 and 5 = number of years between fires; DSH = diameter (cm) at stump height (approximately 20 cm)

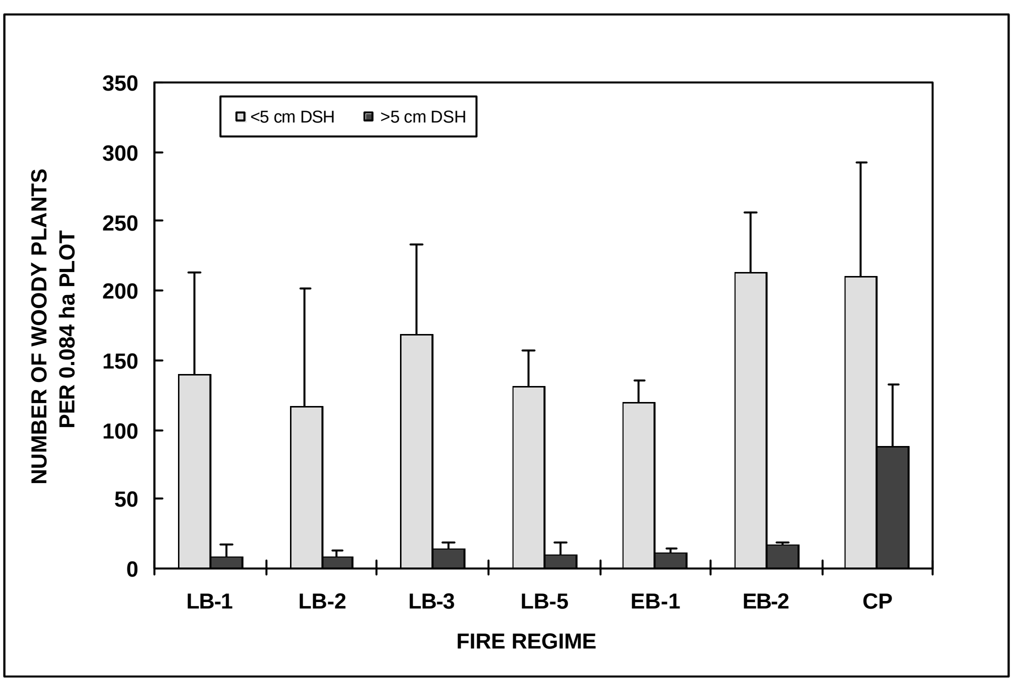


Figure 9. Comparison of woody plant basal area (m^2 ha^{-1}, ± 1 s.d.) under different experimental fire regimes on Sandveld fire plots, Matopos Research Station, Zimbabwe. Measurements were made in 1992. See legend to Figure 8 for further details

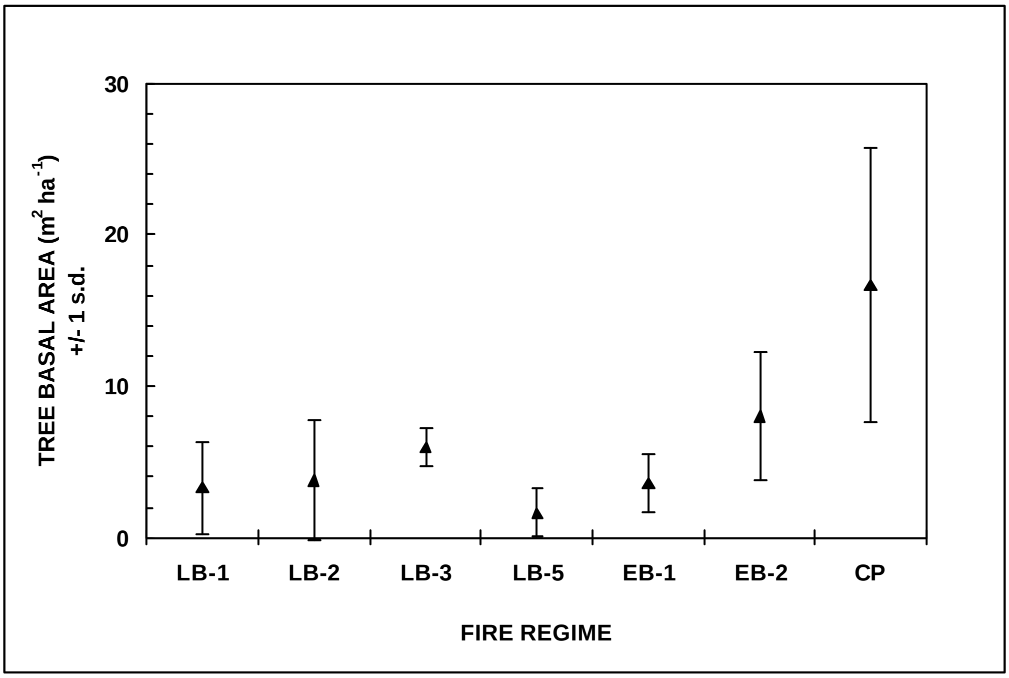
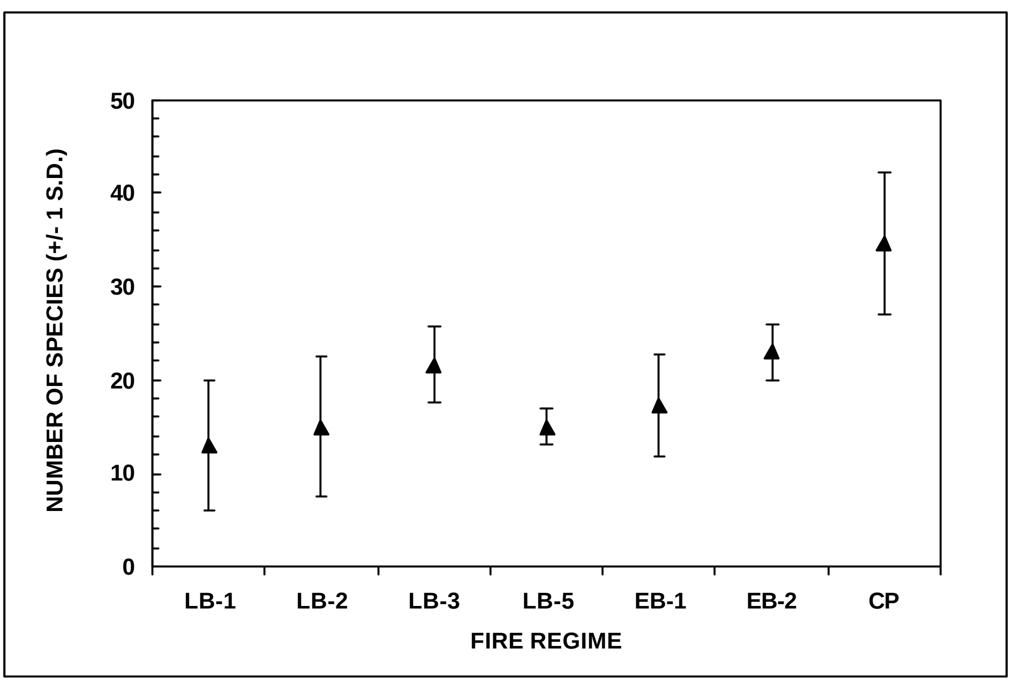


Figure 10. Average number of woody plant species per 0.084 ha plot (± 1 s.d.) on Sandveld experimental fire plots, Matopos Research Station, Zimbabwe. See legend to Figure 8 for further details



<u>**Effects on atmospheric chemistry**</u>

Biomass burning is widely considered to be a significant source of carbon dioxide and other radiatively active and chemically reactive atmospheric trace gases (Crutzen *et al.* 1979, Crutzen and Andreae, 1990; Hao *et al*., 1990; Andreae, 1991, 1997). For Africa south of the equator, Scholes *et al.* (1996b) have estimated the annual emissions of trace gases from wildland fires for one year, 1989, to be 324 Tg CO_2, 14.9 Tg CO, 0.5 Tg CH_4, 1.05 Tg NO_X, and 1.08 Tg particulates <2.5 µm and 0.42 Tg elemental carbon.

Estimates of trace gas emissions from biomass burning are derived from the product of two basic measurements: the amount of biomass consumed by fire and the emission factor for a given gas, defined either as the mass of gas (CO_2, CO, CH_4, NO_X, N_2O, *etc*.) emitted to the atmosphere per unit mass of fuel consumed (usually expressed in the units $g\,kg^{-1}$ dry mass of fuel), or as the mass of carbon or nitrogen emitted in a particular gas per unit mass of carbon or nitrogen released from the fuel. The accuracy of these estimates depends greatly on the quality of the data used to derive them. Substantial advances have been made in recent years in measuring emission factors under both experimental and field conditions (see van Wilgen *et al.* 1997 and papers in a special issue of the *Journal of Geophysical Research*, Volume 101 No. D19, 1996), to the point where these are relatively well known.

In contrast, the amount of fuel consumed by wildland fires is almost never known outside experimental fires. It therefore has to be estimated from a knowledge of the average fuel load present in a given vegetation type within a particular ecological zone and the appropriate combustion factor (the proportion of the potential fuel load that is actually burned by fire). There is huge variation, both between years in response to variations in the amount and timing of rainfall, and between sites in relation to climate, soils, woody vegetation cover, the level of herbivory, and management. Moreover, measurements of fuel load also depend both on the sampling technique and on decisions as to what components of the vegetation and litter to include in the sample (for example, compare the data from the same sites given in Stocks *et al*., 1996; Trollope *et al*., 1996; Shea *et al*., 1996). The amount of fuel actually consumed by fire in turn depends on ambient conditions, fuel load, fuel moisture content, and fuel bed characteristics at the time of burning. Emission factors also vary with combustion efficiency, with those for the products of incomplete combustion (CO, CH_4, particulate matter, *etc*.) being inversely correlated with combustion efficiency (Ward *et al*., 1996).

All this variability introduces considerably uncertainty into the estimates of emissions. Estimates of the amount of biomass burned annually, on which the calculations of emissions are based, are crude and need to be interpreted cautiously. They are derived from highly aggregated data, questionable statistics, and extrapolations from narrow data bases. In view of the negotiations taking place within the United Nations Framework Convention on Climate Change (UNFCCC), there is an urgent need to refine these estimates through more detailed studies of the kinds and frequencies of biomass burning in the tropics, the amounts of biomass burned, and the resulting emissions.

Effects on natural resources and peoples' livelihoods

The loss of woody canopy cover and the reduction in biomass must inevitably mean a reduction in natural resources for people, though quantitative data on this are lacking. Whereas fire undoubtedly enhances the productivity and quality of some resources, notably grasses used for grazing, it diminishes others. These include timber and other wood products, grass used for thatching, and habitat for animals hunted by people. The effects are both direct, by damaging the plants, and indirect, by suppressing regrowth and changing the micro-environmental conditions for establishment and growth. Exclusion of fire, either deliberately through fire control or inadvertently through reduced fuel loads in heavily grazed areas, can also have adverse effects, most notably bush encroachment, leading to a reduction in the grazing capacity of the land. There has been no detailed assessment of the economic or other impacts of these effects on peoples' livelihoods. Clearly, given the widespread and frequent use of fire by people, the perceived benefits would seem to outweigh the costs, though this remain to be quantified and evaluated.

Are fire regimes in the region changing over time?

The incidence of fire in any system has to be viewed in the context of the fire regime of that area. A fire regime is a composite feature that encompasses average fire frequency (or length of the return interval in years), the type of fire and characteristic intensity, and the typical fire size and pattern. Fire regimes differ from system to system as a function of prevailing climate, vegetation and human activities, and are correspondingly dynamic in relation to any changes in these factors.

There are no adequate data on the trends in fire numbers or areas burnt annually in southern Africa. Data from Hwange National Park and the adjoining Matetsi Safari Area in Zimbabwe show no trend in the number of fires occurring annually, and only a slight downward trend in the area burnt each year, during the period 1968-1989. These data come from protected areas, however, and are unlikely to be representative of the region as a whole.

Legal provisions governing the use of fire

Many of the current laws governing forestry and the conservation of natural resources in southern African countries are derived from laws laid down by colonial governments. Such laws were drawn up largely in relation to land held under private tenure and to State-controlled land, although they were applied also to land settled under communal tenure and governed largely by customary law. To illustrate the scope and provisions of the existing laws, examples are given of the laws currently in force in Zambia and Zimbabwe. The laws in other southern African countries are similar.

Zambia

The Natural Resources Conservation Act (Chapter 315, No. 53 of 1970) and the Forests Act (Chapter 311, No. 39 of 1973) both contain provisions for the control of burning. In addition, the Environmental Protection and Pollution Control Act (No. 12 of 1990), while not making specific provisions regarding the control of burning, establishes an Environmental Council which can, among other things, make regulations for the conservation and protection of natural resources. "Conservation" is defined in section 2 of the Act as meaning the preservation of the natural resources and their protection from misuse, **fire** or waste (emphasis added). The 1990 Act also repeals certain Parts of the Natural Resources Conservation Act, though the provisions made in the latter Act in respect of the control of bush fires are unaffected, however.

Natural Resources Conservation Act

The Natural Resources Conservation Act empowers the Minister responsible for water, lands and natural resources to make orders for the conservation of natural resources and for the appointment of provincial and district natural resources committees. The Act also provides for conservation plans and for the establishment of Fire Authorities.

The occupier of any land other than unalienated State Land, a demarcated forest, a game management area, a National Park, or a public road under the authority of the Director of Roads, is required to undertake or adopt measures to prevent, control or combat fires, including making firebreaks and carrying out control burning, where such measures are considered necessary for the conservation of the natural resources on such land (section *thirteen*, subsection (3)(j)). A firebreak is defined as a strip of land that is cleared of inflammable material to a width of 150 feet (46 m) or to such a width, not less than 10 feet (3 m), as may be determined under the provisions of the Act. Failure or neglect to carry out such an order within a reasonable time makes the occupier of the land guilty of an offence. The court may impose a penalty, in addition to ordering the occupier to carry out the order of the Minister within a specified time. Each order made under section *thirteen* must be made by statutory instrument.

Part V of the Act deals specifically with provisions governing the control of bush fires. The key provision is the appointment of a Fire Authority for a particular area. This body is usually the district natural resources committee, unless determined otherwise by the statutory order of the Minister, and is responsible for: cooperating with and assisting the Minister to put into effect the provisions for controlling bush fires; carrying out investigations and inquiries into fires and their causes; keeping records of fires, if called upon to do so; and assisting and coordinating any voluntary arrangements made by occupiers of land in an area to prevent or combat fires.

The Fire Authority has the powers a) to appoint honorary fire rangers or other persons to help detect, report, investigate, and suppress fires; b) to construct and maintain firebreaks in areas where these have been ordered by the Minister; and c) to determine the width of such firebreaks. Using money appropriated by Parliament for such purpose, the Minister may make loans, subsidies or grants to a Fire Authority to enable it to carry out its functions and exercise its powers.

The Fire Authority can, with the approval of the Minister, and at the request of the occupiers of more than half the land within a particular area, prepare and adopt a fire control plan. Such a plan would include provisions for the construction and maintenance of firebreaks and for the place and time of controlled burning, where prescribed by the plan. A fire control plan drawn up in terms of the Act must be published as a statutory instrument made by the Minister. Any person failing to comply with the terms of the plan is deemed to be guilty of an offence.

Burning at specified times and under given conditions can be prohibited by the Fire Authority in areas under its jurisdiction, other than on designated forest land, a game management area, or a National Park. Such bans have to be made by statutory order. The Fire Authority can also carry out control burning to prevent the spread of fires in circumstances where the occupier of land has failed to do so. The Fire Authority can also be directed by the Minister to effect controlled burning of unalienated State Land where this is required in terms of a fire control plan or conservation plan.

Part V of the Act also requires every occupier of land who intends to burn vegetation on his land, or upon land which he is permitted or authorized to burn, to give three days written notice of this intention. This notice must be delivered by hand to all occupiers of land adjacent to that which is to be burnt and must state as nearly as possible the date and time of intended burning.

Forests Act

The Forests Act provides for the establishment and management of National and Local Forests, and makes provision for the conservation and protection of forests and trees. The Act also provides for the licensing and sale of forest produce. National Forests are set aside exclusively for the conservation and development of forests aimed at securing supplies of timber and other forest produce; providing protection against floods, erosion and desiccation; and maintaining river flow. Local Forests are designated exclusively for the purposes of securing supplies of timber and affording protection to local land and water supplies.

Section *sixteen* paragraph (a) stipulates that no person shall fell, cut, fashion, **burn**, injure, take, collect or remove any forest produce from a National Forest without a licence to do so (emphasis added). Paragraph (c) of the same section is more explicit: no unlicensed person shall fire any tree, undergrowth, grass or forest produce, or assist in lighting any fire, or allow any fire lit by himself or his employees or agents to enter a National Forest. The provisions of section *sixteen* also apply to Local Forests, as if a Local Forest were a National Forest (section *twenty-four*). The Act also stipulates (section *twenty-six*) that no person shall fell, cut, fashion, **burn**, injure, take or remove any protected tree without licence, except in or from land held under freehold or leasehold (emphasis added).

The Act also provides for regulations governing the management, conservation, use and development of National and State Forests (section *sixty eight*). Subsection (2) paragraph (n) of this section empowers the Minister to make regulations, by statutory instrument, governing the prevention and fighting of fires in National and Local Forests and in coupes in State Lands, Reserves and Trust Land. Such regulations are contained within The Forest Regulations (SI 98 of 1976 and 31 of 1978).

Protection from fire is dealt with in Part IV of the regulations. In terms of these regulations a licensee is required to prevent and extinguish any fires that break out within or in the vicinity of the coupe, and to carry out such fire-protection works, including the clearing of fire-breaks and the burning of branchwood and waste, as may be required by a forest officer. Burning may only be done under the supervision of the forest officer, unless the licensee is given written permission by the forest officer to do the contrary. Failure to comply with these provisions may result in the work being done by the Forest Department and the costs thereof being recovered from the licensee.

The regulations also make it an offence for any person within any National or Local Forest to smoke where, by notice, smoking is prohibited. Likewise it is an offence to kindle, carry or throw down any lighted or combustible material or article, including fire, matches, lighters, or torch, within or adjacent to any nursery, forest, plantation, mill or depot, except when licensed to do so. Forest officers are empowered to order the surrender of any such lighted or combustible materials or articles where this is considered necessary for safeguarding a forest or forestry property.

Zimbabwe

Provisions for the control of fires and burning of vegetation in Zimbabwe are laid out in Part VIII of the Forest Act (Chapter 19:05). No one is allowed to burn growing or standing vegetation on any land unless they have given notice to the occupiers of all adjoining land and to a police office at the nearest convenient police station, or unless there is a written agreement between the person intending to burn and all the occupiers of adjoining land (section *sixty-seven*). In the latter case, notice of the date and time of the proposed burning must nevertheless be given to a police officer at the nearest convenient police station before the burning takes place. In notifying the owners of adjoining land, the person wishing to burn must first give preliminary notice stating as nearly as possible the date of the proposed burning, which must not be less than two or more than eight weeks after the date of receipt the preliminary notice. This must be followed by a final notice stating the time of proposed burning, which must not be less than six or more than 24 hours after giving that notice. There are further provisions in relation to giving the final notice that allow (a) a fresh final notice to be given if, for any reason, the burning does not take place at the stipulated time; and (b), in the event of it not being practicable to give final notice to the occupier of any land, for the final notice to be given to anyone over 16 years of age on that land, or for a written notice to be fixed in some conspicuous place on the land.

The Act makes provision for any owner or occupier of land who wishes to guard against fires crossing the boundaries of that person's land to request the owners or occupiers of adjoining land to assist in establishing and maintaining fireguards along their common boundary, either by contributing half of the labour or the cost needed to do this within three weeks after such a request (section *sixty-eight*). Should a neighbour refuse to assist or neglects to contribute as required, the person constructing or maintaining the firebreak can do so and recover half of the necessary costs from the neighbour concerned. For the purposes of section *sixty-eight*, Communal Land is regarded as private land and the Minister of Environment and Tourism (now Mines, Environment and Tourism) is deemed to be the owner and occupier of the land.

A fireguard is defined in the Act as "a strip of land, whether under trees or not, which has been cleared of inflammable material" and, for the purposes of section *sixty-eight*, is required to be not less than nine metres wide on each side of the common boundary or other such line as is mutually agreed upon by the parties concerned. If the Minister, in consultation with the Natural Resources Board, considers the nature of the vegetation to be such that a boundary fireguard of 18 metres is insufficient, the Minister may given written orders to the owner or occupier of that land to provide a firebreak wider than nine metres on that person's side of a boundary. The Minister may also require the owner or occupier to establish and maintain on the land internal fireguards of a specified width (section *sixty-nine*). This section also empowers the Minister to authorise the conservation committee of an area declared to be an Intensive Conservation Area under the Natural Resources Act (Chapter 20: 13) to prepare a plan for the prevention of fires within that area. The details of the plan, prescribed by regulation, must include provisions for the following: fireguards; waterpoints; look-out posts; fire rangers; fire-fighting equipment and tools; and communications equipment.

Section *seventy* specifies that anyone on another person's land, whether lawfully or not, or on any road or vacant land, must carefully and properly extinguish any fire kindled or used by that person. Moreover, until this has been done, the person may not go so far from the fire as to be unable to control it by himself or his employees. Section *seventy-one* permits counter-firing to prevent loss or injury to life, person or property, provided that the person concerned takes reasonable care to ensure that the counter fire does not spread beyond the limits needed to secure the person against loss or injury.

If any person acting under the direction or command of his or her employer who by act or omission contravenes any provisions of this Part of the Act, then either or both the employer and employee may be liable for prosecution and, if convicted, punished under the Act (section *seventy-two*). A person who sustains a loss due to fire may recover damages by civil action for such loss, other than for any reasonable and necessary actions taken in terms of sections *seventy-one* or *seventy-five* (section *seventy-three*) . In the event of a person being convicted by a court of an offence against this Act in which it appears that some other person suffered a loss as a result, the court may, on receipt of a written request from the injured party, summarily and without pleading inquire into the amount of damage caused (section *seventy-four*). On receiving proof of such amount, the court shall award damages in favour of the injured party and against the convicted person, the judgement having the same force, effect, and scale of a civil action instituted before the same court. Such a judgement would preclude any subsequent civil suit.

Section *seventy-five* stipulates the procedures to be followed in extinguishing fires. If there is good reason to believe that a fire in the open air may become dangerous to life or property, any person acting in good faith, alone or with other persons under his control, can enter any land for the purpose of extinguishing a fire or preventing its extension (subsection (1)). Alternatively, the person concerned can notify the owner or occupier of the land of his concern and the owner or occupier is obliged to take reasonable steps to extinguish or prevent the spread of the fire. If they do not comply then they will be guilty of an offence (subsection (2)). Other than where a fire is approaching the boundary of a State Forest, in which case the forest officer present has the right to take full control (subsection (3)), any person acting in terms of subsection (1) or any owner or occupier of the land on which there is a fire can assume control of the persons under his command and of any persons who voluntarily place their services at his disposal (subsection (4)).

Section *seventy-five*, subsection (4), also allows the person in control to take whatever measures are deemed reasonable and necessary or expedient in the circumstances to protect life and property, or to extinguish or prevent the spread of the fire. This includes reasonable destruction by cutting, ploughing, burning or otherwise of whatever vegetation or crops may be necessary to achieve control. The person in charge may also call upon any person present or in the vicinity of such a fire to assist or act in whatever way can be reasonably considered to be necessary or expedient to control or extinguish the fire or prevent it from spreading. Provision is also made for the person in charge to order anyone who might be endangered by the fire, or whose presence may interfere with any operations in connection with the fire, to remove himself or any vehicle or any other thing under his control from the vicinity of the fire. Anyone failing to comply with the provisions of subsection (4) is guilty of an offence.

Section *seventy-five*, subsection (6), absolves the State of any liability in respect of any loss or damage arising out of the lawful exercise by a forest officer of the powers conferred on him in this section. It also disallows any claim for compensation or reward by anyone who undertook any acts or provided any services as required by, or ordered to, in terms of subsection (4). The State, however, may compensate or reward a person for loss or damage or services rendered in protecting a State forest from fire, the amount to be paid being determined by Minister with the approval of Treasury. The section also indemnifies anyone in charge of operations lawfully undertaken in terms of the provisions of this section, or anyone assisting in such operations, from any charges of trespass or damages caused in good faith, though the person in charge is required to report the circumstances and actions taken to the nearest police officer, justice of peace, or relevant provincial magistrate.

The penalties for contravening the provisions of the act are given in Part X (Offences and Penalties). The penalty for lighting or assisting in lighting a fire, rekindling a fire, or adding fuel to a fire in a State Forest, without authority, is a fine not exceeding ZWD 4000[20], or imprisonment for a period up to ten years, or both. The penalty for anyone who leaves unattended in the open air on any land a fire that he has lit or helped light, or used, or rekindled, or added fuel, with or without authority, before such a fire is thoroughly extinguished, or who lights, help light, use, rekindle, or add fuel to a fire that spreads or causes injury, may be subject to a fine not exceeding ZWD 1000, or imprisonment for up to two years, or both (section *seventy-eight*). In addition, section *eighty-one* stipulates that it is an offence for anyone in or on a State Forest or private forest to smoke where smoking is by notice prohibited, or to negligently light or throw down any burning match or burning material. A person guilty of such an offence is liable to a fine up to ZWD 200, or imprisonment not exceeding six months, or both.

[20] One Zimbabwe dollar (ZWD) was worth US$ 0.03 in late 1998. The average annual per capita income of Zimbabweans is about US$ 200.

Customary Law

There is little information about the provisions in customary law governing the use of fire and burning of vegetation. In the Western Province of Zambia, whenever local people refer to traditional practice they have in mind the provisions of the Local Authority Orders on bush fires promulgated under the former colonial administration. These provisions included:

a) the right of a Local Authority to set aside areas in which burning was prohibited, including grazing lands and areas in which thatching grass was collected;
b) the responsibility of the Local Authority, in consultation with the District Commissioner and the Agricultural Officer, to organise bush burning in the period May-July, on which occasions everybody in the area was obliged to assist with such burning;
c) the responsibility of every person to construct, by the end of April each year, adequate firebreaks to protect his/her property, including buildings and gardens, from fire;
d) the responsibility and obligation of anyone being aware of a fire that might endanger property to assist in extinguishing that fire;
e) the responsibility and obligation of any person seeing a bush fire to report this to the nearest headman who, with the assistance of all available persons, was obliged to extinguish such a fire, unless the fire was in a garden and under control.

Other provisions included a ban on anyone starting a bush fire without warning neighbouring land owners and users, and a requirement that anyone using fire for cooking to extinguish it afterwards. Within the Western Province of Zambia, the power of Local Authority was vested in the Litunga or king who in turn delegated authority to carry out early burning to *kapasus*, local authority policemen. People found guilty by local courts of violating the local authority orders on fire were fined and the amount put into the Local Authority account. Furthermore, the Litunga designated certain areas (*sitaka*) on the Bulozi (upper Zambezi) Floodplain which were not to be burnt because they were refuges for wildlife (Frost 1992a).

In eastern Zimbabwe, at least one community appoints fire watchers from among the residents whose task is to watch for fires, mobilise fire-fighters where needed, and investigate the cause of, and circumstances surrounding, a fire. The community imposes a sliding scale of fines and sanctions on individuals found to be responsible for lighting a fire without permission, or for failing to control the spread of any fires that they light, the fine depending on such variables as the care taken in lighting the fire, the efforts made to control its spread, and the damaged caused (Mandondo, pers. comm.)[21] The issue of customary law and control over the use of fire is clearly one that needs further investigation.

CONCLUSIONS

Fire as an ecological and socio-cultural phenomenon

Any discussion of policies on fire requires an understanding of the ecological, social and cultural circumstances surrounding its occurrence and uses. People apply fire widely and in many different contexts to manage the land and its resources, and these practices are deeply embedded in the culture and traditions of many societies. These practices interact with and are influenced by the biophysical features of the environment to determine the fire regime, fuel-load dynamics, variations in the probability of ignition, and the impacts of fire on ecological functioning of both natural and anthropogenic landscapes.

Fires have both positive and negative effects that extend far beyond their localized points of origin. Public attitudes on fire are generally shaped by perceptions of the negative effects. These include concerns about the destruction of vegetation, the loss of habitat for plants and animals, threats to biodiversity, reductions in air quality due to smoke, haze and atmospheric pollutants, and the

[21] Mr Alois Mandondo, Institute of Environmental Studies, University of Zimbabwe, Zimbabwe.

contribution of trace gas emissions from fires to global climate change. Only some of these perceptions may be correct but nevertheless they underpin most current policy initiatives on fire.

The positive impacts of fire are less widely appreciated. Fire affects organic matter and nutrient dynamics, maintains habitat for species that have evolved with and are adapted to fire, and acts as a natural disturbance that intermittently alters the composition of plant communities and the age and size structure of constituent populations. In this respect, fire is an important natural phenomenon in the dynamics of most southern African ecosystems, even when it occurs infrequently. It is also a essential tool in the management of such systems and is often necessary for maintaining diversity and productivity.

Options for controlling wildland burning

The problem to address is not one of fire being an unnatural phenomenon nor necessarily one of unwarranted widespread use – people currently use fire because they anticipate and obtain benefits from its use. The problem in southern Africa is one of lack of effective control of fires. The overall goal of a policy on fire therefore must be to reduce the adverse effects of uncontrolled burning. Three policy options seem to be available in this regard (Frost 1992b). First, to do nothing, on the grounds that the problem is overstated or that managing the widespread use of fire is too complex. This *laissez faire* option does not address the concerns identified earlier and it also fails to take account of the considerable available technical knowledge about fire that could be used to improve present practices (Chidumayo 1997). It is not an appropriate option.

The second option, often promoted in public discussions on fire, is to actively discourage or even attempt to ban the use of fire on the grounds that the negative effects far outweigh any possible benefits. This option is impractical, however, because attempts to exclude fire completely from African savanna environments have never yet been successful, other than on small, intensively protected plots. Nor are they likely to be. With the prevalence of lightning and the ease and frequency with which people use fire, often for quite legitimate purposes, an accidental or lightning-induced fire will almost inevitably occur long before the growth of woody cover naturally suppresses fire fuels in the undergrowth. Without fuel-reduction fires, or some other means of lessening fuel loads, such as intensive livestock grazing, the accumulation of fuel over time merely increases the risk of a more intense, and more damaging, later fire. Moreover, exclusion of fire from African savannas would seriously distort ecological functioning in these fire-adapted ecosystems. This option therefore does not adequately address the problem. Any attempt to restrict the general use of fire will fail because people will simply use it covertly and hope they do not get caught. The chances are that they will not.

The third option, to promote a policy of planned and controlled burning is considered here to be the only one that is viable. This option is based on the reality that the use of fire entails both advantages and disadvantages, and that what is needed is to influence and encourage people to use fire in a more responsible, controlled, and beneficial manner so that they obtain the benefits while reducing the environmental, economic and social costs.

Given the wide range of objectives, and the resulting differences in priorities among those who manage the land and its resources, a single approach to implementing this option is neither appropriate nor practical. The challenge is to establish a policy framework that is flexible enough to accommodate different ecological conditions, traditions, cultural values, practices, and social circumstances of the communities concerned while nevertheless promoting actions that will result in a more restrained pattern of use and fewer uncontrolled fires. More emphasis needs to be placed on incentives for improved fire management and control than on sanctions; there is currently too much stress on punitive measures (and too little capacity to enforce these), leaving most people unwilling to take responsibility.

A policy on the use of fire cannot properly be formulated and implemented in isolation from other policies influencing how the land and its resources are used. To be effective, such policies will need to be developed in conjunction and integrated with the broader policies on land use in the agricultural and forestry sectors, otherwise the gains made in one sector may be nullified by conflicting developments in the others.

Fire as a tool in land and resource management

The use of fire as a tool in the management of the land and its resources is integral to the culture and traditions of many southern African societies. People use fire as part their normal agricultural practices both to enhance production and to open up new land for settlement and cultivation in response to the continuing growth of the human populations in these areas. Fire is generally cheaper and easier to use than other available methods to clear unwanted biomass. Attempts to ban its use, in the absence of any more cost-effective alternatives, will not work under current circumstances.

To a large extent the current legislation in southern Africa, as illustrated by the statutes in Zambia and Zimbabwe, implicitly recognises that fire is a legitimate and cost-effective management tool. Despite this, however, there is not necessarily any better control of fire in these countries at present than in many other parts of the world. This illustrates the ineffectiveness of laws that are not, or cannot, be implemented, no matter how well intentioned they might be. Uncontrolled burning is still widespread because the statutory provisions are largely inappropriate for land being used under communal or customary land tenure, where many fires occur. Most governments retain overall responsibility for land and natural resource management in these areas, but often without sufficient capacity to undertake the necessary management and enforcement.

This argues for a shift in emphasis away from government control of natural resources towards a policy of community-based management. Considering that most fires are caused by people, and that those closest to a fire can detect and respond more rapidly to limit its spread and damage than can a centralized agency, responsibility for fire management should be de-centralized to the lowest accountable level. Nevertheless, although the potential benefits of community-based management of natural resources are widely recognized, there are few examples and even fewer successes. Communities are currently limited by a shortage of financial and other resources for management and by a lack of clarity on the limits of individual and communal responsibilities. For communities that have been disempowered for so long it will take time for them to resume responsibility and build or re-create the institutions needed for effective decision-making and action. It will also require ample time, resources and skills to support such initiatives. These costs and conditions should not be underestimated.

To be effective and sustainable, community-based natural resource management programmes therefore require more than just the devolution of management responsibility from central government to local-level institutions. They also require a change in the way governments interact with these institutions. Communities may need assistance initially with making decisions. Appropriate technical information and advice is often needed on the hazards and opportunities associated with using fire in different landscapes; how to use fire more effectively to achieve particular management objectives; and how best to contain and control fires in different circumstances. It also includes ensuring that the communities have, or can easily access, the resources needed to carry out whatever activities are required.

Broad consultation is also needed to ensure that prospective policies are compatible with peoples' land-use objectives, understanding, and capacity to fulfil their obligations. Where peoples' current perceptions and practices conflict with proposals to do things differently, there has to be a reasonable prospect of resolving this through education, training and the adoption and use of alternative technologies. In this respect, more should be done to promote public understanding of the reasons for controlled use of fire. More investment is needed in appropriate educational, extension, and public awareness programmes on fire control and land use.

Technical issues

Reducing the incidence and extent of uncontrolled burning and its adverse impacts has technical, social and political elements, all with important economic and other implications. The key technical issues include the need for the development and adoption of improved land-management techniques, to reduce the necessity for burning and to minimise the risk of uncontrolled fires. Improved early warning systems for assessing fire hazard and estimating risk are needed, but this in turn requires improved regional capacity and infrastructure to use remotely-sensed data from satellites for hazard assessment and long-range climate forecasts. Given experiences elsewhere in the world with smoke haze and related adverse health effects, the capacity to model the dispersion and transport of emissions and resulting changes in air quality should also be developed.

The main social issues centre on the need to develop appropriate and effective institutions for community control over the use of fire, and how best to effect the necessary change in public attitudes and actions. This requires improving peoples' awareness and understanding of the ecological, environmental, social, cultural, land use, and public health issues arising from the use of fire.

Developing community-based institutions to manage the use of fire and to control wildfires requires devolution of responsibilities for the use of fire to local communities, support for community-based decision making and action, and provision of the resources and personnel required to support such programmes. These initiatives will be helped by having harmonized national policies on settlement, land use, agriculture, and forestry, accompanied where necessary by revision of existing policies and laws. Appropriate land-tenure arrangements also need to be introduced, to provide the necessary incentives for communities to make the essential investments of time, effort and resources required for natural resource management and fire protection and control.

Many countries in Africa are currently constrained in their ability to develop and implement effective policies on the use of fire. Issues of social and economic development, education, agricultural production and food security, are often seen to be more pressing. The resources and capacity required to implement policies are limited and declining, more so as governments come under pressure to restructure their economies and reduce spending. Any initiative to reduce the frequency and extent of uncontrolled burning will need to ensure that the necessary capacity exists to put the policies into practice, for they will be ineffective if governments lack the willingness and the means to implement and support them.

Information needs

Given the rapid social, economic, political and environmental changes that are occurring in southern Africa, policies in general and on fire in particular need regular review and, where necessary, revision to allow for their adaptive evolution in a changing landscape. This requires information on the effectiveness of current policies and programmes, as well as monitoring of changes in the environmental conditions and socio-economic circumstances that influence the occurrence of fire. To support development of a comprehensive policy and strategy to address the problems, accurate, up-to-date information is required on the numbers, kinds, locations and sizes of the areas burned, and the causes and effects of these fires. Similar information is needed for monitoring and evaluating the performance of different fire management programmes aimed at reducing the incidence of uncontrolled burning.

Obtaining such information is difficult because of the diffuse nature of fire, with thousands of fires of different sizes, origins and impacts occurring annually across the region, and with wide variation among years. Only satellite-based remote sensing techniques have the potential to monitor fires at such large scales, although the technology and algorithms are still under development (Justice *et al.* 1996, Kendall *et al.* 1997). Support is required for further development and expansion of these initiatives, including the important task of making the information rapidly and readily available to the numerous and diverse user groups.

If responsibility for controlling fires is to be vested in local communities, more information will be needed on the extent of indigenous technical knowledge on the use of fire and its relevance under current circumstances. Given the long history of anthropogenic fire, the many traditions and cultural beliefs surrounding its use, it would be surprizing if there was not a substantial body of knowledge about fire and fire management in different environments. This knowledge has seldom been documented in any systematic way. It urgently needs to be done.

Finally, the costs and benefits of using fire, or promoting its exclusion, have rarely been assessed. The monetary and non-market values of the resources affected by fire, together with the direct and indirect economic impacts of burning, need to be quantified. This would allow decision-makers and society overall to assess the costs and benefits of different policies and practices. In short, we need an integrated, multi-disciplinary approach to the problem, to develop the comprehensive understanding required for framing effective and equable policies on the use and control of fire.

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COMMENTS ON THE SITUATION IN AFRICA

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INTRODUCTION

In this paper, Southern Africa refers to the countries of the Southern Africa Development Community (SADC) which comprise Angola, Botswana, the Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

Forests provide a wide range of goods and services that are important in supporting human life. The value of forests in achieving sustainable livelihoods of the people of Southern Africa cannot be overemphasized. However, the existence of forest resources is threatened with a number of problems and constraints such as forest fires, population pressure leading to increased forest clearing, pests and diseases, overexploitation for wood resource and illegal grazing, amongst others. All these impact negatively on the availability of forest resources and lead to deforestation with is the greatest problem in Southern Africa.

Forest fires are rampant in Southern Africa and are caused by a variety of factors. This paper highlights policy related factors (economic, social, political and legal) which are responsible for forest fires in most parts of Southern Africa.

TYPES OF FOREST RESOURCES

The forest resources in Southern Africa can be classified broadly into indigenous and planted forests. They cover over 60 percent of the land area of the region.

Natural vegetation is predominantly open woodland, relatively dry savannah and dry wooded steppes. There is a total of over 20 botanically distinct indigenous forest ecozones. The major forest ecozones are miombo woodlands, forest savanna mosaics, mangroves, dry deciduous forests, wooded grasslands, and closed forests such as mixed evergreen and semi-evergreen types. The miombo woodland is the most extensive forest type, covering nearly 3.0 million hectares. Due to varying edaphic, climatic and ecological conditions, which are diverse in Southern Africa, there are various types of indigenous forests.

The history of plantation forestry dates back over 100 years. For example, in West Cape in South Africa, a pioneering plantation was established in 1876 to supplement the natural resources for fuel for the early railways reaching into the interior. By 1995, the total area under forest plantations in countries of Southern Africa was estimated at 2,331,100 hectares. The current area under plantations has not been established because not all countries have undertaken inventories of their forest resources. Over 70 percent of the plantations established are meant for the supply of wood to industries and the remaining for fuelwood. Plantations are mainly of Eucalyptus, Cypress, Pine and Wattle species.

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IMPORTANCE OF FOREST RESOURCES

Indigenous and planted forest resources are important from many aspects. These include aesthetic, nutritional, economic, ecological, environmental, medicinal, social, recreational and environmental values, amongst others. A wide range of goods and services are provided which include sawlogs, fuelwood, poles, fodder, edible fruits, medicines, honey, beeswax and various no-tangible benefits, over 80 percent of the people of Southern Africa depend on fuelwood for cooking, heating and lighting. Forests in some countries support a thriving industry based on safaris and game hunting expeditions.

Generally, the importance of forests cannot be overemphasized. They are important in multiple ways and are crucial in supporting sustainable livelihoods.

PROBLEMS IN THE MANAGEMENT OF FOREST RESOURCES

The problems affecting the forestry sector in southern Africa are many and their extent and magnitude differ from one country to another. These include:

- deforestation,
- inadequate information on extent and types of forest resources available,
- inadequate equipment,
- inadequate trained staff,
- inadequate financial resources,
- inadequate research, for example, on indigenous tree species,
- drought and climatic variation,
- inadequate environmental education programmes,
- population presence,
- ineffective forest policies and legislation,
- overgrazing,
- ineffective exchange of information on forestry,
- inadequate training and education, and
- forest fires.

The above problems are common to the countries of Southern Africa, but are not exhaustive. The magnitude of each problem at country level depends on a number of factors, most arising from inadequate financial resources and prevailing policies. Deforestation is the major problem and its causes are numerous. Over one million hectares of forests are felled or burnt every year. The major causes include: Population growth that leads to increased wood demand that outstrips supply, overgrazing, agricultural production, and forest fires, amongst others.

FOREST FIRES

Forest fires are one of the greatest threats to forestry development in Southern Africa. Every year, forests are set a blaze for one reason or another. Forest fires cause enormous physical damage to forests, particularly planted forests of such species as eucalyptus and pines which are not as resilient as indigenous forests. They can be destroyed completely depending on age of the Forests and intensity of forest fires.

Public policies affecting forest fires

The causes of forest fires are many and varied, and an analysis of them indicate that they arise from policies, rules, regulations, procedures which have been put in place by Governments or forestry institutions. However, some of these factors are exogenous; hence Governments and forestry institutions in Southern Africa have little control over them. The various causes outlined below are influenced by factors which are policy related. They fall under political, economic, social and administrative causes.

Political

Fires are caused in some cases because of unsound political decisions. Large areas of forest cover have been lost in the past because of lack of political will and commitment by governments to promote sustainable management and conservation of forest resources. While public statements have been made by politicians on the importance of forest resources, such statements are not matched by practical action, for example, provision of adequate funding for sustainable management and conservation of forest resources. Action undertaken by Governments is, in most instances, reactive rather than proactive. For example, there is the traditional norm to provide extra funds to public forestry institutions when forests have been burnt. Governments seem to become concerned only when the forest asset has been burnt. Due to lack of political will and commitment to promote forestry development, financial allocations to public forest management and environmental protection are by far inadequate, hence protection of the forest resources is not adequately undertaken. There is little preparedness to fight forest fires when they do occur. As a consequence of inadequate funding to forestry institutions and Government managed forestry estates, Plantations Managers:

- cannot procure adequate forest fire-fighting equipment,
- cannot maintain adequate labour force to protect the forestry estate, and
- are practically incapacitated to undertake all essential forest protection activities.

Plantation managers are not able to prepare themselves adequately to prevent forest fires. Thus when there is fire, large areas of forest cover are burnt.

Although the importance of forests cannot be overemphasized throughout Southern Africa, their management and protection are not the priority they deserve, yet forests are the basis of agricultural production and industrial development. Forestry is often recognized as a crucial sector in words only. Priority areas for Government funding often entail defence, internal security, agriculture, education, health and commerce, amongst others. Forestry in the structure of Governments is often a section or division under Ministries of Agriculture, Environment or Tourism, thus submerging its importance. It is in few countries where forestry has been recognized at departmental or ministry levels of Government structures. Governments are slowly recognizing the importance of creating ministries of forestry to give prominence to forestry.

With the advent of pluralism in Southern Africa, there is the perception by most people that they can do what they like. Many people do not understand their rights and interpret democracy as the right to do anything they wish. This has in some cases led to individuals/communities setting forests on fires for whatever purpose.

Development of the forestry sector needs guidance and direction from leaders who are committed to providing services that will promote the sustainable management of forest resources. It has not been uncommon in the past to have ministries, entailing forestry sections, divisions or departments headed by politicians who have little interest or even knowledge of the activities of such ministries. Political support at the highest level on crucial issues that affect sustainable management conservation and utilization of forest resources in such cases is not forthcoming.

Economic

Countries in Southern Africa started adopting Economic Structural Adjustment Programmes (ESAP) in order to improve the welfare of their people and their economies beginning early 1980s. The first countries to adopt ESAP in the SADC region were Zambia and Zimbabwe. The impact of ESAP on the forestry sector has largely been negative.

At national level ESAP has meant:

- reduced public funding,

- restructuring of public institutions (Civil Service) resulting in staff retrenchments/ redundancies,
- adjustment of foreign exchange rates (devaluation),
- privatization of public companies.

In Malawi, for example, the Department of Forestry (DF) is the public forestry institution charged with the mandate of spearheading forestry development in the country and SADC region. During the past four years, funding provided to it has decreased more than 10 fold. ESAP has triggered, the following in the Department of Forestry:

- retrenchment between 30-40 percent of staff in timber, pole and fuelwood plantations in 1995 and 1996,
- reduced funding to various forestry operations. On average the approved annual budgets have been 30 percent of the total financial requirements. In 1997/98, funds disbursed to the Department of Forestry were less than what the legislature had approved. Apparently, funds meant for Department of Forestry were channelled to other public institutions. Therefore it was not possible for managers to:
  - carry out all forest fire prevention measures, and
  - acquire new forest fire-fighting equipment from within and outside the country.

Between June and October of 1997, the Department of Forestry lost 25,000 ha., (nearly 25 percent) of its total plantation resource. Most of the fires were caused by the people who had been retrenched and were still residing in the plantation as Government was not able to pay them their terminal benefits. This situation largely remains the same up to now. There are still some retrenched persons who have not been paid their dues and these are behind some of the forest fires. They reckon that they were unfairly treated and so they take it upon themselves to take revenge against the Government.

Emphasis on exotic plantations

Most countries in Southern Africa have placed greater attention on planting exotic species at the expense of managing indigenous woodlands illustrated by large scale development of Eucalyptus and pine species for fuelwood and construction wood. This emphasis is mainly for economic reasons. This scenario has resulted in neglect of indigenous forests, most of which do not have management plans. The perception by many poor people is that Government is interested in exotic plantation forests, hence resort to undertaking illegal activities such as setting indigenous forests on fire.

Indigenous forest resources for example in forest reserves that are located in rural areas are not given all the attention they deserve. There are few patrol staff who are deployed around them. Poachers can go into forest reserves unchallenged and set fire to forests. Forest staff come to know when fires have reached alarming proportions.

Agricultural production

Areas of natural vegetation are burnt to give way to agricultural production. The system practised is shifting cultivation (known as visoso in Malawi and chitemene in Zambia). Land is cleared of its vegetation and put to agricultural use for two to four years before it is abandoned for another area. Vegetation is often burnt to expand gardens for agricultural production. This system is destructive. With high cost of inorganic fertilizers, most people cannot afford to buy them in order to engage in intensive agricultural production, hence the dependence on shifting cultivation. In some cases, governments have removed subsidies on inputs (essential factors of production) but effected them on consumption. Such policies need to be revisited as they eventually impact negatively on forest resources as highlighted earlier.

Sale of forest produce

Many people in Zambia, Malawi, Tanzania and Mozambique are engaged in the production of charcoal in the rural areas mainly for sale as a means to generate household income. In many charcoal producing areas, there are few seasonal income generating opportunities which people can engage in, hence selling of charcoal appears to be the only business opportunity that exists throughout the year. People are aware that producing charcoal destroys the forest, but they have limited choice for survival. Making charcoal destroys substantial forest. Three hectares of forest are cut to produce one ton of charcoal. Some governments have not been forthcoming to introduce income generating activities in charcoal producing areas so as to shift people's dependence on forests.

Social

The following are social factors which lead to forest fires.

Grazing practices: In many areas, grass vegetation is burnt to give way to flush (green grass). This practice is common among local people who burn the dry vegetation usually during the hot season. This causes damage to regenerating saplings. In many areas of Southern Africa, livestock (cattle and goats) graze on communal lands on a free range basis. Ranching and intensive production of livestock are undertaken, only in a few areas, hence burning of vegetation is relied upon as a means of producing feed for livestock.

Lack of involvement by local communities: For many years beginning with the colonial era, some forest areas were managed by Governments as no-go areas. Local communities (men, women, boys and girls) could not have access to forest products available in such areas, such as grass, fuelwood, mushrooms and timber amongst others.

This latter situation has created animosity in many areas between local communities and public forestry institutions. These conflicts have resulted in people engaging in illegal activities such as deliberately burning the forests. Because of Government Policies on excluding people from participating in the management of the forest resources in their areas, the attitude developed by the people has been that forests belong to the government and not to them. Thus, there is apparently little concern for burning forests, in fact, people take pleasure in torching the forest.

Managing forest areas as exclusion zones for those living around them has been practised by most countries until the late 1980s. It was then realised that the participation of communities in the management, conservation and utilization of forest resources is crucial. The assumption was that public forestry institutions were better managers of forest resources than local communities. Lack of ownership leads to apathy for a burning forest.

Inadequate incentives: Most forest resources such as forest plantations and indigenous forest reserves exist in rural areas, usually isolated areas. In many cases, the people working in rural areas do not enjoy the same social services as those in peri-urban and urban areas. Therefore, the need for motivating staff working in such areas cannot be overemphasized. Unfortunately, staff working in such areas are not given the necessary incentives for them to appreciate that their employers value their services. People working in rural areas also work under harsh and risky conditions. For example, forestry work other than fire-fighting entails activities such as tree climbing and patrolling which are risky. Risk allowances are not provided to fire-fighting personnel. This, couple with the fact that officers working in forest stations are generally not given the necessary incentives, leads to reduced morale. Thus, some forest fires occurring today are a result of low staff morale resulting from poor policies on social services and staff incentives.

Communal property resources: Forests have tended to be adversely affected when there is no title deed to the land. For example in Malawi, Zambia and Zimbabwe, most of the land is communally owned or traditional land. Forests on such lands are viewed by the local communities as *God given*, hence everyone has free access to forests on such lands. This leads to the tragedy of the commons, overexploitation. Every year the forests are burnt by the people for various uses which include agricultural production, hunting and grazing amongst others. The underlying cause are ineffective policies on land use which Government has put in place.

Inadequate coordination: There is inadequate coordination in some cases between forestry institutions and other public institutions, NGOs, and the private sector. The view by many of these institutions has been that forestry development is the responsibility of Government and those private institutions dealing with forestry. Such attitude has led to little participation of NGOs, the private sector and other institutions in the forestry sector in order to provide financial and material support to forestry institutions to enable them procure forest fire equipment or undertake forest fire control measures. Inadequate coordination occurs as a consequence of forestry policies that are outdated and do not emphasize the involvement of community and private sector forestry development.

The forestry sector, for a long time has not been guided by multisectoral forestry. It is only recently that those countries, which have reviewed their policies, have come up with forestry boards composed of members from different disciplines to guide operations of public forestry institutions. Such a move will enhance an unbiased approach to management of forests as well as bring more awareness about the importance of forests to an array of decision-makers.

Administrative

Many Governments in Southern Africa have forestry institutions which do not match with their mandate. Over the years, due to implementation of various projects and programmes which have come though donor support, the mandate of forestry institutions has considerably expanded. However, once the projects phase out and donors pull out, there is very little support from Governments to continue with the activities which were started due to lack of resources and commitment. There are no clear guidelines or procedures on how to continue with donor initiated activities to promote sustainability of the activities. In many countries forest fire equipment acquired through donor assistance has not been maintained since the donors ceased funding the projects. Such equipment is no longer functional.

Enforcement of legal instruments

The forest act is the legal framework for implementing the forestry policy. Any weakness in law will render policy implementation ineffective.

In many countries, the legal instruments that are in place to promote sustainable management and conservation of forest resources have not been effective. For example, penalties for offences committed for setting fire to forests have not been deterrent. For over 25 years in Malawi the fine was about K5.00 (US$ 0.12). This if anything promoted offences to be committed in forest reserves as more benefits were realised by offenders as compared to the fines.

Inadequate forest research: Due to Government policies a lot of emphasis was given to forest research on exotic plantation species in various areas of silviculture, pathology, entomology and against diseases and insect pests amongst others.

Research on forest fire management exists but its use is limited because such research has not been consolidated or its results circulated to implementing agencies. The linkages between forestry research and extension are weak. In addition, many forestry policies are outdated and do not include research on participatory forest fire management. Although forest fires are destructive, to many policy makers it appears natural that people should be burning forests every year as has been for time immemorial. With population growth and pressure on land for a number of land uses that attitude needs to change.

RECOMMENDATIONS

The following recommendations are made to improve forest fire management, and consequently reduce damage caused to forests by fires.

- There is need for political commitment to achieve sustainable management and conservation of forest resources. Governments should ensure that politicians give the political support that is necessary for forestry development and protection. There is need to accord priority to the forestry sector by providing adequate funding and other essential resources (personnel, equipment, etc.).
- There is need to make people aware of the dangers fires pose on forests and consequently their livelihoods. There is also need to educate them on the meaning of democracy, that it entails responsibility now and accountability in future.
- The international world, particularly donors and cooperating partners need to review the ESAP that countries in Southern Africa amongst others are going through considering that unemployment rates in the region exceed employment rates. Implementation of ESAP has negatively affected the forestry sector. Donors particularly lending agencies such as the International Monetary Fund and the World Bank should consider softening the conditions they impose on the forestry sector since the benefits form forestry are mostly social and global.
- The participation of local communities, NGOs and private sector in the management, conservation and utilization of forest resources should be promoted by all governments in Southern Africa. Local Communities have lived within or near forests for a long time, even before policy and legal structures were established. Therefore, the local communities have a basic right to the management of forest resources.

CONCLUSION

Causes that lead to forest fires are related to policies that are in place. Most of these policies are outdated and need to be reviewed so that they are in line with the current social, economic, political and legal development. There is need for governments to have in place a forestry policy that takes into account the needs of the various organizations without compromising the sustainable management, conservation and utilization of forest resources. Participatory forestry development is the key to forestry development, protection and sustainability. Forestry Policies should be formulated not only by Governments alone but also including all the stakeholders so that interests of various sectors are taken into account.

The importance of forestry fire management cannot be overemphasized. There is need for various organizations to appreciate its importance in relation to the socio-economic development of the countries. Participation by various stakeholders in promoting sound forest fire management should be the ultimate aim as this leads to sustainable management and conservation of forest resources.

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REPORT OF THE WORKING GROUP ON AFRICA

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MAIN POINTS RAISED IN DISCUSSION

The discussion began by addressing the question: is fire actually a problem in Africa? It was agreed that, while file is an integral part of some African ecosystems, it can and does cause problems.

This discussion lead to the question: why is fire a problem? In response to this question problems of fire in Africa were characterized into three major categories:

1. Inappropriate use
   - changing fire frequency:
     - increase, leading, for instance, to erosion of biodiversity;
     - decrease, leading, for instance, to accumulation of excessive fuel loads;
   - mistiming – e.g. burning at the end of the dry season instead of the beginning;
   - exclusion of fire:
     - deliberate;
     - inadvertent – reducing fuel load to the point where fires cannot be sustained, e.g. by intensive grazing of livestock.

2. Uncontrolled fires
   - reasons:
     - lack of capacity to control fire;
     - lack of incentives and willingness to effect control;
     - lack of awareness of effects and consequences of fire;
   - consequences:
     - displacement of people;
     - damage to fragile or fire intolerant ecosystems.

3. Policy failures
   - poor integration among sectors;
   - over-emphasis on punishment/sanctions rather than on incentives.

The underlying causes of fire were then identified and analyzed. They were:

- conflicting development policies;
- inappropriate balance and lack of due recognition of different land use options, e.g. cultivation agriculture favoured over pastoralism, which is given inadequate recognition even in areas where it is the optimum land use;

- inappropriate land use and management practises;
- political conflicts or environmental degradation which lead to migration;
- inadequate information, awareness and education at both grassroots and decision making levels;
- adverse macroeconomic policies (devaluation of currencies, reduced or removed subsidies, price deregulation and access to and cost of credit);
- cultural practises, e.g. some cultures have fire festivals or ceremonies during which fires are ritually started without regard to the consequences they may have.

CONCLUSIONS

The group concluded that it was not in a position to make specific policy recommendations, but that it was possible to identify key principles that should guide policy making in fire management. These were:

1) fire management practises should take account of ecological differences/variations, which involves recognizing that in some ecosystems, e.g. the Sahelian annual grasslands, fire should be completely excluded, whereas in others, e.g. moist savanas, it is an essential management tool;
2) fire management must be an integral part of overall land-use policies and practises;
3) fire is a legitimate management tool in a number of African ecosystems;
4) greater regional cooperation is needed in sharing information and resources and taking joint action in relation to fire or its adverse effects;
5) cultural values and socio-economic realities need to be taken into account in formulating policies for different areas, particularly in communicating information and instructions about fire use and management;
6) community based natural resource management programmes require not only the devolution of responsibility from central government to local communities but also increased support for local decision making, including provision of technical information on the effective management of fire.

On the basis of these principles the following policy options and recommendations were identified:

1) to increase its influence on overall policies, the forest sector could be more proactive in enhancing the value of forest resources (e.g. promotion and marketing of NTFPs) and the benefits accruing from them, without compromising their long term productivity;
2) the economic valuation of fire damage should be routinely done;
3) monitoring and evaluation of fire risk, occurrence, extent and impact on resources and human health should be encouraged;
4) forest agencies should create policy review units to respond to emerging opportunities and threats, such as conflicts and environmental degradation leading to migration;
5) the risk of fire damage on fragile sites and associated rehabilitation needs should be taken into account by land use planners;
6) the formulation of fire management policies must involve local communities and take into account their skills and responsibilities.

REGIONAL CONSIDERATIONS

- Since the distribution of natural resources such as forests and water bodies transcends national boundaries, it is necessary that national policies complement each other;
- sharing of technologies, data, training facilities and technical capabilities is desirable;
- priority should be given to building on existing initiatives with respect to fire detection and early warning, rather than starting new ones.

RECOMMENDATIONS

1) FAO should seek to play a catalytic and facilitatory role to enhance the initiatives of regional and national organizations or bodies.
2) FAO should seek to promote and encourage better harmonization of national agricultural and forestry policies.

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1. INTRODUCTION

On behalf of the Executive Director of the United Nations Environment Programme, Dr Klaus Töpfer, I want to thank the organizers of this event, FAO, for inviting us to participate in this important Meeting on Public Policies Affecting Forest Fires. Dr Töpfer wishes all of you the greatest success in your deliberations.

The forest fires of 1997, particularly in Indonesia, sounded an alarm to the international community that we in the United Nations system are ill-prepared to respond effectively to catastrophic environmental emergencies, specifically large-scale forest fires.

Natural and manmade forest and other vegetation fires have always existed, but have only attracted global concern in recent years. The awareness of the over-exploitation of the world's natural resources has been increasing the last two decades. The fast disappearance of the biodiversity in rich tropical rain forests has been especially a growing concern. The first internationally recognized global forest fire disaster was in 1982-1983. In Indonesia forest fires burned down millions of hectares of natural forest, secondary forest and other vegetation types and had serious impacts on human health and on the economies of Indonesia and other countries in the region. More large-scale forest fires followed in 1987, in 1991 and in 1994, with shorter periods in between. Environment and people suffered in the Archipelago and on the neighbouring Asian mainland. Disastrous fires in other parts of the world took place and received more and more international attention.

Closely related with the outbreaks of the fires is the climate phenomenon of El Niño, the process of heating up of the surface water in the Pacific Ocean in the southern hemisphere which has its influence on the climate all over the world. This El Niño phenomenon was particularly strong in the fall of 1997 and in the beginning of this year, creating particularly severe drought conditions.

Throughout the world disastrous large scale fires have affected a number of regions in the last 12 months: in Indonesia, USA, Brazil, Canada, Greece, Spain, Mexico and Eastern Russia. But also in numerous other countries in South and Central America and in Europe, fires caused more environmental degradation and human suffering than previously.

Concerning the involvement of UNEP

As background information, in 1994, the Office of Coordination of Humanitarian Affairs (OCHA) and UNEP established close cooperation to respond to humanitarian and environmental disasters by putting into place a Joint Unit within the Disaster Response Branch of OCHA in Geneva.

OCHA and UNEP was early on closely monitoring the forest fire in Indonesia in 1997 and staying in close contact with the national authorities through the Joint UNEP/OCHA Unit on Environmental Emergencies.

OCHA and UNEP, through this unit, responded to the forest fire emergency in Indonesia. A UN Disaster Assessment and Coordination (UNDAC) mission was deployed to the region and sizeable resources (human, material and financial) were duly mobilized. In this endeavour, we worked closely with UNDP.

The UNDAC Team stayed in Indonesia until 18 November. In December and January the extent of the fires was temporarily reduced by rains but regained strength again in February. A second UNDAC Team went to Indonesia from 28 March – 7 April 1998 to assess again the situation after the fires had escalated.

Earlier, on 6 March 1998, Dr Klaus Töpfer was requested by the UN Secretary-General, Kofi Annan, to coordinate the UN system response to the Indonesian fires. As an immediate measure, the Executive Director established a Forest Fire Team to strengthen the Joint UNEP/OCHA Environment Emergencies Unit in Geneva, drawing staff from UNEP's Assessment Division, the Regional Office for Asia and the Pacific, the Human Health and Well-Being Unit and the Biodiversity Unit.

Specific UNEP activities

Broadly speaking, UNEP carried out seven sets of activities in response to the Indonesian forest fires, namely,

i. In response to the mandate of the Secretary-General, in late April 1998 the Executive Director of UNEP and the Under Secretary General of OCHA organized three back-to-back meetings in Geneva not just on forest fires, but also peat fires and coal seam fires. The first meeting convened international fire-fighting experts, many with experience in Indonesia, to identify priorities and prepare a short-term action plan. The objectives of the plan were to contain and prevent the recurrence of fires in priority areas in East Kalimantan and in other critical areas identified by the Indonesian Government. The plan contained provisions for the fighting packages and other specialized equipment, training, expertise, special aircraft support, and communications. At the second meeting UN agencies and other organizations were invited to provide their perspectives on medium- and long-term actions that could prevent fires. The final meeting was of donors, where we made an appeal for coordinated international assistance and discussed efforts that the international community might take, individually and together, to aid Indonesia. At the time, it was agreed that $10 million in resources and 30,000 fire-fighters were needed only to contain the fires and stop them from spreading.

ii. As a follow-up to these meetings, the UNEP/OCHA Joint Unit on Environmental Emergencies (in Geneva), led the UN system-wide coordination of Indonesian Fires and was successful in the mobilization of international funds and other assistance, in the amount of over $10 million from donors such as Germany, the U.S.A., Norway, and New Zealand, as well as from the private sector; some of this went to the ASEAN Regional Haze Action Plan.

iii. Concurrently, with the support of its Global Reserve Information Database (GRID) UNEP launched a world-wide web site of satellite images from August through October 1998 on the status and distribution of the fires which was utilized extensively by experts world-wide, and in Southeast Asia in particular.

iv. With the World Conservation and Monitoring Centre (WCMC), UNEP financed WCMS's launching of their www. site carrying detailed scientific information on endangered species in those countries concerned.

v. UNEP also funded and facilitated the production of a TVE (Television Trust for the Environment) film on Indonesian Fires (entitled "Primates, Palm Oil and Pyromania"), which was televised by BBC everyday between 19 and 25 February.

vi. Since May, our top expert in our GRID Bangkok office has provided UNEP's technical assistance for relevant activities to the Government of Indonesia, in particular in the fields of assessment of impacts and early detection and preparedness capacity building.

vii. UNEP also has collaborated with other UN agencies on related issues, including WHO, ITTO and FAO. UNEP is implementing a US$750,000 project funded by the Global Environment Facility (GEF) to assist the governments of the ASEAN region (the Association of South East Asian Nations) in capacity building and preparedness for future fire emergencies. The purpose of the project is to help combat forest fires in Indonesia and to prevent regional haze in South-East

Asia. To this end the project provides support to the coordination of existing efforts, the design and establishment of a fire early warning system for South-East Asia, including aerial and satellite surveillance, and public awareness, including the dissemination of the lessons learned. These activities are being developed and implemented in close collaboration with the ASEAN Secretariat. The early warning system that is being designed and set up will have a resolution at 5x5 meters, which will allow for much earlier detection than the previous system that has a resolution of 1 km^2. It is easier to control small fires early on.

The international community's response to the forest fire emergency in Indonesia has been positive. The appeal, made on the basis of recommendations from the Fire-Fighting Experts Meeting in Geneva, in April 1998, was made at a time when fires raged in large parts of Indonesia's East Kalimantan province, threatening much of the region with detrimental smog. With the twin objectives of containing and preventing the recurrence of fires in priority areas, aid priorities were identified such as fire-fighting packages and other specialized equipment, expert advice, training, aerial surveillance, and enhanced communications.

In response to the joint UNEP/OCHA appeal, Germany has provided approximately US$5.5 million in direct assistance for 15 fire-fighting vehicles, forest protection equipment for 50 teams of 20 persons each, small mobile water treatment plants and drilling equipment. The United States is contributing an additional US$2 million for emergency purposes in 1998 – this is in addition to US$3.5 million provided earlier. Other countries also responded and contributed equipment, experts, and cash – notably, Norway and New Zealand.

UNEP's activities were not limited to Indonesia. The organization was invited by Brazil and the Russian Federation, through the joint UNEP/OCHA Environmental Emergencies Unit to provide assistance in dealing with range and forest fires. A United Nations Disaster Assessment and Coordination Team (UNDAC) was recently dispatched to Russia with an earlier one sent to Brazil in April-May. The Team sent to Russia was tasked, in particular, with assessment of the impact of the fires in situ, evaluation and needs for complementary international assistance, and preparation of relevant recommendations to the international community.

What will be future activities of UNEP concerning forest fires and environment emergencies?

Basically, they are divided into six areas:

- First, any policy recommendation should look into fires as one of the underlying causes of deforestation. UNEP as the lead agency in the Intergovernmental Forum on Forests (IFF) Programme Element in *underlying causes of deforestation* and in partnership with CIFOR is ready to work with FAO and other members of the Interagency Task Force on Forests (ITFF) to develop policy options to mitigate and reduce forest fires world-wide. This should be done through the framework of the ITFF, where the role of each agency on forest fires should be defined according to the agency's comparative advantage.

- Second, strengthening the joint UNEP/OCHA Unit on Environmental Emergencies is necessary. The capacity of the needs to be substantially increased, plus the capacity of the rest of the organization to backstop the unit in areas such as assessment, advisory services to governments and policy-development (noting that UNEP/OCHA only responds to emergencies).

- Third, prioritizing the development of early warning systems for environmental emergencies in selected thematic areas. In other words, we will not focus on environmental emergencies where a response has already been mandated to other agencies. For example, oil spills in oceans and coastal areas are the responsibility of IMO (International Maritime Organization) and nuclear accidents are the responsibility of the International Atomic Energy Association. If asked by these to assist, we will. Our focus in early warning and support in response to environmental emergencies will be concentrated in four areas: forest fires, freshwater emergencies, industrial accidents, and chemical accidents. The development of early warning systems for environmental emergencies was adopted as one of UNEP's six areas of concentration by the Governing Council of UNEP at its Fifth Special Session.

- Fourth, strengthening implementation of early warning and response capabilities in developing countries through capacity building. This requires integrating local communities, NGOs and civil society in early warning systems. Early experience shows that fire prevention and suppression are best organized at the local level.

- Fifth, promoting public awareness on causes of selected environmental emergencies and involvement in the implementation of necessary preventive measures.

- Sixth, provision of advisory services to governments on the development of policy instruments for preventing and responding to environmental emergencies, particularly through the development of regional and national legal instruments.

As you can see, I have moved from environmental emergency response, to early warning systems, to capacity building, to the need for policies and relevant instruments. It makes sense that policies and preventive measures are required for preventing forest fires and floods that, when they occur, often result in billions of dollars in losses. It is estimated that the Indonesian fires of 1997-1998 resulted in economic losses to tourism, industry, transportation, agriculture, forestry and additional health costs in excess of $4 billion. This without factoring in the economic losses resulting from negative impacts on biodiversity and ecosystem function loss, nor the loss of the lives of human beings.

Unfortunately, when an environmental emergency of a catastrophic nature occurs, the UN system is simply not equipped to respond expeditiously and effectively. War time efforts and resources can be required. Bear in mind that the UN peace-keeping mission to Bosnia-Herzegovina required 17,000 soldiers. Simply <u>to contain</u> the fires in Indonesia, to stop them from spreading, but not extinguishing them, according to the meeting of fire-fighting experts in Geneva, required 30,000 trained fire-fighters.

Much of the preventive work in reducing environmental emergencies, certainly for forest fires and floods, requires changes in land-use policies and policies for financing preventive measures, including national capacity building in early warning, fire-fighting and flood control, among others.

Mr Chairman, I would like to close with one final point. Policy instruments are required at the international level and not just at the national level. The ASEAN Governments have requested the Executive Director of UNEP, in close collaboration with the Asian Development Bank, to assist them in the development and negotiation of a “Protocol on Transboundary Atmospheric Pollution for the ASEAN Region”. We have been asked to assist because of our expertise in brokering or assisting to broker 24 global and regional conventions and soft legal instruments. At this point, it is too premature to inform you of the elements to be addressed by such a Protocol. We are currently organizing a scoping mission of legal experts to discuss possible elements for a protocol with the ASEAN Governments, their Secretariat, the Asian Development Bank and partner UN agencies. A draft protocol will subsequently be prepared and intergovernmental negotiations launched by 1999. We would welcome the opportunity to consider the recommendations of this meeting and their relevance for the preparation of this protocol. Follow-up with national legislation will be required.

Once again, Mr Chairman, on behalf of Dr Töpfer we sincerely appreciate your invitation to address this meeting and share ideas with you.

Thank you.

GLOBAL MONITORING FIRE POTENTIAL FROM OPERATIONAL SATELLITES

Felix Kogan[23]

SUMMARY

Wildfires are one of the major natural disasters damaging huge forest and grassland areas world-wide. Several hundred million hectares of vegetative lands are burnt world-wide annually having adverse impacts on countries' economies, environment, safety, human health, and wild life. Fire prevention is one of the major tasks of fire policies requiring, first of all, accurate and timely fire monitoring. Considering huge areas vulnerable to fire in the world and limited ground observations, monitoring of fire potential from operational satellites is an important task of global observing system. This paper presents a new technique for monitoring potential fire danger globally from NOAA operational polar-orbiting satellites. The techniques was developed recently and used for assessment of fire danger during the 1998 season of fire-based vegetation clearing in the Brazilian Amazon. Preliminary validations indicate that this technique is useful providing early warning and estimating area and intensity of possible fire activity.

RATIONAL

Wildfires represent the major natural hazards threatening world ecosystems. In forested and wooded areas it destroys more trees than other natural calamities, including pest attacks, tornadoes, frost, volcanoes etc. In both developed and especially developing countries of the world, wildfires have detrimental impacts on economies, environment, safety, human health, and wild life.

The number of wildfires and the amount of burnt areas on all continents is staggering. Several hundred million hectares of forest lands are burnt world-wide annually. During the 1987-1996, around 66,000 fires were recorded in Europe and 133,000 in North America every year. The annual average size of the affected areas were around 544,000 and 4,295,000 hectares, respectively (FAO, 1997). In the Brazilian Amazon, fires burn an area twice the size of Costa Rica each year (Nepstad et al, 1999).

Fire-affected areas increase twofold in years with severe and prolonged droughts. This occurs even in the areas of wet tropical climate, such as the Amazon basin. The most recent examples are severe droughts during the 1997/98 El Niño event, which triggered huge fires in Southeast Asia, central America, South America (Brazil), and eastern Russia. The consequences included dense smog, human health problems, destruction of ecological resources, population displacement, and losses of life.

OBJECTIVES

Fire prevention is one of the major tasks of fire policies requiring, first of all, accurate and timely fire monitoring. Early fire indicators can help prepare resources for fire management well in advance of fire development, use them completely and more effectively, and alert the public.

Considering huge areas vulnerable to fire in the world and limited ground observations, monitoring of fire potential from operational satellites should be an important task of global observing system. The National Environmental Satellite Data and Information Services of NOAA (USA) manages

[23] National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite Data and Information Services (NESDIS), U.S.A.

environmental satellites, collects data, and develops techniques for monitoring Earth's land, atmosphere, and ocean. Recently, a new technique for monitoring potential fire danger was developed and used during the 1998 season of fire-based vegetation clearing in the Brazilian Amazon. This technique provides early warning and estimation of area and intensity of possible fire activity. Some principals and results of fire monitoring in 1998 are discussed here.

BACKGROUND

Two issues of fire monitoring can be currently addressed to by using operational environmental satellites: monitoring active fire and monitoring potential fire danger (fire, which is potentially possible if vegetation material is ignited). Active fire can be monitored from several satellite systems NOAA polar-orbiting satellites, Geostationary Environmental Satellites (GOES), Defence Meteorological Satellite Program (DAMS), and ERS-1. Most techniques are developed for active fire monitoring (Prins and Mensal, 1992; Cahoon et al 1992; Kasischke et al 1994; Roust et al 1997).

Very few techniques are available for monitoring fire potential. One of them, operational Wildland Fire Assessment System was developed and used in the United States (Burgeon 1988). This system contains models for simulation of fire danger, fuel moisture, and drought index. In addition to satellite data, the system requires comprehensive ground observations, which are provided by a network of regular and specialized weather stations. Unfortunately, ground data are not easily available for the entire globe. Therefore, an attempt was made to develop satellite-based system for estimation of fire potential hazard.

PRINCIPLES

Among many factors affecting potential fire danger, the amount of moisture in vegetation and ambient temperature control vegetation dryness. Limited moisture supply and high temperatures can lead to water loss from vegetation, deterioration of vegetation health, dryness, and vegetation stress. Persistent vegetation dryness along with continuation of dry and hot weather can set conditions for fire development. Therefore, estimated intensity and duration of vegetation stress can be used as a proxy for assessment of fire potential and possible fire danger on a large area.

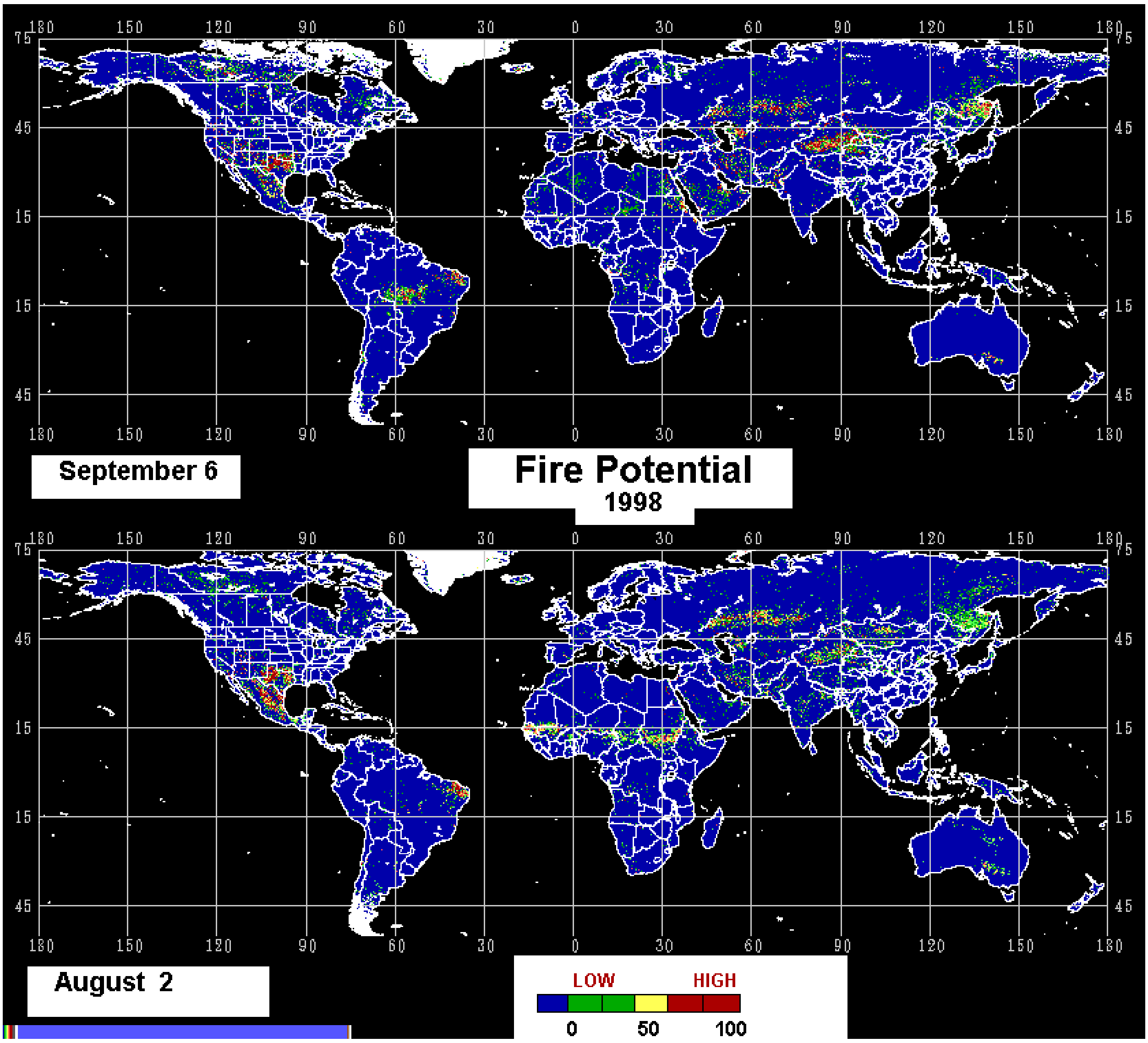
Vegetation stress is derived from a new AVHRR-based drought product (Kogan 1997). This product combines the Normalised Difference Vegetation Index (NDVI) and thermal data into indices estimating numeric vegetation health (condition). The conditions are scaled from extreme vegetation stress (zero) to favourable (100) based on 14-year period of AVHRR data. Reduction of the indices below 35 indicates the beginning of environmental stress when vegetation deteriorate loosing greenness and vigour. Persistent and intensive vegetation stress is a good indicator of potential fire danger.

APPLICATION

Since June 1998, this method was applied to estimate potential fire danger in South America (focus on Brazil). The calendar year summer is a dry season in Brazil when farmers burn vegetation to prepare land for the new cropping year. When this season is drier than normal, fires get out of control destroying vegetation on a large area. Early estimation of fire danger is important for effective fire prevention and control.

The product includes colour coded maps of Vegetation health, Moisture and Thermal condition, and Fire potential. The estimates are produced every week and shown on NOAA/NESDIS Home Page: http://orbit-net.nesdis.noaa.gov/crad/sat/fpm

The **Vegetation Health** map provides information on vegetation condition estimated from both **Moisture** and **Thermal** conditions. The area of deteriorated vegetation health is always delineated when both moisture and thermal stress are detected. However, some areas might experience only thermal stress, while moisture conditions might be fair and favourable or vice versa. Stressful conditions related to only one of the indicators provide some warning, especially if stress is moisture-related. The **Fire potential** estimate is based on intensity and duration of combine moisture and thermal stress. If severe stress (index less than 15) continues for one week, fire potential is minimal, while it reaches maximum if this condition continues for five weeks and longer. Fire potential is higher if vegetation stress is severe and persistent. High level of fire potential due to both moisture and temperature conditions can be used as a **fire danger** warning.



VALIDATION

Analysis of the 1998 fire potential assessments in the Amazonian Brazil, showed that at the beginning of the vegetation burning period (June), which coincides with the start of dry season, vegetation health was close to normal and similar to the 1997 estimates. However, vegetation health deteriorated in the next three months mostly due to severe thermal stress. At the end of August, the area of vegetation stress expanded to nearly 480,000 km^2 compared to around 300,000 km^2 in 1997. Reports from Brazil indicated that 30 percent more active fires were registered during the 1998 dry season as compared to 1997.

The 1998 was a year of high fire potential in a few other world areas. In the Russian Far East and northern Sakhalin island, large area (nearly one million km^2) of high intensity fire potential was well identified in August. In the following two months, huge area of wildfires were developed, as a result, 15 million cubic meters of timber were reported to be burnt and many people were displaced and lost their homes. An early sign of vegetation stress on satellite maps appeared in mid July. Extended fire activity was also estimated in Mexico resulting from intensive and widespread dryness. Satellite indices showed that, severe vegetation stress started in spring 1998 and continued for several months. The affected area was classified as potentially vulnerable to fires activity since early May. In the first several months of 1998, dry and hot weather induced also a high level of fire potential in Indonesia (especially southern Borneo) and Malaysia. Intensive wildfires developed in the area later, as reported, destroying nearly 3 million hectares of woodland and affecting human health by smoke.

CONCLUDING REMARKS

The new indices provided accurate and early information about potential fire activity. Their advantages are clearly justified because they:

- provide an early warning and global view for efficient fire management;
- utilize universal approach permitting comparison between the ecosystems;
- independent on ground measurements, which are not available;
- provide satisfactory preliminary results of validation.

Further work should include validation of this results in other areas and weather conditions different from 1998. In addition to a media reports used for validation, it would be desirable to have actual measurements of fire activity, such as area affected (with coordinates or administrative regions) by fires, time of the fire start and end, and a size of vegetated area burnt. These in situ measurements will help to calibrate satellite-based fire potential indices and adjust them to specifics of local environmental resources and management practice.

Therefore, we are open for a cooperation with the global community regarding these issues.

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FOREST FIRES: CAUSES AND IMPACTS, PREVENTION AND REHABILITATION

INFORMATION NOTE ON RECENT, CURRENT AND FUTURE ACTIVITIES WITHIN UNESCO'S PROGRAMMES

Malcolm Hadley[24]

The recent extensive fires in forested lands in many regions of the world –Sumatra, Kalimantan and other parts of South East Asia, "Siberia and other eastern regions of the Eurasian land mass, Amazonia, Mexico and Southeaster USA, lands around the Mediterranean basin, etc. – have served to focus public and political attention on approaches to rehabilitation as well as on prevention. UNESCO has a certain experience in these fields, from both a technical and operational angle, as indicated in the following summaries.

TECHNICAL INFORMATION ON THE REHABILITATION OF FIRE-AFFECTED LANDS

Secondary forests, degraded zones and other human-impacted areas comprise an increasingly large proportion of terrestrial ecosystems, in tropical, subtropical, Mediterranean and indeed other regions. Such systems have received relatively little attention compared with "intact" systems, and there is a growing need for improved scientific understanding on which the effective management (including the rehabilitation of degraded areas) can be based. Several initiatives sponsored or supported by UNESCO have sought to compile and compare existing information on rehabilitation processes and practices, and to plan future collaborative activities.

In the Mediterranean-climate region, syntheses of information in the past have included a multi-authored review of fire and fuel management, published as MAB Technical Note 11.

In South East Asia, several UNESCO regional technical seminars on tropical forest rehabilitation have been held: in Kuala Lumpur (February 1992), Hanoi (June-July 1993) and Brisbane (November 1991 and February 1997). In July 1993, a regional training workshop on the rehabilitation of degraded lands took place in Thailand, following an earlier study tour to field sites in Indonesia, Malaysia, Thailand and Vietnam in April 1993. Bringing together recently published work on the rehabilitation of degraded lands was the aim of a 468-page annotated bibliography published in late 1995 by the UNESCO Office in Jakarta.

PRIVATE SECTOR-GOVERNMENT COOPERATION IN RESOURCE MANAGEMENT AT KUTAI, KALIMANTAN

At Kutai National Park in East Kalimantan (Indonesia), an association has been formed between the park authorities and private companies involved in the exploitation of coal, petroleum, natural gas or forest products within or adjacent to the park. These companies are represented on the Friends of Kutai, a mechanism for mobilizing support from private corporations for national park management and for the Kutai National park Management Support Project initiated in mid-1995 as a joint initiative of the Government of Indonesia, UNDP and UNESCO.

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Activities include rehabilitation of degraded forest areas, integration of park zonation with regional land use plans, agricultural extension work in the park buffer zone, and preparation of conservation education materials for inclusion in local school curricula. Factors contributing to initial achievements include the operation starting at a relatively small scale, the importance of enlisting the active support of at least one company from the very beginning, avoidance of creating a new bureaucracy, and basing activities on a bottom-up approach. As such, the Friends of Kutai operation has implications for promoting industry-government cooperation in protected area management and degraded land rehabilitation elsewhere in Indonesia and in other countries.

An overview of the project has been prepared by the UNESCO Chief Technical Adviser (Raleigh Blouch) and two Indonesian experts (Warsito and Yaya Mulyana) and published in evaluation report on the two-year UNDP-UNESCO project at Kutai provides additional background and information.

OCEAN-BASED DATA FOR FORECASTING FOREST FIRES

Fires are more likely to occur during exceptionally arid conditions like those brought about in south East Asia by the occurrence of El Niño events every four years or so on average. El Niño events are now predictable with a high degree of accuracy nine months to one year ahead of time, allowing preventive measures to be developed and safety precautions to be taken. The forecasts are made using advance numerical models that threat the atmosphere and the ocean as a coupled system. The data used by the models to make the predictions come from a variety of observing systems in the Pacific Ocean and South East Asia, including:

- the array of 70 or so buoys deployed by Japan and the USA in the Tropical-Atmosphere-Ocean (TAO) array in the equatorial Pacific Ocean, and which measure the properties of the surface, the upper ocean, and the air over the ocean;
- the commercial vessels in the Ship of Opportunity Programme (SOOP) which is run jointly by the Intergovernmental Oceanographic Commission (IOC) of UNESCO, and the World Meteorological Organization (WMO) as part of IGOSS (the Integrated Global Ocean Services System). The ships use disposable bathythermographs to measure upper ocean conditions along their tracks;
- the tide gauges of the IOC's Global Ocean Sea Level System (GLOSS), which are placed on mainland and island coasts around the Pacific and South-eastern Asia. Changes in sea-level measured by the gauges are accurate indicators of El Niño events;
- the satellite remote sensing devices such as the altimeters which measure the tiny variations in the height of the sea surface as well as the radiometers which measure the sea surface temperature.

These various observing systems form parts of the Initial Observing System of the Global Ocean Observing System (GOOS), which is sponsored by the IOC, WMO, UNEP and ICSU.

CLIMATIC VARIATIONS AND THEIR EFFECTS IN SOUTH EAST ASIA

For several years, the UNESCO Office in Jakarta has been carrying out ongoing assessments of climatic variations of the El Niño-Southern Oscillation (ENSO) and the occurrence of drought in Indonesia and other countries of the region such as the Philippines. Examples of long-term data sets have been compiled and analysed are those of air temperatures for Jakarta from 1865 to the present. Approaches and results have been described in volumes in a series on "Contending with Global Change" produced by the UNESCO Office in Jakarta and in research papers in the open scientific literature (see for example two papers by J.R.E. Harger in the journal *Atmospheric Environment*, Volume 29, Number 16, 1995, including one on "ENSO variations and drought occurrence in Indonesia and the Philippines").

APPROACHES TO FIRE PREVENTION AND MANAGEMENT

Field research has underlined the importance of forest cover in ensuring a number of ecological services, including those of preventing soil erosion and mitigating against the spread of fires. Thus, during the 1982-1983 fires in eastern Kalimantan, burned-out areas were mainly confined to logged-over forests, with intact forest systems remaining largely unaffected. More generally, testing of integrated approaches to sustainable development is one of the principal aims of sites contributing to the World Network of Biosphere Reserves. Biosphere reserves contribute to the *in situ* conservation of biological diversity, as do a number of sites inscribed on UNESCO's World heritage List. At a number of specific Biosphere Reserves and World Heritage sites, national collaborating institutions carry out fire-related research and management, including Kakadu (Australia), Cerrado (Brazil), Comoé (Côte d'Ivoire), Galapagos (Ecuador), Cibodas (Indonesia), Amboseli (Kenya), Yellowstone (USA).

INPUTS INTO MEETINGS, STUDIES AND PROJECTS

Technical and other inputs have been provided into a range of recent activities organized by national institutions relating to fire ecology and management, including the effects of El Niño. Thus, in Indonesia, examples include:

- Participation in the "International Conference on Science and Technology for the Assessment of Global Environment Change and its Impact on the Maritime Continent of Indonesia" (Jakarta, 10-12 November 1997).
- A joint water supply project entitled "Clean Water Programme" for remote highland villages in and around the Baliem Valley in Indonesia's Irian Jaya province, as a response to the drought affecting East Indonesia. Collaborative project of UNESCO, UNICEF and the Danish and German Embassies in Indonesia.
- UNESCO support to "A Preliminary Study on the Impact of Forest Fire on the Biodiversity and its Ecosystem in Cibodas Biosphere Reserve, West Java", carried out by the Indonesian Institute of Sciences (LIPI).
- UNESCO-IOC support of the "National Workshop on El Niño Impacts Assessment" (Jakarta, 7-14-26 March 1998).
- Support for and participation in the photo and art exhibition "Kalimantan on Fire", designed to heighten general public awareness and information on the forest fire issue (Jakarta, 20-30 April 1998). An on-line version of the exhibition has been opened at the UNESCO-Jakarta web site (http://www.un.or.id/unesco/forestfire).
- Enhancing national information capacity for fire management for improving biodiversity conservation in Indonesia, in cooperation with MAB-Indonesia and the Indonesian Institute of Sciences (LIPI) and the Ministry of Forestry, in line with the Clearing House mechanism for the Convention of Biodiversity. Support has also been provided to the development of public awareness campaigns using national television and radio as well as Internet and printed materials.

PROJECT ON THE UNDERLYING CAUSES AND IMPACTS OF FIRES IN SOUTHEAST ASIA

Plans have taken shape in 1997-98 for a project on the underlying causes and impacts of fires in Southeast Asia, as a joint initiative of the Center for International Forestry Research (CIFOR), the International Center for Research in Agroforestry (ICRAF) and UNESCO. The project builds on existing cooperation between the three organizations, for example in a project on "Alternatives to Slash and Burn".

A three-tiered approach is envisaged, including (1) a general overview of the fire situation for the entire region, (2) a more detailed assessment in Sumatra and Kalimantan to examine the extent to which their fire characteristics are representative of Indonesia as a whole, and (3) a detailed assessment of causes and effects at the site specific level with several detailed study sites in Kalimantan and Sumatra. The research is designed in a modular way: each module can stand independently but complements and supports the others. The general assessment will identify where and when fires have occurred in Indonesia over time, whilst the site-specific assessments will identify, over time, what kind of actors/agents have caused certain types of fire and why.

A project proposal was developed in 1997 and has subsequently been revised through a process of successive approximation and in the light of discussions with various Indonesian institutions and interested donor agencies. Financial support for the first two parts of the project has been approved by USAID.

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WORKSHOP ON WHO HEALTH GUIDELINES FOR EPISODIC VEGETATION FIRE EVENTS

Dietrich Schwela[25]

I. BACKGROUND

Human-caused and natural wildfires in forests and other vegetation as well as land-use fires occur in many parts of the world. Smoke from vegetation fires consists mainly of fine particulate matter in the respirable range and to a lesser extent, of carbon monoxide and polycyclic aromatic hydrocarbons, which are not generally relevant to the long distance transport of air pollutants. During the episode of smoke in the South East Asian countries, monitoring of particulate matter of mean aerodynamic diameter at or below 10u has shown that short-term air quality standards of WHO's 1987 air quality guidelines for respirable particulate matter are largely exceeded.

The recurrence of transboundary smoke originating from uncontrolled forest fire and land-use fires in many countries around the world causing acute and long-term respiratory health problems requires a comprehensive strategy based on broad international consensus. Any comprehensive strategy must include:

- rapid detection capability of uncontrolled forest fire emergencies on a global scale;
- the gathering of useful and reliable monitoring data and health surveillance;
- the dissemination of information to all affected parties for appropriate decision making; and
- the development of national environmental and health response plans to forest fire emergencies, based on an international guideline.

Environmental as well as health aspects, cause-effect relationships, long-range pollution transport, etc. must be taken into consideration.

Case studies on the health impact of past and current large area forest fires must be examined and used to:

- correlate induced health effects with downwind concentration levels of particulate emissions and other pollutants; and
- develop a series of recommended steps for decision making and actions to be taken, when particulate and other pollutants from regional vegetation burning reach unacceptable levels.

Advanced monitoring data already collected and currently being measured in case studies of regional fire and smoke episodes from satellites, aircraft, and ground-based air sampling networks must be reviewed and examined in the context of its possible interpretation and use by the international health care community, in early decision making after the detection of fire event. The combination of global and regional meteorological data, atmospheric mass transport modelling, and real-time monitoring data on primary biomass particulate emissions, secondary aerosols, and other pollutants must be viewed as a vital part of any comprehensive strategy to both determine large area forest fire or source emissions characterization and downwind air quality impact on human population, quickly, for decision making during the episode.

A workshop of a small group of high-level experts with personal experience covering collectively all pertinent aspects of the problem was convened and the experts were organized into two Work Groups covering:

[25] Air Pollution Specialist, WHO, Switzerland. Paper sponsored by World Health Organization (WHO), World Meteorological Organization (WMO), United Nations Environmental Programme (UNEP), CEPIS/PAHO/WHO.

Work Group I – Environmental Health Issues:

a) medical case studies of induced health effects resulting from large fire events;
b) air pollution exposure assessment;
c) air pollution (particulate matter) toxicology and epidemiology;
d) effects of smoke from vegetation fires on human health;
e) methods of health surveillance; and
f) government health policies, including early emergency response procedures.

Work Group II – Environmental Monitoring and Global Meteorological Modelling Techniques:

a) chemical properties/speciation of compounds, especially particulates;
b) advanced regional and global satellite, aircraft mounted, and ground based environmental monitoring technologies;
c) global and regional meteorological mass transport modelling, forecasting, prediction of concentrations; and
d) regulatory environmental policies, including early emergency response procedures.

The experts came from different regions having shared interest in this problem (i.e. Latin America, North America, South East Asia, Western Pacific, and Africa).

WHO, at present, does not have any guidelines on how to advise Governments in emergency cases such as encountered with respect to vegetation fires and the smoke possibly affecting millions of people. As a consequence, it was determined that such guidelines should be developed on a very short time base.

The final guidelines will be based on a background document developed by a consultant from background papers that were solicited from and prepared by the small group of high level experts. The consultant, Orman Simpson, USA was named by AMRO/PAHO for the purpose of commissioning background papers, developing the background document, organizing a working meeting of the expert group, hereinafter referred to as the Expert meeting, and preparing a final draft referred to as the Expert Meeting, and preparing a final draft Guidelines document for delivery to WHO. The outcome of the Expert Meeting was a first draft Guideline document "WHO Guidelines for Vegetation Fire Periodic Events" which will be reviewed on a time-limited basis after the Expert meeting by the Workshop Chair and two Vice-Chairs. Based on the results of the Review, a final draft Guidelines document are to be prepared and delivered to WHO. WHO will then review, edit, and publish the final Guidelines. In addiction, the background document of papers written by the experts will be published as a scientific reference to the final Guidelines.

Elements of the draft guideline document include, but are not limited to the following:

1. review and summary of globally available information and case studies on the health impacts of vegetation fires;
2. review and summary of globally available monitoring information and data from measurement campaigns on vegetation fires;
3. characterization of air pollutant components in vegetation fires and their associated health effects;
4. recommendations on the interpretation and use of monitoring data, global and regional meteorological data, and atmospheric mass transport modelling to determine source apportionment of smoke episodes (i.e., large area source emissions characterization) and determine or predict down-wind air quality impact on human population;
5. review and summary of existing national guidelines on forest fires emergencies;
6. guidance on scientific methodologies for studying vegetation fire-induced health effects;
7. guidance for contingency plans, including a series of recommended steps to be used in decision making during a fire episode and actions to be taken:
   - protective devices
   - information of the public
   - practical advice
   - training
8. guidance on regulatory environmental and health governmental policies and legal aspects.

The Expert Meeting was held at CEPIS, Lima, Peru during the week of 5-9 October and was co-sponsored by WHO, WMO, and UNEP.

The Lima Expert Meeting objectives included the following:

1. Review and summarize globally available information and case studies on the health impacts of smoke generated by vegetation fires;
2. Review and summarize globally available monitoring data and information from measurement campaigns on vegetation fires;
3. Review and summarize existing national guidelines of forest fires emergencies;
4. Develop a draft "Health Guidelines on Periodic Vegetation Fire Events" giving guidance on mitigation measures, vulnerability reduction, preventive action, environmental policy options, and future emergency response mechanisms.

These recommendations and guidelines should then be brought to the attention of the responsible national, regional (e.g. ASEAN) and international bodies (e.g. UNCSD) by the WHO Director-General. These recommendations should also form the basis for suitable arrangements and mechanisms (e.g. emergency response, vulnerability reduction, environmental health action plans, etc.) within WHO, at country, regional, interregional and global levels.

II. OUTLINE OF THE GUIDELINES DOCUMENT

Title: WHO Health Guidelines for Episodic Vegetation Fire Events

Introduction

General Introductory Section

Air pollution from forest fires and health

This section sets the scene for the rationale and development of the guidelines for fire and smoke emergencies, implementation, etc.

Basic facts

Types and causes of wildfires and land-use fires, physico-chemical aspects of air pollutants from forest fires, definitions, notation, measurement techniques, sources of different types of data, interpretation of data for decision making, influencing factors affecting concentrations, source emission characterization and determining downwind exposures and their associated health effects, assessment of health effects in practice, quality assurance issues in implementation of guidelines for forest fires, etc.;

Global situation

Overview of the exposure situation with regard to forest fires events in different world regions; highlighting key problems and issues, with emphasis on developing countries, lessons learned, on the basis of literature and case studies.

Role of guidelines for forest fire emergencies

How to use and apply the guidelines. Developing a national policy and strategy for responding to vegetation fire and smoke emergencies. How to obtain and use data for decision making in environmental health action plans.

Guidelines on “forest” “vegetation” fire emergencies for public health protection

1.1 Smoke episodes emissions characterization and assessment of health risks related to downwind air quality.

1.2 Guidance on measures in emergency cases, contingency plans:
- information of the public
- protective devices
- mitigation measures
- practical advice
- training

1.3 Guidance on methodology for assessment of health effects induced by burning of vegetation: epidemiological studies of short-term, long term effects, study design, confounding variable, statistical evaluation, etc.

1.4 Application of appropriate short-term air quality guidelines: applicability of WHO air quality guidelines, application of other short-term guidelines, e.g. emergency values

1.5 Factors influencing health outcomes: description of the influence of elevation, humidity, tropical climate, nutritional status, health status, vulnerability, etc. on the actual health impacts of air pollutants from vegetation burning on the individual and on vulnerable groups

1.6 Guidance on regulatory environmental and health governmental policies and possible legal issues.

Prevention of future health affecting events

Emergency response and present technological tools available to minimize and/or prevent health impact of smoke episodes. Policies and actions to prevent future uncontrolled wildfires and undesirable land-use fires around the world. Recommendations for future environmental data gathering during smoke episodes and its interpretation/use by public health officials.

EXPERT MEETING

Title: Expert meeting on Health Guidelines for Episodic Vegetation Fire Events

Venue: CEPIS, Lima, Peru

Time: 6-9 October 1998

Objectives:

1. review and summarise globally available information and case studies on the health impacts of smoke from vegetation fires;
2. review and summarize globally available monitoring data and information from measurement campaigns on vegetation fires;
3. review and summarise existing national guidelines for forest fires emergencies;
4. review and finalise a daft “WHO Health Guidelines for Episodic Vegetation Fire Events”

SUSTAINABLE FORESTRY NATIONAL AND GLOBAL PERSPECTIVES - A MULTI-YEAR TRAINING PROGRAMME MANAGED BY THE ENVIRONMENT AND NATURAL RESOURCES DIVISION OF THE ECONOMIC DEVELOPMENT INSTITUTE OF THE WORLD BANK (EDIEN)

Nalin Kishor and Carlos E. Bertao[26]

PROGRAMME BRIEF

Title of Programme: **Sustainable Forestry: National and Global Perspectives**

Targeted Regions: AFR, EAP and LAC

Duration: Three year programme for FY99, FY00, FY01

Managing Division: Environment and Natural Resources Division of EDI

Programme Team: Bertao, Blanchez, Ducrot, Furtado, Kishor, Wachira.

Justification and Objectives: Despite ongoing national and international efforts at controlling deforestation, the loss of forest cover on a world-wide basis continues at an alarming rate. Recent estimates put the loss of tropical rainforests due to human intervention at about 20 million hectares per year. Of this, it is estimated that a forest area equal to the size of Switzerland is being lost each year in South East Asia alone. In addition, 1997 was particularly bad for forests because of the El Niño effect and may well be remembered as the year in which the world's forests caught fire and over 12 million acres of forests burnt in Indonesia and Brazil alone. In fact, the forest fires of 1997 for Indonesia may be a contributory factor to the severity of the current economic crisis; and require to be addressed on an urgent basis to get the economy back on track. The full extent of the damage caused by the forest fires in Roraima (Brazil) is still to be estimated.

While national level commitment to control deforestation is crucial, regional coordination is often critical. For example, the Congo Basin includes the second most important rain forest in the world after the Amazon Forest. For six of the Basin countries (Cameroon, Gabon, Congo-Brazzaville, Congo-Kinshasa, Central Africa Republic, Equatorial Guinea) the forest is disappearing at an alarming rate. There is a need for these countries to coordinate their efforts and harmonize their policies so that the forest and natural resources are managed in a manner consistent with sustainable growth.

Recognizing that forests world-wide are under threat (as are the ecological, economic, environmental and social services they provide) provides the justification to examine policies and options for sustainable forest management. Besides, there are no existing professional networks that allow for the exchange of information and experiences which in turn would help stimulate institutional and policy reforms in the regions where tropical rainforests are important assets.

Thus, the basic goals of the programme are: (a) to develop dissemination and training activities on forestry issues; (b) to create professional networks to foster institutional and policy reforms in the forestry sector, and (c) to foster a regional approach to forest conservation where the boundaries of the forest ecosystem go beyond geographical boundaries. In this context, there is a need to take a

[26] The, World Bank, Washington, D.C. 20433 U.S.A.

second and more careful look at the "traditional" issues such as concession management policies, stumpage fees, forest based industry, certification, ecolabelling and international timber trade, and how they can be implemented more effectively. It is equally important to examine how emerging issues such as global markets for carbon sequestration, bioprospecting, soil and watershed protection, etc. are relevant in providing additional tools for forest management.

The important reasons for EDI to initiate a programme in this area arise from:

- demand from operations (EAP, AFR and LAC) to help with training on forestry policy reforms;
- request from Bank staff involved in the ongoing review of the Bank Forestry Policy;
- demand from donors, for example from the G-7 associated with the Rainforest Pilot Program in the Amazon, and the Commission of European Communities for the Congo Basin programme;
- the need to identify priority areas for policy training within the context of the recently finalized WWF-World Bank alliance for sustainable forest management;
- recommendations from our client country representatives made, for example, at the forestry workshop in the Asia Development Forum;
- the set of meetings between James D. Wolfensohn and CEOs of forestry companies.

Overall, this programme fits into the revamped strategy of EDIEN which includes forestry management and biodiversity conservation as a major focus area. It will also include the division's ongoing efforts on forestry in the Congo basin and on forest fires in East Asia. Furthermore, EDIEN is well placed to tap into the synergy offered by global networks and partnerships and by organizing cross-regional dissemination and training activities for multisectoral audiences.

Programme Design and Components: Overall, this programme will consist of multi-sectoral, stakeholder and audience policy seminars on a regional basis that promote (a) an exchange of concerns and priorities between stakeholders and sectoral interests, and (b) an exchange of experiences between countries, so that participants identify constraints and solutions to the setting of priorities and implementation of policies at all levels. The programme will focus on three themes: issues identification, learning of methods and exchanging experiences, and problem solving.

The programme has two focussed yet interconnected components. These are: (i) International; and (ii) Congo Basin.

<u>(i) International:</u> This component will be implemented in two stages. First FY99 will be dedicated to convening three international workshops/conferences (one in AFR, one in EAP and one in LAC) to discuss the following forestry issues on a broad level:

(a) Fire Hazards, Transboundary Haze and Sustainable Forestry[27];
(b) Policies for Sustainable Logging, Forest based Industry, and Timber Trade; and
(c) Managing Forests for Biodiversity Conservation and Climate Change Mitigation[28].

These topics were chosen on the basis of initial feedback and consultations. The objective of these activities is to identify specific regional training needs foster the formation of networks, gather training materials on best practice examples around the world and identify resource persons on specific issues in preparation for the second phase. In order to encourage cross-regional networks and sharing of information, each activity will be interregional in nature, including a group of "core" participants from each of the three regions (AFR, EAP, and LAC), who would participate in all three international events, plus 20/25 "regional" participants, who would attend only the workshop/conference in his/her region. Dissemination and learning will be fostered via presentation of topical papers and panel discussions; and is likely to include a field trip to enhance the learning experience via a hands-on activity.

The second phase of the programme will be implemented during FY00 and FY01 and will respond to region and country specific needs, based on the information gathered in the first phase activities.

[27] Donor funding for the East Asia component of this programme is available.
[28] This also supports the activities under the Biodiversity and Conservation, and Globalization and Sustainable Development (Global Environmental Issues) programmes of EDIEN.

(ii) Congo Basin: The programme was designed by Operations and the Commission of European Communities. It consists of five activities three of which will be implemented by EDI[29].

The first activity is a Hearing to outline the regional problems and prospects for the African forest. The second activity is a ministerial level workshop to design a training/dialogue programme/process for the Congo Basin countries. These two activities have already been completed.

The third activity is a workshop on the development of forest policies for key policy makers. Besides providing participants with analytical and managerial tools, the workshop will promote the emergence of a common vision on the place of natural resources (including managed forests responding to regionally accepted criteria of sustainability) in the sustainable development of the region.

The fourth activity is a study tour for key policy makers in a region outside Africa which is facing comparable challenges in creating policies for the sustainable development of their forest.

A final regional workshop will serve as a forum to propose the important common elements of joint regional forestry policies (including the setting of criteria and indicators of sustainability) and the instruments to implement them. These common elements will be taken into consideration in the subsequent workshops which will take place in the second phase of the Congo Basin Program.

This component is linked to the international since the “core” participant group from Africa will be drawn from the Congo Basin countries. As far as possible the same participants will be chosen to maximize the learning impacts.

Target audience: Since the problems in this area are complex and their resolution will likely involve government policymakers, executives from the corporate sector, NGOs and civil society, the programme will include representatives from each of these important stakeholder groups. A multistakeholder approach will therefore be crucial in forging alliances for policy reform.

Partnerships: AUSAID, CIFOR, CIRAD, ICRAF, IBAMA, FAO, IUCN, UNESCO, UNEP, WWF, USFS, EC, CEFDHAC, OAB, DFID, and others (to be identified).

Exit strategy: The option to devolve responsibility to regional institutions to provide future training needs and policy advise will be explored.

Leverage with Bank operations: In general, this programme has been developed in tandem with the Bank’s move towards high quality non-lending services, and complements the Bank’s strategy to include new audiences. More specifically, the programme responds to the needs expressed by Bank staff in AFR, EAP, LAC and RDV.

Dissemination of Bank findings of best practice: Bank staff (including from the Regions, DEC, ESSD and PREM networks, RDV, GEF Secretariat) will be consulted in the design and delivery of the programme. Best practice experiences from the Bank as well as specific topical case-examples will be developed as training materials.

Synergy with other EDI programmes: This programme will draw upon the experiences of past training activities for forestry and biodiversity conducted by EDIEN such as Forestry Management for Sustainable Development, Biodiversity and Land Use in S. Asia; Bioprospecting and Medicinal Plants. It will be coordinated with several current EDIEN activities especially in the areas of rural development, global environmental issues and managing the environmental impacts of growth.

Learning outcome indicators: Better understanding of (a) new policy and technological options for sustainable forest management; and (b) tools (such as an effective information network, sustainable development matrix and participatory approaches for resource management) for policy reform analysis and conflict resolution.

Impact indicators: Enhanced involvement of multisectoral groups in decision-making on policy reform for sustainable utilization of forest resources.

[29] Cofinancing for the Congo Basin programme is already available. Further details are available upon request.

Cost sharing/recovery: The feasibility of recovering a proportion of costs from the private sector will be explored. In addition, client country governments and partners will be requested to bear a share of the costs.

Pedagogy: Lectures, group/panel discussions, study materials, case example development, and field trips.

Monitoring, quality and evaluation: There will be a systematic review of training materials and seminar quality for each activity within the programme. In addition to interim evaluations, a comprehensive assessment report will be prepared at the conclusion of the programme. This work will be coordinated by the Evaluation and Scholarship Unit of EDI.

PROJECT FIRE-FIGHT - PROMOTING INTERNATIONAL COLLABORATION TO ADDRESS THE UNDERLYING CAUSES OF FOREST FIRES WORLD-WIDE

William J. Jackson[30]

BACKGROUND

WWF and IUCN believe that the global forest fire crisis requires a coordinated international response.

Responses to large forest fires have focused on extinguishing fires and providing humanitarian aid at the expense of focusing on addressing underlying causes.

Uncontrolled forest fires have had serious impacts on:

- biodiversity,
- human health,
- agriculture,
- air and water quality,
- soils,
- global climate,
- economic activity.

THE NEED

- to address the underlying causes of forest fires,
- to fully incorporate conservation and socio-economic concerns into fire management policies and practices,
- to pursue a coordinated multi-stakeholder response.

WHY A MULTI-STAKEHOLDER APPROACH?

- the role of governments is changing as a result of economic and political necessities,
- general trend to smaller governments, privatization and reliance on local organizations,
- the role of the private sector, NGOs and citizen groups in land management is increasing,
- globalization of economic activity has resulted in decision makers being beyond the reach of national laws,
- the scope of the problem is beyond the capacity of national governments and the UN system to handle alone.

GOAL AND PURPOSE

- to eliminate the adverse environmental, social, and economic impacts of forest fires,

[30] Coordinator, Forest Conservation Programme, IUCN, Switzerland. This presentation was prepared jointly by WWF and IUCN.

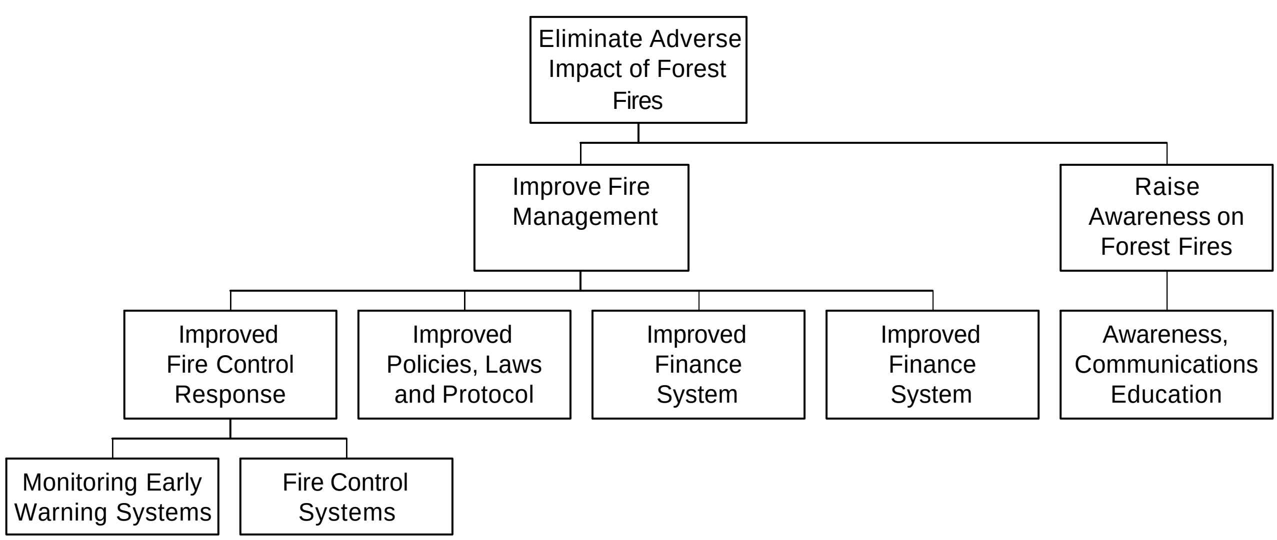
- to secure essential policy reforms at national and international level to provide an improved legislative, economic and technical basis for controlling the harmful anthropogenic forest fires.

OBJECTIVES

- to enhance the knowledge and skills of key stakeholders and, where necessary, change their attitudes,
- to identify and promote the removal of perverse incentives, such as market mechanisms that exacerbate forest fires,
- to identify and promote economic incentives and appropriate technologies for fire management,
- to promote policies and legislation that safeguard forests from the harmful effects of fires and secure high level political commitment to their adoption.

OUTPUTS

- policies and legislation that safeguard forests from harmful fires,
- perverse incentives removed,
- economic incentives in place,
- improved technology and methods,
- knowledge and skills of key stakeholders enhanced and attitudes changed,
- a clearer understanding of the underlying causes, trends and impacts of forest fires,
- a clearer understanding of the institutional and policy reforms needed to address the underlying causes of fires and high level commitment to adopt policies,
- strengthened fire prevention and management at national and regional levels.



FOREST FIRE MANAGEMENT - INITIATIVES TAKEN BY THE INTERNATIONAL TROPICAL TIMBER ORGANIZATION

Dr. Efransjah [31]

1. INTRODUCTION

In the recent past, forest fire influenced by the El Niño phenomena has become a major problem adversely affecting the sustainable management of tropical forests. From September to November 1997, parts of Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand were blanketed by dense haze stemming largely from large-scale forest fires in Indonesia. The 1997 fires were somewhat alleviated by the rains in December, but the onset of the dry season in May started a new cycle of large-scale forest fire in 1998, particularly in the Indonesian province of East Kalimantan. Hazards to human health, the destruction of valuable forest resources and biodiversity, accidents and difficulties for land, water and air transportation, the disruption to the lives and livelihood of millions of people and the far-reaching negative impact to several sectors of the economy, have all been widely reported.

Forest fires on the scale now being experienced are most devastating with serious implications to sustainable management and indeed the ITTO Year 2000 Objective. What is more, this problem is not only confined to Southeast Asia. Obviously, forest fire management is a new dimension which must be accorded urgent and utmost attention and vigilance. This paper outlines initiatives to be undertaken by the ITTO as a basis for discussion for and coordination with other interested agencies on this matter.

2. ITTO'S WORK ON FOREST FIRE MANAGEMENT

Forest fire was identified as a major problem by the International Tropical Timber Council (ITTC) since it started operational activities in 1986. Indeed a small mission was undertaken in 1987 to Indonesia to examine the extent and nature of the major forest fire in 1983/1985 and formulate measures to rehabilitate the fire-devastated areas through a pre-project study. This resulted in project PD 17/87 (F) entitled "Investigation of the Steps Needed to Rehabilitate the Areas of East Kalimantan Seriously Affected by Fire" in which various species and planting techniques were investigated.

In 1992, a project entitled *"The Establishment of a Demonstration Plot for Rehabilitation of Forests Affected by Fire in East Kalimantan"* {PD 84/90 (F)} was implemented in Samboja, East Kalimantan in cooperation with a local research institution under the Ministry of Forestry. The project aimed at developing a methodology for rehabilitating forest areas damaged by fire, study its natural succession, and establish a demonstration area for research and training purposes. The project's outputs include:

a) Detailed experimental design of forest inventory for areas affected by fire and related classification of degree of degradation;
b) Technical Guidelines on proposed silvicultural options for rehabilitating such forests devastated by fire depending upon degree of degradation;
c) Detailed growth and yield data of the stands after various silvicultural treatments; and
d) Systematic analysis of volumes and distribution of natural and planted species in the forest areas affected by fire.

In January 1992, ITTO conducted a consultative mission to Indonesia to identify priorities and initiate an integrated forest fire management system. The resulting project, PD 12/93 Rev.3 (F) *"Integrated Forest Fire Management in Indonesia: Phase I -- National Guidelines on Forest Protection Against Fire"*, is currently being implemented in collaboration with the Directorate General of Forest Protection

[31] Projects Manager for Reforestation and Forest Management, ITTO, Japan.

and Nature Conservation of the Ministry of Forestry and the Bogor Agricultural University. The project co-financed by the ITTO and the Common Fund for Commodities has engaged local and international consultants to develop a draft of national Guidelines on integrated forest fire management. In the process it involved intensive consultations among the national institutions involved and two international workshops. The first workshop was held in 8 and 9 December 1997 in Bogor, while the second workshop will be convened in march 1999.

The project also reviewed and developed the following draft publications:

- Appropriate mission and organizational structure of central forest fire management organization,
- A fire incident monitoring and reporting system,
- A national network for communication on forest fire,
- National standard on forest fire equipment,
- A national forest fire prevention education programme with the involvement of local people,
- A national and regional coordination guide to prevent and suppress forest fire involving related agencies and local people.

In addition, reports on the following issues are under preparation:

- Social-economic aspects of forest fire,
- Traditional shifting cultivation system,
- Rehabilitation of forests degraded by fire.

The National Guidelines for Indonesia are expected to be finalized in early 1999.

Pursuant to a Decision of the International Tropical Timber Council, ITTO undertook the development of a set of international guidelines for the protection of tropical forests against fire. This resulted in the publication "*ITTO Guidelines on Fire Management in Tropical Forests"* in 1996. The Guidelines contain 29 Principles and recommended actions: Policy and Legislation, Strategies (Fire Management Planning, Fire Management Options, Fire Suppression, Role of Communities in Fire Protection), Monitoring and Research, Institutional Framework and Capacity Development, Socio-economic Considerations, Land Resources Management and Utilization, and Training and Public Education.

The synthesis of the ITTO Guidelines is as follows:

Scope

Since the very beginning it was recognized that these Guidelines would have to address a wider range of issues than just the suppression of wildfires in tropical forests. The guidelines were subsequently "upgraded" to address issues at a fire management level rather than protection only. This improvement has increased the value of its contents.

The Guidelines target tropical timber producing countries which have decided to develop fire management programmes but have little experience in this area. To this end, the global community will benefit from the success of such efforts.

It must be understood that all of the recommended actions listed in these Guidelines will not necessarily be implemented in any one country. Some may be very necessary in some countries; whilst unnecessary and/or impossible to implement in others.

The ability of any given country to finance a recommended action was not a consideration in preparing these guidelines. If an action was deemed to be necessary to accomplish a goal, it was presented with the understanding that it might be beyond the present means of some countries. Other countries may have that same problem, and have the financial means to implement the recommended actions. While proposing the necessary measures and actions, it is hoped that other, more affluent countries, could be brought into the effort to help fund such necessary actions.

The Guidelines contain 29 principles, with each principle containing several relevant recommended actions. Eight appendices were included in the Guidelines.

Policy and legislation

Broad-based support from all sectors of society is the main issue concerning policy and legislation. Given that in most tropical timber producing countries, the government assumes a major role in establishing the framework within which a fire management programme would have to operate, the emphasis of the Guidelines was directed towards encouraging governments to develop the necessary policies and legislation for such a programme to work. The Guidelines are based on the concept that, when establishing such a programme, persuasion is often more effective than legislation.

The principles and recommended actions presented in this chapter are based on the concept that the resources to be protected are important to all segments of society, and that the population will readily support the required sacrifices which may be necessary.

Strategies

This section provides the foundation for the Guidelines, because it addresses the four main components of a fire management programme:

- Fire Management Planning,
- Fire Management Options,
- Fire Suppression, and
- The Role of Communities in Fire Protection.

The principles and recommended actions which accompany them, form the basis for the success of any forest fire management programme. It is in performing these tasks that the timber producing countries will have to meet the challenge. If this portion is not carried out appropriately, the entire programme could be at risk of failure.

Monitoring and research

This chapter of the Guidelines recognizes the fact that a great deal of information is needed before a fire management programme can be established. This information will involve items such as a history of fires, weather variables, fuel modelling, and other data which are unique to the country in which the programme is being developed. Development of models to evaluate damage and losses of burnt areas are also important for establishing fire management programmes.

The proposed recommended actions can be implemented with the cooperation of the global community. Much of the work has already been carried out elsewhere, especially in developed countries; it simply needs to be modified or adapted to the conditions of the countries involved.

Institutional framework and capacity development

Four principles and a large number of recommended actions are contained in this chapter. This indicates the importance of building a stable foundation upon which to base a fire management programme. The chapter is divided into two sections:

A. *Institutional development.* A fire management programme cannot exist without the institutional structure with which to carry it out. The governments of tropical timber producing nations must establish, staff, and fund the agencies through which they will implement fire management programmes. These agencies must be directed to cooperate and function throughout the entire realm of human interaction, from the top government agencies to the smallest communities. Although the establishment of this structure will be from the top down, its operation must begin at the community level and progress upwards; and

B. *Funding and implementation.* This is an important issue for almost every nation that has tropical forests. Funding for a fire management programme should be high on the priority list. The financial resources of many producer nations are already strained to meet other challenges, and the addition of a fire management programme, no matter how important, may stretch those resources to a breaking point. Because the protection of the tropical forests is an international issue, it is proper to ask that other countries, including those far away from the tropics to cooperate in such efforts.

Socio-economic considerations

This Chapter is based on the fact that any programme must meet the needs of people in at least two major areas: their need for financial security, and the security they have grown to expect form their customary life-styles.

Two principles are directed at identifying the need to point out the financial damage resulting from wildfires, and in showing how the prevention of these fires can improve everyone's quality of life. Any economic evaluation of the proposed actions must address both the costs of the programme and their benefits. Ideally, the benefits will outweigh the costs, and the course is clear. In the case of fire management programmes, however, where the costs are fairly easy to tally, the benefits are sometimes difficult to identify properly. This seems to be true even for some of the most valuable benefits. Care must be taken to identify those benefits clearly, otherwise the more easily identifiable costs will heavily influence decisions.

Another two principles address the fact that in many instances, cultural, religious, and traditional values often outweigh financial reasons for dealing with wildfires, and that these same values tend to complicate the solutions. The recommended actions suggest ways of exploiting these values to the advantage of the fire management programmes. Emphasis is placed on consulting with local leaders and women in a community in order to obtain their perspectives on the problem.

Land resources management and utilization

Two major forces are at work in tropical forests that affect fire management. These are forest management (including the management of other land-based resources), and forest utilization. Methods used in each of these disciplines strongly affect on how a fire management programme is designed and carried out. In addition to these categories, we recognize that there are long-standing, and other more recently developed "other uses", to which tropical forests are subjected to. It is also important to remember that savannas and grasslands are important ecosystems, usually interrelated with forest lands, and therefore a fire management plan must take them on consideration.

Training and public education

This chapter addresses the fact that, for any programme to work, there are a number of people who will have to be trained and informed about the purpose and process of the programme. In the case of a fire management programme, this includes the managers of the various activities in the forest, as well as the communities in the area. Emphasis should be given to environmental education at primary and secondary school levels.

3. RECENT INITIATIVES

In May 1998, the ITTC adopted a Decision to undertake additional initiatives including the dispatch of Missions to affected countries and also to convene a technical consultation at the earliest opportunity in cooperation with all relevant international and national organizations, non-governmental organizations and individual experts.

The Mission was undertaken from 9 to 15 September 1998 in Indonesia and from 16 to 19 September 1998 in Sarawak, Malaysia. Excerpts from the Mission Findings and Mission Recommendations have been made available.

It is planned that ITTO, in cooperation with JICA and other interested bodies convene a technical consultation on all aspects of forest fire management on 7 and 8 December 1998. The meeting, to be hosted by the Indonesian Government, with the sponsorship of JICA and ITTO, will be convened under the theme “International Cross-Sectoral Forum on South-East Asia Forest Fire Management”.

The scope of the Forum is as follows:

a) Examine the report by the Mission undertaken in Indonesia and Malaysia focusing on:
   - the extent and causes of forest fires during 1997-1998, and
   - national and international initiatives being undertaken;
b) Assess various measures on prevention, detection, fire-fighting and remedial measures;
c) Discuss training needs and public education campaigns;
d) Assess the applicability of the ITTO Guidelines on Fire Management in Tropical Forest and other relevant initiatives; and
e) Develop a draft ASEAN Integrated Action Plan for Forest Fire Prevention and Management.

The ITTO acknowledges and is appreciative of the work being undertaken by various organizations and bodies in forest fire management; prevention, detection, fire-fighting and remedial measures. UNEP, FAO and the World Bank, amongst others, are undertaking similar initiatives. The ITTO seeks to fully work together and cooperate with these organizations including national and non-governmental organization in the field of forest fire management to ensure the conservation, management and sustainable development of tropical forests.

THE INDONESIAN PERSPECTIVE AND EXPERIENCE IN FOREST FIRE MANAGEMENT

Dr. F. Gunarwan Suratmo[32]

ABSTRACT

The pattern of forest and land fires in Indonesia is unique. It should be understood to be able to determine the causes, impact of forest and land fires and fire management. International assistance and cooperation which have been conducted since 1986 have for the greater part been conducted in certain areas/provinces in Indonesia. ITTO has initiated to give more assistance to projects with macro objectives such as National Guidelines on Integrated Forest Fire Management.

The Government of Indonesia has developed middle future plans which can be used as one of the basic considerations to develop assistance in the future. The Consultative Group on Indonesian Forests (CGIF) which was established in 1994 can play an important role in communication, coordination and cooperation among all related parties working on forest fire management in Indonesia.

This paper highlighted pertinent issues on forest and land fire disaster occurred in Indonesia during the period of 1997-1998. Forest fire causes and damaging impacts have been summarized, while existing international initiatives to address forest fire have also been compiled. Special emphasis was given to the on going attempt of the MOFEC (Ministry of Forestry and Estate Crop) with the support from ITTO (International Tropical Timber Organization) and the CFC (Common Fund for Commodities), to develop comprehensive national guidelines which covers the entire gamut of integrated forest fire management.

I. INTRODUCTION

Indonesian tropical forests rank third in the world after Brazil and Zaire. They were initially estimated to cover 164 million ha.. (1.64 million km^2), and later estimated to have decreased to 143 million ha.. The current forests cover is estimated to extend over 90-120 million ha. (0,9-1,2 million km^2) or 48-64 percent of the total area. Indonesia's total land area is about 190 million ha. (1,9 million km^2). According to the Director General of Forest Protection and Nature Conservation, Mr. Soemarsono (1998) this includes protection forests, 30.5 million ha., conservation forests, 18.9 million ha., and production forests, 64.4 million ha. (total 113.8 million ha.).

Indonesia, like other developing countries, has not reached a stable ratio between forest and non-forest land area. The rapidly growing population and economy have converted natural forest into other land uses. Besides changing the natural forest into production forest (selective cutting of natural forests for plywood and plantation forests for pulp and paper) also they have also converted natural forests into tree crop plantations (oil palm tree plantations and rubber tree plantations), agricultural plantations, new settlements (transmigration) and other land uses. Changing the natural tropical forest to other land uses make the land cover more susceptible to fire.

In Indonesia forest and land fires have became a serious problem since 1982/1983 when a fire burned about 3.6 million ha. of forests in East Kalimantan. This had never happened before. After the forest fires in 1982/1983, forest and land fires occurred again in 1987, 1991, 1994 and 1997/1998. The discussion continues to find answers to the following questions: Why did these forest and land fires happen continuously after 1982/1983? Why they happened in those years? What is the difference

32 Faculty of Forestry; Bogor Agricultural University (IPB), Kampus IPB Dramaga, Bogor, Indonesia.

between the no-fire years and fire years? What significant changes in vegetation cover and human activities were there in Indonesia?

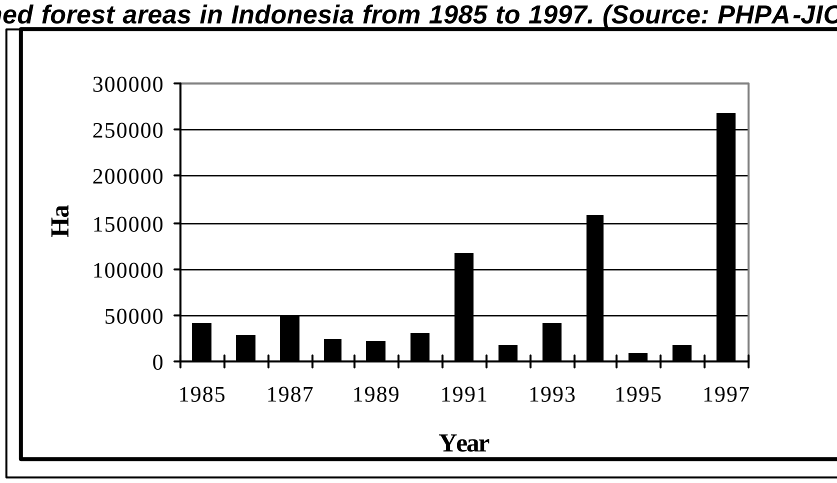
By understanding the answers to all of those questions, a strategic and appropriate Integrated Forest and Land Fire Management System for Indonesia can be developed.

II. FOREST FIRES IN INDONESIA

1. General forest and land fire

A very long drought in East Kalimantan from June 1982 to April 1983, burned forests estimated to extend over about 3,6 million ha. This kind of forest fire never happened before. Extended dry periods happened again in 1987, 1991, 1994 and 1997 which created forest and land fires of 49,323 ha. in 1987, 118,881 ha. in 1991 and 161,798 ha. in 1994 (Deddy, A and Brady, M. 1997). In 1997 this figure reached 263,992 ha. The extent of forest and land fire is depicted in Figure 1.

Figure 1. Burned forest areas in Indonesia from 1985 to 1997. (Source: PHPA-JICA, 1998)

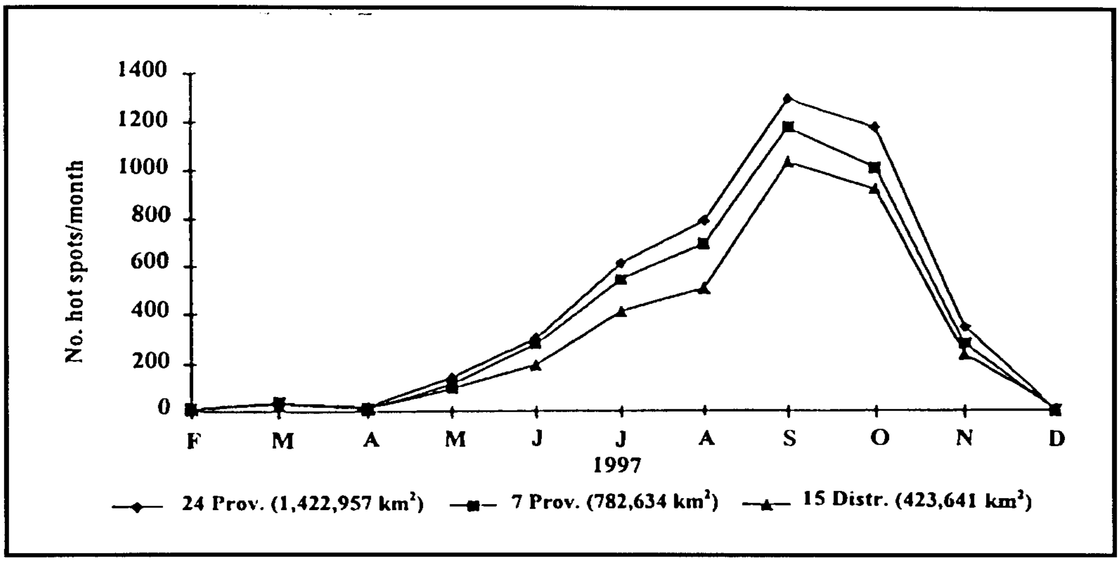


2. Forest and land fire 1997/1998

Long drought periods caused by El-Niño in 1997 were quite different from the droughts in 1987, 1991 and 1994, but close to the long drought in 1982/1983, in 1982/1983 forest fires only occurred in East Kalimantan Province but in 1997/1998 forest and land fires occurred in 24 provinces especially in Sumatra, Kalimantan, Sulawesi and Irian Jaya.

The fire started in May 1997 reaching its maximum in September 1997 and declining rapidly from October to December 1997 (7 months drought). The pattern of hot spots in 1997 can be seen in Figure 2 and 3.

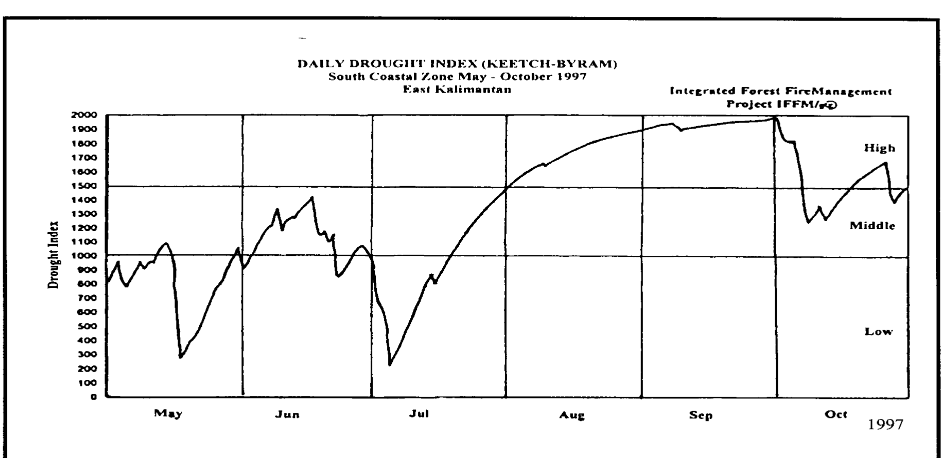
Figure 2. Pattern of hot spot occurrences in 24 Provinces and cities in western Indonesia during 1997. About 82 percent of the total recorder hot spot bcated in seven Provinces. Moreover, about 72 percent were located in 15 Districts occupying are of 423,641 km^2, or less than 30 percent of the total land monitored in western Indonesia. (Source : GTZ, 1998).



Forest and land fires during the East Kalimantan Province drought periods still continued until April 1998 (11 months drought). This means that forest and land fires in East Kalimantan Province covered 489,280 ha. in 1997/1998.

In normal conditions the easterly monsoonal winds which blow from **April** to **September** are generally dry. During this time the farmers, agribusiness and forest plantations usually do land preparation using fire. From **October** to **March** the westerly monsoonal winds blow. These winds which are always wet cause rainfall and consequently the planting season begins. In 1997 the dry season reached its peak in September and until December 1997 there was no rainfall. This condition caused wildfire to spread everywhere uncontrolled (Winarso, 1997).

Figure 3. The East Kalimantan Fire Danger Index, which was developed by IFFM and is calculated with basic meteorological data (rainfall, maximum temperature) reached the "high level" on August 1997. The IFFM Index is derived from the Keetch-Byram Drought Index. Its number represents the net effect of evapotranspiration and precipitation in producing a cumulative measure of moisture deficiency in the deep duff and soil layers. The Index is progressively increased by the computation of the daily drought factor which depends on maximum daily temperature. The Index is reduced for by the amount daily rainfall. (Source : GTZ, 1997)



In 1997 haze air pollution occurred from May 1997 up to November 1997 covering parts of Indonesia, Singapore, Malaysia, the Philippines and Thailand.

According to the Directorate General of Forest Protection and Nature Conservation (1988) details of the forest affected by fires in 1997 based on the forests classification are as follows:

a.	Protection forest	21,963 ha.	(8.32%)
b.	Production forest	163,444 ha.	(61.91%)
c.	Conservation forest	17,238 ha.	(6.53%)
d.	Tourism forest	1,415 ha.	(0.54%)
e.	National park	54,331 ha.	(20.58%)
f.	Forest park	653 ha.	(0.297%)
g.	Research forest	4,741 ha.	(1.80%)
h.	Urban forest	5 ha.	(0.019%)
i.	Hunting park	202 ha.	(0.08%)
Total area		**263,992 ha.**	**(100%)**

Details of the area damaged by fire, based on the potential vegetation is as follows:

a.	Grassland/Shrub	56,398 ha.	(21.36%)
b.	Secondary forest	62,254 ha.	(23.58%)
c.	Secondary forest and plantation	62,476 ha.	(23.67%)
d.	Industrial plantation forest	82,864 ha.	(31.39%)

Other institutions have estimated that the fires in 1997 may have burned up to 2 million ha. (hectares), 150,000 to 300,000 ha. of which was forest. In 1994 it was estimated that more than 5 million ha. of land was burned and only 160,000 ha. was forest, in 1995 and 1996 only 3,000 ha., in 1997 up to 3 million ha. (CIFOR, 1998).

EEPSEA and WWF estimated that the area burned in 1997 was 5 million ha., of which 20 percent consisted of forests, 50 percent Agriculture/plantations, 30 percent others. It is very difficult to say which estimation is right: the estimation made by the government agencies, the companies or the NGOs. This is due to the fact that they all have different perception and different methods for estimating.

The average mean of the monthly rainfall pattern in Kalimantan can be seen in Fig. 4 and the monthly rainfall in 1982/1983 can be seen in Fig. 5. Those two figures clearly show that drought conditions are the main factor triggering the forest and land fires in 1982/1983 and 1997.

Figure 4. Average Monthly Rainfall (mm) Balikpapan/Samarinda, East Kalimantan (1975 to 1981 and 1984 to 1985) in normal climate. Source : Hancock, 1986)

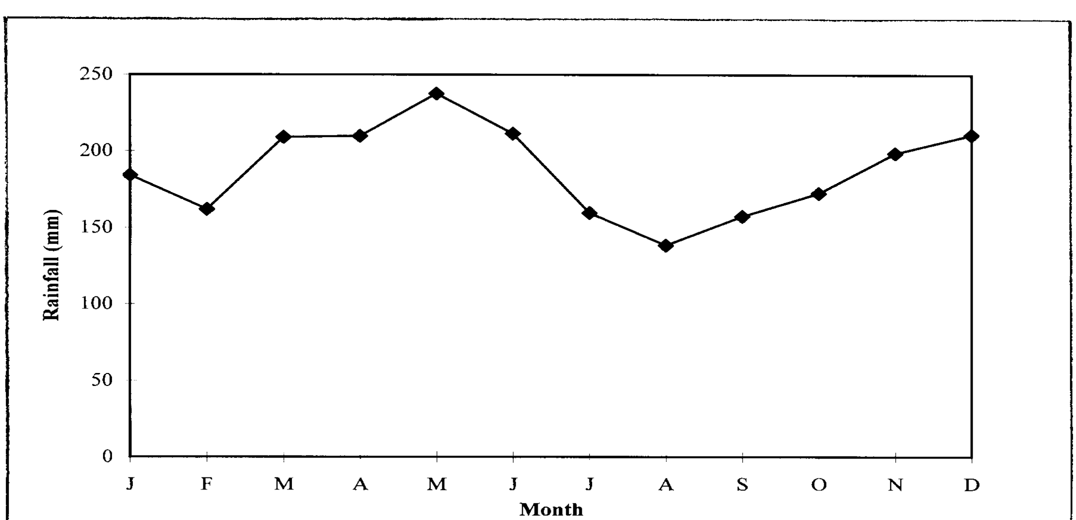
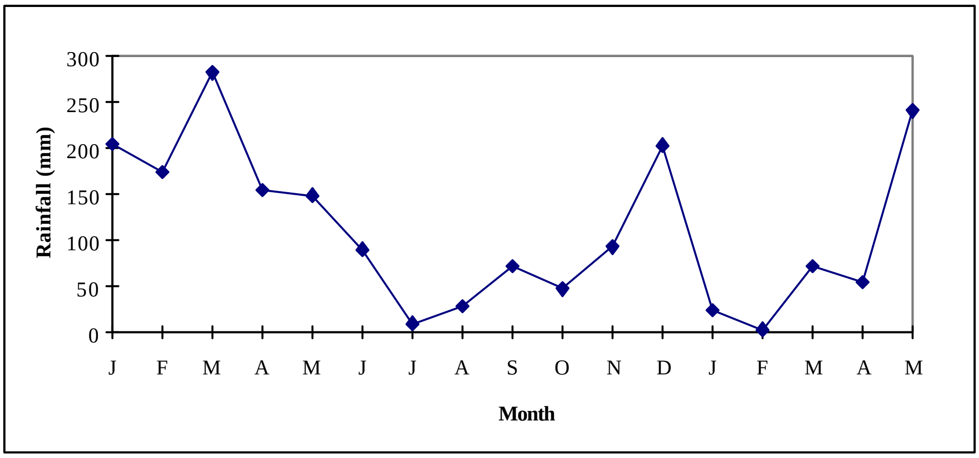


Figure 5. Monthly Rainfall (mm) Balikpapan/Samarinda, East Kalimantan (1982 to May 1983) in El Niño condition in 1982/1983. (Source : Hancock, 1986)



In previous normal conditions, forest and land fires usually extend over areas of less than 50,000 ha., with an average of less than 25,000 ha.

III. FOREST FIRE IMPACT

Forest and land fires in 1982/1983, 1987, 1991 and 1994 have had only local impact but fires in 1997 had a great impact on a very vast area. Parts of several countries in south-east Asia including Singapore, Malaysia, the Philippines, Thailand, and Indonesia were affected by heavy smoke pollution. Smoke-haze pollution in 1997 brought significant damage to various aspects, as follows:

1. Health

The health of over 20 million people living in the above mentioned region was affected by the smoke-haze pollution causing respiratory diseases, asthma and eye irritation. In Central Kalimantan it was reported that 23,000 people suffered from respiratory diseases; in Jambi 35,358 cases of respiratory infection were reported, in West Sumatra 47,565 cases and in Padang city, 22,690. The air quality of eleven provinces in Indonesia were affected. South Sumatra and Central Kalimantan were the most seriously affected. Burning peat swamps in Sumatra and Central Kalimantan and also coal fires in East Kalimantan released sulphur and nitrous oxides which seriously affected human health.

2. Transportation

Air transportation, water transportation and ground transportation were seriously affected by smoke in Indonesia, Singapore and Malaysia. Flights often had to be postponed or cancelled and airports were closed several times. These have resulted a significant cost implication.

3. Tourism industry

Tourism in Indonesia, Singapore and Malaysia dropped as travellers and tour groups especially from European and Asian countries could not be transported. The first 9 months in 1997 indicated that tourism in Indonesia had decreased to 3.7 percent.

4. Economy

National commerce was disrupted because of the delays and cancellations of transportation of agriculture and industrial products.

5. Commercial logs

The burning and killing of commercial trees created great losses which will affect the production of wood industries in both the near and distant future.

6. Agriculture

It is reported that 450.000 ha. of rice fields have already been affected by drought; the harvest of rice fields has dropped drastically. Rice fields and other crop plantations are suffering from an extreme water shortage. Crop failure also happened in crop plantations such as coffee plantations. More then 60,000 ha. of crop plantations such as oil palm, rubber, coffee, cacao, sugar cane plantations were burned. The agricultural production failure created problems in food supply and drinking water.

7. Biodiversity

Forest fires in Indonesia have burned at least 19 conservation areas of more then 90,000 ha. (Protection forest, National Park, etc.), including internationally important world heritages, such as Ujung Kulon National Park-Jawa (Rhinos conservation), Berbak-Sumatra (Ramsar wetland ecosystem), Tanjung Puting in Central Kalimantan (Orang Utan), Kutai National Park-East Kalimantan (various flora and fauna).

A wide variety of wildlife, plant species and unique forest ecosystems which are protected under national or international Acts were affected by the fires. The structure and composition of vegetation and other life have also been disrupted.

8. Human activity

Problems in transportation and smoke-haze pollution in the air has hindered many people from doing their normal activities and as a result they prefer to stay at home.

9. Soil

A change in the physical and chemical characteristics of soil or nutrients and erosion will happen during the next rainy season. Floods might occur in the coming rainy season especially if La Nina phenomena occurs in 1998.

10. Global climate change

Carbon emission from forest and land fires is estimated at more than one billion tons of CO_2. This means that the increase of greenhouse gases in the atmosphere and the decrease of CO_2 absorption potential of the vegetation may affect the climate.

11. Transboundary smoke-haze pollution

Neighbouring countries like Singapore, Malaysia, Brunei and other countries were affected by heavy smoke-haze pollution which created a negative impact on social, economic and political conditions.

12. Property

Besides affecting human health and life, forest fires have also destroyed many public and private properties such as schools, houses, offices, etc.

13. Loss in US Dollar

It is not easy to estimate the loss caused by forest and land fire. The only way is to estimate tangible value but not intangible value such as the environmental functions of forest, habitats, biodiversity and the ecosystem. The estimated total damage in 1997 was nearly US$ 4.5 billion; it was estimated to be about US$ 5-6 billion (March 1998).

Loss in health care, industrial production, tourism and travel in Indonesia, Malaysia and Singapore in 1997 alone was about US$ 1.4 billion. Loss in timber, plantations and biodiversity was estimated at about US$ 2 billion.

Economy and Environment Program for Southeast Asia (EEPSA) and World Wide Fund for Nature (WWF) estimated the damage caused by the 1998 Fire and Haze to be about US$ 4.5 billion.

a. Damage caused by the 1997 Forest Fires is as follows:

Type of loss	*Loss in Indonesia*	*Loss to other countries*
	(in US$ millions)	
Timber	493.7	-
Agriculture	470.4	-
Direct Forest benefits	705.0	-
Industrial Forest benefits	1,077.1	-
Capturable Biodiversity	30.0	-
Fire-fighting Costs	11.7	13.4
Carbon release	-	272.1
Total	2,787.9	285.5

b. Haze-related damages

Type of loss	*Loss in Indonesia*	*Loss to other countries*
	(in US$ millions)	
Health	924.0	16.8
Tourism	70.4	185.8
Others	17.6	181.5
Total	1,012.0	384.1

IV. FOREST FIRE CAUSES

Before the year 1982, Indonesia never experienced serious forest and land fires. The yearly forest and land fires before 1982 always occurred in less than 25,000 ha. from the 190 million ha of total land area and 164 million ha. of forest land. In other words, in normal conditions forest and land fires only affected less than 0.001 percent of the total land area and could usually be controlled by the Ministry of Forestry and Estate Crop.

Since 1982/1983 the Indonesian Government has been shocked by very large forest and land fires which were believed to have been caused by changes in the conditions in Indonesia. Researches, seminars, workshops and discussions have been carried out since then at local, national, regional and international levels.

Some of the conclusions have been reported as follows:

1. El-Niño phenomenon

According to Winarno (1998) forest and land fires in Indonesia since 1982/1983 or at the end of 20th century have been encouraged by the long drought over Indonesia as the impact of the long warming period over the equatorial Pacific Ocean region known as the **El-Niño** phenomenon or **ENSO** (El-Niño Southern Oscillation phenomenon). Figure 4 and Figure 5 clearly show the differences in rainfall patterns between the normal climate and the rainfall in 1982/1983 (El Niño phenomena).

El-Niño is a complex sea atmosphere coupling in the South Pacific that results in the tropical low pressure system normally over Indonesia moving to the Central Pacific. The eastern wind creates drought conditions after the dry season. Long periods without any rainfall decreases humidity, light surface temperature which encourages very large forest and land fires.

In the abnormal climate conditions in 1982/1983, drought periods started from April 1982 to April 1983 with rainfall only in December. Those conditions created fires over 3.6 million ha.

The El-Niño phenomena in 1987, 1991 and 1994 caused fires covering about 50,000 ha., 120,000 and 150,000 ha. in respective years. But in 1997 a long drought starting from May to December 1997 was caused by El-Niño occurred again like in 1982/1983, except in East Kalimantan where it lasted up to April 1998.

All forest and land fires in 1997 were estimated to cover 2-5 million ha. The question when the El-Niño phenomenon will occur is still unanswerable. It usually occurs irregularly every 2 to 5 years and some scientists predict that it will come more often. The problem is how to stop or avoid the El Niño phenomenon.

2. The conversion of forest land

Due to the rapidly growing population and economy of the country, 30 million ha. of forest land is planned to be converted to non-forest land such as oil palm plantations, rubber plantations, transmigration, rice fields, dry agriculture, mining, etc.

This change of natural tropical forest land to other land uses will increase susceptibility to fire. Development of forest plantations extending over more than 4 million ha increases susceptibility to fires.

3. Land preparation

Some companies use fire in land preparation for developing forest plantations, oil palm plantations and other plantation estates. During long drought periods fire from land preparation can become wildfire which burn natural forests and production forests. In 1997, the government prohibited land preparation with fire. Since about 1990 new agribusiness concessions have been developing with a quite large land clearing every year.

4. Agricultural preparation

The traditional practice of using fire in agricultural preparation and also burning agricultural waste, beginning from shifting cultivation or slash and burn system followed by permanent agriculture.

Using fire in land preparation for agricultural crop is the easiest and cheapest way for lay farmers and is usually done one or two months before the rainy season. These fires can be controlled easily if there is no lengthening of the dry season or a long drought.

5. Changing peat swamp area for agricultural land

Some peat swamp areas had been changed by farmers and also the government into rice fields and dry land agriculture. In 1996, 1 million ha. of peat swamp areas in Central Kalimantan was changed into agricultural land. Decreasing water levels and land preparation using fire by farmers created serious ground fire in the peat swamp areas in Sumatra and Kalimantan.

6. Human activity in the forest land

Many local people carry out traditional activities in the forests such as cutting trees, harvesting rattan and some resin, poaching, etc. During their activities in the forest, they often use fire for cooking and other needs. The risk to ignite fire during the dry period is very high.

7. Law enforcement

Law enforcement among local people who do the above mentioned activities in the forest (no. 6) as part of their traditional culture is difficult.

8. Organization

Apart from the Forest Fire organization Forest, land fire organizations to handle very large fire incidents have not been established. Since 1997 forest and land fire organizations are still being developed at the central, province and district levels.

9. Fire-fighting crew

Forest and land fire crews are still very limited and insufficient in quantity and quality. Training for fire-fighting crew are needed immediately.

10. Fire equipment

Appropriate equipment available at the governmental agencies is very limited. Hand tools, semi-mechanic and mechanic equipment are inadequate and insufficient to combat the fire incidents in the country.

11. Integrated Forest Fire Management (IFFM)

The development of national guidelines for IFFM is still in progress. Forest fires are not quickly attended to and the suppression of a large number and size of fire are not very effective and take a long time as a result of weak coordination and communication. Volunteers from the army and villages are not trained and equipped to suppress fires.

V. INTERNATIONAL ASSISTANCE AND COOPERATION

Since forest and land fires in Indonesia in 1982/1983 covered a very large area (3.6 M ha.), international organizations and countries have provided a wide range of assistance to Indonesia in the form of consultants, seminars, workshops, training and research projects etc. The assistance varied in terms of time, ranging from several days to several months and long periods from one year to several years.

Important assistance and cooperation which have been provided to Indonesia can be described as follows:

1. **Short term assistance and cooperation**

1.1 **FAO**
Duration : July 21 to October 13, 1986
Title : Assistance to forest fire prevention and control (TCP/INS/15131)
Consultant : M.S.D. Hancock

1.2 **USA**
Duration : August 1 - 13, 1986
Title : Training in forest fire prevention, detection and mitigation
Location : Jakarta and Sukabumi (West Jawa)
Participant : 10 foresters from 9 provinces
Instructors : S.F. Pedigo, S.K. Maddox, J.G. Shepherd, K. Hulick, W. Lerer.

1.3 **Germany (DFS, ITTO-PD 17/87 (F), GTZ-PN 38.3021.3)**
Duration : 1989
Title : Investigation of the steps needed to rehabilitate the areas of East Kalimantan seriously affected by fire (FR-Report No. 1, 1989)
Prepared by : W. Schindele

1.4 **UNDP**
Duration : One year from January 1991
Title : Preparatory phase national forest fire management capacity

1.5 **Australia**
Duration : October 18-25, 1991
Title : Report Assessment team on forest and forest related fires in Indonesia
Team members : T. Gates, B. Jackson, M. Bird, K. Simpson, M. Watts, J. Travers, B. Schopield, K. McKellar

1.6 **USA**
Duration : October 21 - November 7, 1991
Title : US Fire Assessment team on forest related fires in Indonesia
Team members : K. Yamashita, K. Suzuki, H. Ishikura, K. Toda, H. Naito, Y. Goto

1.7 **JICA**
Duration : November 18 - December 1, 1991
Title : Fast Finding Survey
Team Members : K. Yamashita, K. Suzuki, H. Ishikura, K. Toda, H. Naito, Y. Goto

1.8 **FAO**
Duration : December 1 -10, 1991
Title : Emergency Assistance to Forest Fire Management TCP/INS/0155
Consultant : D.M. Bird and J.P.L. Srivasteva

1.9 **ITTO**
Duration : January 27 - February 7, 1992
Title : Consultative visit to Indonesia with regard to ITTO activity on the protection of tropical forest against fire.
Consultant : I.G.M. Tantra, Y. Suzuki, S. Pedigo, S. Korsgaard

1.10 **JICA**
Duration : February 1992
Title : Provision of forest fire-fighting equipment

1.11 **Canada**

Duration	:	May 5, 1992 at Medan, North Sumatra May 9, 1992 at Samarinda, East Kalimantan
Title	:	Seminar on forest fire suppression
Consultant	:	J. A. White, K.E. Kepke, P. Sanhueza

1.12 **Government of Indonesia**

Duration	:	June 1992
Title	:	International Conference on long-term Integrated Forest Fire Management
Location	:	Bandung
Participants	:	Australia, Canada, E.C., FAO, France, Germany, Japan, UK, USA and Indonesia

1.13 **E.C. (The European Community)**

Duration	:	June 26 - July 3, 1992
Title	:	EC Forestry Mission - Fire Protection
Locations	:	North Sumatra and South Sumatra
Consultant	:	N. Cooper

1.14 **USA**

Duration	:	July 29 - August 1, 1992
Title	:	Training in Forest Fire Prevention, Control and Mitigation
Participants	:	121 participants from 22 provinces
Instructors	:	D.A. Frederick, S.K. Maddut, J.C. Sorenson, L. Howard, G. Brundervold, L. Kearuny

1.15 **Finland (Finnida)**

Duration	:	August 21- September 11, 1992
Title	:	Seminar on Forest Fire Control in Indonesia
Locations	:	Balikpapan, Banjarbaru, Bali and Jakarta
Participants	:	20 forestry officers
Instructors	:	A. Ploadpliew (Thailand), M. Therues (Finland), G. Mastart (Zimbabwe), L. Joyno (Philippines) A. Dulama (Finland), A. Sagala (Indonesia)

1.16 **UNDP/FAO**

Duration	:	June 1993
Title	:	The Establishment of a Demonstration Plot for the Rehabilitation of Forests Affected by Fire in East Kalimantan

1.17 **USA**

Duration	:	July 20 - 29, 1993
Title	:	Training in Forest Fire Prevention, Control and Mitigation
Locations	:	Ujung Pandang (South Sulawesi) and Pekanbaru (Riau)
Participants	:	90 foresters, NGO and private sector from 20 provinces.
Instructors	:	G. Bundervold, L. Howard, J.M. Passele, A. Kisser, J.C. Sorenson, D.A. Frederick, L. Kearny, C. Maynard

1.18 **JAFTA (Japan Forest Technical Association)**

Duration	:	September 11 - 30, 1993
Title	:	Study on Development of Technology for the Rehabilitation of Devastated Tropical Forest by Fire
Team Members	:	H. Watanabe, S. Koike, Y. Wada

1.19 **UNDAC (United Nations Disaster Assessment and Coordination team)**

Duration	:	September 28 - November 18, 1997
Title	:	A Coordination Center established in the UNDP office in Jakarta to provide support to the Resident Coordinator in assisting the government of Indonesia with essential disaster assessment and coordination tasks.
Team Members	:	E. Haegglund, OCHA and experts from UNEP and UNDP

2. Long term assistance and cooperation

2.1 ITTO Project PD 84/90 (F)

Duration : 1990-1992, after a review mission conducted by ITTO in June 1993
Title : The establishment of a demonstration plot for rehabilitation of forest affected by fire in East Kalimantan.
Output : A model to rehabilitate the light and medium burnt over forest and preparation of a technical manual on rehabilitation technique on forest affected by fire.
Team Members : K. Kadir, J. Tangetasik, P. Hess

2.2 FAO

Duration : May 1992 - December 1993
Title : Forest Fire Management (TCP/INS/2253 (A)
Objective : The objective of this technical cooperation project is to provide assistance in strengthening the institutional capacity of the Ministry of Forestry in the field of forest fire management, by a pilot scheme in a particular measurable area.

Output:

a. Prevention

a.1 Conduct analysis of the basic causes offices and the various forget group which should receive information on fire prevention.
a.2 Prepare forest fire prevention.
a.3 Design and print forest fire materials.

b. Pre-suppression

Prepare a comprehensive fire management plan for a demonstration area to be selected by the government of Indonesia. The plan will be based on fire history, fuel types, access, forest resources and land use practices, including:

b.1 Identify fuel management needs.
b.2 Identify detection and dispatch procedures.
b.3 Recommend and appropriate members of fire brigade location.
b.4 Identify priority areas for fire suppression.

c. Suppression

c.1 Purchase fire-fighting tools and communication equipment for one brigade and dispatch centre.
c.2 Provide training for fire personnel in techniques of modern fire control.

2.3 GTZ (Deutsche Gesellschaft für Technische Zusammernarbeit, GmbH)

Duration : April 1994 - March 1997 (Phase I)
April 1997 - March 2000 (Phase II)
Project Title : Integrated Forest Fire Management (IFFM)
Project objective : Integrated forest and land fire management system (IFFM), which functions operationally at a selected area as a forest fire station in East Kalimantan.
Project target : Reducing losses caused by fire for humans and the environment in East Kalimantan.

Output and activities

a. IFFM system infrastructure functioning operationally.

Activities:

a.1 Provincial Forest Fire Center established in 1997 with available required funds. Based on the collaboration plan of Phase II, the centre will be located at the Provincial Forest Service (*Dinas Kehutanan*) as it is the operational executor.
a.2 The sample area at district level was chosen in 1994 (Bukit Soeharto).
a.3 A local fire centre at district level (Bukit Soeharto) is operational.

a.4 The local fire centre has its own equipment such as: 2 fire pumper units, 2 patrol/pick-up units, 2 trail motorcycles, 2 wajax pump + hose, water tank, 2 chain saws, 2 mowers, 2 portable water tanks, hand tools and safety kits which were sponsored by the GTZ.
a.5 A radio communication system has been installed, operated and used in line with the national network of the Department of Forestry.
a.6 NOAA receiving system using a portable machine - water tank with a combination of pumps and truck/pick-up has been introduced and tested.
a.7 A report on coal fire handling has been disseminated to all related institutions in Indonesia and English. There has been no response yet so far. GTZ has offered assistance in suppressing one of the coal fires as an experiment.

b. The organization and implementation of the IFFM system has been operated in line with the concept of the government and PUSDALKARHUTLA.

Activities:
b.1 Review an official framework and translate the decree of the governor in English.
b.2 Restrengthen duty, structure and organization line of fire management.
b.3 Form a fire information system: Fire Danger Rating for East Kalimantan has been operating since 1995.
b.4 Implement the economic analysis from IFFM and disseminate its report to all related institutions.

c. Personnel from the Forest Fire Center/Extension Hall and Task force are ready to carry out their duties.

Activities:
c.1 Send staff for three months training in USA (1995).
c.2 Provide basic and advanced fire training to Jagawana of Bukit Soeharto. The advanced training includes the use of water. Concessionaires and Wanariset participated in this training.
c.3 Project personnel are introduced to the use of the latest and complete radio communication system.
c.4 Fire training for administration staff of Kanwil and Dinas, Boy scouts and university students.
c.5 Provide basic fire training for villagers from all villages and villagers near Bukit Soeharto, and present one set of suppression equipment to each village.
c.6 Provision of training tools (materials, videos, slides).
c.7 Four Jagawana will be trained in USA for 3 months to become local trainers for fire suppression personnel.
c.8 For Phase II, IFFM training will be organized in cooperation with Kanwil and Dinas assisted by GTZ.

d. IFFM involves local residents, BUMN and Private organizations around Bukit Soeharto.

Activities:
d.1 Several fire prevention materials have been published, disseminated, implemented and supported jointly with Kanwil and Dinas staff at local, province and national levels.
d.2 Personnel from 6 concessions also participated in the IFFM training course.

2.4 **EU (European Union)**

Duration	:	April 1995 - April 1999
Project Title	:	Forest Fire Prevention and Control Project (FFPCP) in Palembang (South Sumatera Province) in the Indonesia Forest Sector Support Program (IFSSP).
Project objectives	:	Forest Fire Prevention and Control Project (FFPCP)

Output and activities:
(1) Develop NOAA stations for early detection areal in South Sumatra, Jambi and Riau Province.
(2) Develop a vegetation index for evaluation.
(3) Develop a Forest Fire Center for developing a forest fire reporting system.
(4) Fire Protection plan for:
    a. Small farmers
    b. Land clearing (big companies)

c. Accidental fires (by people who reside nearby forests).
d. Unsatisfied, unhappy people:
- increasing income of the people living near the forest
- bee keeping and social forestry programmes
- starting horticultural and coffee tree plantations
- training for volunteers
- providing incentives for non-wood forest products

(5) Develop NOAA management system in Palembang
(6) Upgrade equipment
(7) Develop a Fire Danger Rating
(8) Develop a communication system
(9) Develop extension materials (booklets, leaflets, cassettes, video cassettes, posters, stickers, etc.)

2.5 **JICA (Japan International Cooperation Agency)**

Duration : 15 April 1996 -15 April 2001
Project Title : Integrated Forest Fire Management (IFFM)

Project objectives:
(1) Overall goal: To reduce damage caused by forest fires in Indonesia, and therefore reduce forest devastation and Environmental disturbances caused by the smoke from forest fires.
(2) Project Purpose: To improve methods of taking prompt measures against forest fires at the central government level and methods of forest fires prevention and initial suppression at the local community level and therefore contribute to the reduction of occurrence and spread of the forest fire.

Project output:
Central government level: To improve methods of taking prompt measures against forest fires.
Local community level: To improve methods of forest fire prevention and initial suppression.

Project activities:

At central government level:
(1) To observe forest fires by using satellite information.
(2) To suggest methods of improving the existing system for taking prompt measures against forest fires and to support their implementation.

Local community level:
(3) -1) To support public relations for forest fire prevention.
-2) To support the forest fire initial suppression system.
(4) -1) To research and analyze socio-economic aspects including the culture of local residents.
-2) To research, analyze and make trials of forest fire management techniques which are effective for forest fire prevention.
-3) To suggest participatory methods of forest fire prevention applying the forest management techniques mentioned above.

Note: Activities (1) and (2) will be carried out in Bogor, West Jawa.
Activity (3) will be at Rantau Rassau area (Jambi province) and Nanga Pinoh area (West Kalimantan province).
Activities (4)-3) and (4)-2) will be at Rantau Rassau
Activities (4)-1) and (4)-2) are not limited to a certain area.

2.6 **ITTO (International Tropical Timber Organization) and CFC (Common Fund For Commodities)**

Duration : March 1997 - March 1999 (Phase I)
Project Title : Integrated Forest Fire Management (IFFM)
Team Members : Z. Coto. G. Suratmo, S. Manan, E. Husaeni, N. Surati Jaya
Consultants : J. Goldammer, J. Hansen, A. Siri, D. Bird

Project objectives

Main: To develop a National Guidelines on the Protection of Forest against Fire for Indonesia.

Specific:
1.1 To develop fire protection programmes to reduce the incidence of upland fires and to achieve adequate readiness level so as to effectively and efficiently suppress forest fires.
1.2 To develop strategies and practices to reduce the effect of smoke resulting from forest fires.
1.3 To identify the appropriate equipment to be used to suppress forest fires.
1.4 To develop a coordination system between a few agencies and local people involved in forest fire prevention and suppression programmes and activities.
1.5 To design and implement a national forest fire prevention programme that is responsive to land use, traditional practice and resource value.

Output and activities:
a A cohesive national policy to guide forest protection against fire.

Activities:
a.1 Define elements to be contained in a national forest management policy.
a.2 Draft alternative guidelines options for review, clearance and approval by MOF.

b. Appropriate mission and organizational structure of central forest fire management organization is identified.

Activities:
b.1 Define organizational mission, goals and objectives.
b.2 Identify multisectoral linkages including technical support to the national fire management coordinating committee.
b.3 Prepare organizational proposal for review and approval by appropriate authorities.

c. A fire incident monitoring and reporting system established.

Activities:
c.1 Design format and protocols for reporting fire occurrences.
c.2 Identify key variables required to access social, economic and ecological impact of forest fires.

d. A national network for communications and forest fire dispatch established.

Activities:
d.1 Define communication equipment at national, provincial and local levels to ensure the system.
d.2 Develop standards and guidelines for proper use of communication equipment.

e. A national standard to guide the fast burning system and implementation for demonstration.

Activities:
e.1 Define and identify key variables to access standard guidelines.
e.2 Draft alternative guidelines, options for view, clearance and approval by MOF.
e.3 Conduct demonstration for burning system in place.

f. A national standard of forest fire equipment.

Activities:
f.1 Define equipment requirements at national, provincial and local levels to ensure the system.
f.2 Design and prepare standard fire equipment.
f.3 Purchase samples of equipment and test them in the field.

g. A national and regional coordination guide to prevent and suppress forest fires involving related agencies and local people.

Activities:
Identify multisectoral linkages between related agencies and local communities in order to prevent and suppress forest fires.

h. A national forest fire prevention education programme in place by involving local people.

Activities:
h.1 Conduct a national analysis of the causes of forest fires in Indonesia.
h.2 Design and prepare educational programmes directed at specific public including local people.
h.3 Sponsor workshops, study tours and seminars.

Expected outputs are:
a. Improved coordination among on-going projects dealing with fire management.
b. A national policy and guidelines for forest fire management.
c. A coordinated national programme for forest fire management including a monitoring system.
d. An International Workshop on Integrated Forest Fire Management.
 d.1 First Workshop: to focus on forest fire prevention strategy.
 d.2 Second Workshop: to emphasize on fire suppression aspects.
e. A fully defined coordination and monitoring system.

VI. DEVELOPMENT OF A NATIONAL GUIDELINES FOR INDONESIA

Since the forest fires in 1982/1983 Indonesia has developed cooperation with various countries and international organizations. Many international experts on forest and land fires have conducted researches and developed an integrated forest fire management for Indonesia.

Most of the international assistance has been carried out in certain areas or provinces and more **micro** areas, for example GTZ has worked in East Kalimantan, JICA in West Jawa, Jambi and West Kalimantan, EU in South Sumatra. ITTO assistance is delivered on a more **macro scope,** which applies to the whole of Indonesia.

The implementation of the cooperation between ITTO and Government of Indonesia was done in collaboration with the Common Fund for Commodities and the Faculty of Forestry, Bogor Agricultural University as the executor. The cooperation project is called ITTO Project PD 12/93 Rev. 3 (F) Integrated Forest Fire Management. Phase I which started in March 1997 lasted for 2 years (March 1999), with the topic: **National Guidelines on the Protection of Forests against Fire**.

This project is designed to assist the Government of Indonesia especially the Ministry of Forestry and Estate Crops in developing Integrated Forest Fire Management and Planning with an emphasis on protecting tropical forests against fire.

The output from this project can be classified into: 1) the main output and 2) the specific output.

1. **The main output**

The main output of this project is a comprehensive **National Guidelines on the Protection of Forests against Fire.** It is observed that this kind of Guidelines at national level was not exist in Indonesia until 1997. It is then expected that the Guidelines will be immediately adopted by the Indonesian Government through a Ministerial Decree, upon its completion in March 1999.

2. **Specific outputs**

2.1 A cohesive national policy defined to guide forest protection against fire.
2.2 Appropriate mission and organizational structure of central forest fire management organization.
2.3 A fire incident monitoring and reporting system.
2.4 A national network for communication and reporting system.

2.5 A national standard to guide fast burning system.
2.6 A national standard for forest fire equipment.
2.7 A national and regional coordination guide to prevent and suppress forest fires involving related agencies and local people.
2.8 A national forest fire prevention education programme.
2.9 International Workshops on Integrated Forest Fire Management (with objectives: training and dissemination).
 a. First workshop: Concentrate on forest fire prevention
 b. Second workshop: Emphasize on fire suppression
2.10 Coordination among on-going projects dealing with fire management (CGIF)

As already mentioned earlier, there is a lack of trained fire-fighting crew. As a consequence of this condition, a **Specific Manual of Forest Fire Education including Public Extension** should be developed. To initiate the training of the fire-fighting crew, the Faculty of Forestry, Bogor Agricultural University, with support from ITTO, will conduct **training for trainers** in three locations in Sumatra and Kalimantan.

Insufficient forest fire equipment has made fire suppression ineffective, thus the project developed as well as the **Manual on Appropriate Forest Fire Equipment**.

The most challenging output, which dealt with the governmental agencies was the **organization**, **coordination** and **communication** arrangements. The output required an intensive consultations with the government institutions related to the issues of forest fire in Indonesia.

The first International Workshop was successfully held in Bogor from 8 to 9 December 1997, attended by invited participants from the developing countries (Asia, Africa and South America), as well as experts from Germany, USA, Japan and other developed countries.

The second International Workshop will be held in mid-February 1999 in Bogor, Indonesia while the Field Test will be conducted in East Kalimantan, Indonesia.

VII. INDONESIAN GOVERNMENT POLICY

The Director General for Forest Protection and Nature Conservation (1998) has laid the middle term strategies of the government on forest and land fire. Relevant issues can be highlighted as the following:

1. Zero burning policy for land preparation

The Government has adopted the zero burning policy, meaning the total prohibition of using fire as a tool of farming system or land clearing to prepare permanent crops in Indonesia. The Zero Burning System will be implemented in the process of forest conversion to other land use including plantations on imperata grassland. To implement this, some measures should be taken:

1.1 Review and modify the existing regulations or guidelines on land preparation or land clearing system.
1.2 Develop wood waste technology (wood waste utilization) in land preparation by chipping wood for the pulp and paper industry, fertilizer processing, etc.

2. Control over the forest and estate plantations

Eight principles have been developed in order to implement this strategy as follows:

2.1 Improvement of manpower

To enhance the skill needed and manpower for forest and plantation through:

a. Formal, non-formal and informal education.
b. Education and training: in-house training at production forest concessions, on-the job training for forestry and plantation staff and developing degree programmes on forest fire management at universities.
c. Participate in national and international seminars and workshops on forest fire management.
d. Develop qualified cadre in administration and technical knowledge for supporting forest fire management activities.
e. Build, motivate and control personnel involved in forest protection scheme.
f. Activate research activities on forest fire.
g. Develop skilled forest fire control brigade.

2.2 Organization

Evaluate and improve existing organizations at the central (national), provincial and local levels, especially in terms of coordination and communication, and development of necessary standard operation procedures (SOP).

2.3 Facilities and infrastructure

a. Identification and selection of appropriate forest fire equipment for different types of forest ecosystems in Indonesia.
b. Encourage all forest and estate plantation concessions to provide facilities in supporting the forest fire prevention and fire-fighting. Develop cooperation among the concession holders in forest protection especially forest and land fire.
c. Develop post fire activities especially for existing forest and land fire management, with a priority on human resources and volunteers for forest and land fire.
d. Explore the possibilities of using aeroplanes from Canada Air (CL 215/415), using bumbi buckets for water bombing and developing water storage (small check-dam).

2.4 Fire prevention and suppression

Particular attention should be given observing the Ministry of Forestry decree No. 260/Kpts-II/1995 concerning Forest Fire Prevention and Suppression. Improving the coordination at all levels with particular attention to the provincial level.

The following activities have been advised to disseminate all laws and regulations to the public:

a. Integrated extension by several institution, forestry agency, NGO and donor countries.
b. Using mass media such as electronic mediators (television, radio), printed media (newspapers, magazines, leaflets), traditional culture.
c. Coordination in mass-media extension and public education activities.
d. Development of the danger rate maps of the selected area susceptible to fire incidents.

2.5 Funding

Exploring fund resources from various institutions to finance and support the implementation of forest fire programmes such as:

a. National budget allocated by the National Planning Board through the Ministry of Forestry and Estate Crop.
b. Contingency budget in case of emergency situation.
c. Province and district budgets, cross-sectoral budgets
d. Management and supervision command centre (Kodal).
e. Foreign assistance. Technical assistance from foreign countries obtained through various institutions such as the Ministry of Foreign Affairs; the Coordinator Ministry for People's Welfare/the National Disaster Management Coordinating Board, and other related institutions.

2.6 Law enforcement

Optimizing enforcement of existing laws by outlawing people or companies involved in irresponsible activities led to forest and land fires. Increasing monitor activities and enforcing administrative and civil law sanction.

2.7 Research and development

Government policy, forest and land fire management system, and a long list of problems created by fire should be supported by the results of many research and development programmes.

Closed cooperation between the Ministry of Forestry and Estate Crop with national and international research programmes will be increased, but a **list of priority programmes** should be developed.

2.8 Rehabilitation of forest fire areas

Forest and land fires in 1997 – 1998 affected a very large forest area. This area should be rehabilitated in order to restore the forest original functions. in accordance with the original function. Rehabilitation methods, technology or systems should be developed.

Task Force for rehabilitation on forest fire areas will be established with the participation of:

a. Ministry of Forestry and Estate Crops (MOFEC)
b. Donor project on forest and land fire
c. National Universities
d. Related institutions
e. NGOs

The task force will be chaired by the Director of Forest Protection of the Ministry of Forestry and Estate Crops (MOFEC).

VIII. FUTURE INTERNATIONAL COOPERATION

The Government of Indonesia still needs international assistance and cooperation with ASEAN countries and developed countries to implement an integrated forest fire management.

It is recognized that international assistance and cooperation have been conducted since 1986 until now (1998) and many important results from their research, field tests and policy review have been achieved. All data and information should be **compiled as integrated data and information** which can be used easily by the Government of Indonesia especially the Ministry of Forestry and Estate

Crop to develop their policy and strategy in Forest Fire Management. CGIF as a coordinating forum can take the initiative to implement the idea.

In 1994, forum known as **"The Consultative Group on Indonesian Forests (CGIF)"** has been established through a Ministerial Decree. The objective of this CGIF forum is to strengthen the communication, coordination and cooperation among multi-parties (government e.g. the Ministry of Forestry and Estate Crop , Donor Institutions/countries, NGOs, private sectors, universities, research stations, related institutions, etc.) in forest sector development.

The CGIF was developed as a tool to improve strategic planning in the Ministry of Forestry and Estate Crop. During its 8th meeting on 12 December 1997 in addressing problems affected by forest and land fires, the CGIF decided to form a small team as a CGIF task force under the responsibility of the Director General for Forest Protection and Nature Conservation of the MOFEC.

The objective of the task force is to reduce the numbers of and negative impact of forest and land fires for CGIF. It will serve as a communication, coordination and cooperation forum which may develop a list of research priorities based on the identified problem of prevention and suppression of forest and land fires.

The Forum is also expected to provide research and assistance to strengthen the government policy, for example:

1) Develop national guidelines on forest and land fire management.
2) Develop national guidelines for the education curriculum of forest and land fire management and conduct training and extension for all levels.
3) Develop national guidelines on appropriate equipment in terms of number, size, specification and maintenance.
4) Develop appropriate organization, coordination and communication.
5) Study various social-economic aspects, including traditional culture, shifting cultivation, etc.
6) Study preparation techniques with zero-burning system.

CIFOR - ICRAF - UNESCO proposed to carry out a joint 3-year research into the underlying causes of forest and land fires in Sumatra and Kalimantan.

CIFOR - ICRAF - UNESCO propose a three-tiered approach:

1. A general overview of the fire situation for the whole archipelago.
2. A more detailed assessment at the level of Sumatra and Kalimantan.
3. Detail assessment of causes and effects at the site specific level (Kalimantan and Sumatra).

EEPSA and WWF (1998) recommend that the Indonesia Government should be supported by the International community in:

1. Moratorium 1 million ha project to change peat forest into agricultural land.
2. Clarify land ownership laws for staking a claim.
3. Enforce existing laws that regulate the use of fire for land clearing.
4. Change policies that keep the price of wood to processing mill's law, providing little incentive to protect standing timber or to sell scrap wood rather than burn it.
5. Investigate no-burn methods for land clearing.
6. Reduce targets for planned forest conversion and instead new plantation in unused alang-alang, grassland several million ha.
7. Study on specific forest and land fire, such as peat-swamp fire, coal fire, etc.
8. Study on environmental impact caused by fire.
9. Loss impact of fire.
10. Develop **national guidelines** on early warning systems and early detection systems.
11. Review forest conversion plan (total about 30 million ha.) and develop replanting or reuse unproductive areas of imperata grassland.

CLOSING REMARKS

1. The extreme **El-Niño phenomenon in 1982/1983** and **1997/1998** created a very long drought and made many areas become very susceptible to fire. These conditions had created fire which ravaged over 3,6 million ha. during 1982/1983 and about 5 million ha. of land and forest during 1997/1998.

2. **The traditional practice** of using fire in land preparation for farming has been identified as a main fire source which ignites forest and land fires. As the use of fire for land preparation is the easiest and cheapest way for farmers, law enforcement on the local farmers is difficult.

3. **Organization**, **coordination** and **communication** in fire management is other persistent and crucial aspect which obviously needs significant improvement. This involves numerous governmental agencies in the national, provincial and local levels. Until September 1998 discussions about several alternatives pertain to this issue were still being held.

4. Trained **Fire-fighting Crew** and **equipment** are still inadequate. National Guidelines for Training Curriculum should be immediately developed and be facilitated by competent instructors.

5. There have been many initiatives under international assistance and cooperation recorded since 1986. **CGIF should be more active in compiling all data and information** gathered as an integrated information in order to strengthen government policy and strategy and in developing a Forest Fire Management System in the country..

6. **List of research priorities** has to be developed and be discussed under CGIF 's coordination. Hence, it will facilitate donors to support an integrated fire management in Indonesia in a more synergized and effective manners.

7. A national guidelines on integrated forest fire management on the basis of the current prepared draft should be immediately published by the government. The expected guidelines will cover the entire issues related to prevention, detection, combating forest fire, rehabilitation, organization, research and training.

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GLOSSARY

CFC	:	Common Fund for Commodities
CGIF	:	The Consultative Group on Indonesian Forestry
CIFOR	:	Center for International Forest Research
EC	:	The European Community
EEPSEA	:	Economic and Environmental Programme for South East Asia
ENSO	:	El Niño Southern Oscillation
EU	:	European Union
FAO	:	Food and Agriculture Organization
GTZ	:	Deutsche Gesellschaft für Technische Zusamernarbeit, GmbH
ICRAF	:	International Center for Research in Agroforestry
IFFM	:	Integrated Forest Fire Management
IFSSP	:	Indonesian Forest Sector Support Program
ITTO	:	International Tropical Timber Organization
JAFTA	:	Japan Forest Technical Association
JICA	:	Japan International Cooperation Agency
MOFEC	:	Ministry of Forestry and Estate Crops
PHPA	:	Forest Protection and Nature Conservation
UNDAC	:	United Nations Disaster Assessment and Coordination
UNDP	:	United Nation Development Programme
UNESCO	:	United Nation Education, Scientific and Cultural Organization
USA	:	United States of America
WWF	:	World Wide Fund for Nature

UNITED STATES SOUTHEAST ASIA ENVIRONMENTAL INITIATIVE (SEA-EI)

Implementation Status Report - November 1998

BACKGROUND

The August 1998 report, "SEA-EI Program Description and Implementation Report," provided the background, descriptions, and implementation status for each activity approved for US Government support under the Southeast Asia Environmental Initiative. This and subsequent reports will provide further information to update the progress on implementing each activity.

IMPLEMENTATION STATUS OF ACTIVITIES

A. Better forest management techniques and policies

USAID amended, on September 8, 1998, the existing Interagency Agreement with the U.S. Department of Agriculture Forest Service (USDA/FS) to provide assistance to (A) the Center for International Forestry (CIFOR) and the International Center for Agroforestry Research (ICRAF) for assessing the underlying causes and impacts of fires in Southeast Asia, and (B) a collaborative network, including the Indonesian Ministry of Forestry, the Association of Indonesian Concession Holders, the Center for International Forestry Research (CIFOR), the Tropical Forest Foundation (a U.S. NGO) for reduction of fire risk in Indonesian forests through reduced-impact harvesting. The Interagency Agreement was further amended on September 30, 1998 to add a third activity, (C) Alternatives to Slash and Burn Agriculture with the International Center for Research in Agroforestry (ICRAF) to promote agricultural practices involving cash-earning tree crops that improve the livelihood of small farmers and that do not depend on the slashing and burning of forests.

A.1. Assessing the underlying causes and impacts of fires in Southeast Asia

The USDA Forest Service is working with the Center for International Forestry Research (CIFOR) and the International Center for Agroforestry Research (ICRAF) to conduct a timely and accurate assessment of the location, nature and causes of the recent fires in Southeast Asia, particularly Indonesia. Results of the assessment will be used to: (1) guide an analysis of the underlying policy and economic causes of the fires; (2) foster key policy changes needed to reduce the likelihood of future fires; and (3) develop a fire risk assessment model to identify areas most at risk in future droughts.

Implementation status

A detailed work plan is being developed between the Forest Service, CIFOR and ICRAF. This plan should be completed by early December. Additionally, the Forest Service and ICRAF are in the process of looking for sources of satellite imagery and other geospatial data. This data will be used to derive burned area, vegetation, and land use maps which will assist in assessing the underlying causes of the fires.

CIFOR and ICRAF will visit the Forest Service's Remote Sensing Applications Center in Salt Lake City in early November to look at imagery and other data collected to determine what they can use in the assessment and refine the work plan. CIFOR and ICRAF are in the process of gathering local site information which will be used to validate the geospatial data and help complete other aspects of the assessment.

A.2. Reduction of fire risk in forests through Reduced-Impact Harvesting (RIH)

A collaborative network, including the Indonesian Ministry of Forestry, the Association of Indonesian Concession Holders, the Center for International Forestry Research (CIFOR), the Tropical Forest Foundation (a U.S. NGO), the U.S. Forest Service and USAID/Jakarta, has been formed to integrate research, demonstration and training in the use of reduced-impact harvesting in Indonesian forests. A key element of this strategy is the combination of training and technical assistance to organizations implementing RIH on an operational scale, beginning with 100,000+ ha concessions in East Kalimantan, West Kalimantan and Sumatra. Particular attention will be given to the use of RIH as a means of reducing the risk of catastrophic fires.

Implementation status

The Tropical Forest Foundation will soon be advertizing for a Coordinator to develop their programme in Asia. It is expected a person will be selected by early 1999. The Forest Service and the Tropical Forest Foundation are also collaborating with the Asia/Pacific Forestry Commission, on a programme of sustainable forest management which includes reduced impact harvesting.

The activities to date include the development of a “Code on Forest Harvesting Practices” and a work plan for future activities. Immediate actions will include a study tour for upper managers and policy makers to view reduced impact harvesting practices; a training course on implementing the code of practices; and the development of proposals for operational training, demonstration sites and research.

A.3. Alternatives to slash and burn agriculture

The USDA Forest Service is working with the International Center for Agroforestry Research (ICRAF) to promote agricultural practices involving cash-earning tree crops that improve the livelihood of small farmers and that do not depend on the slashing and burning of forests. This programme is being closely coordinated with similar NGO programmes in Indonesia supported by USAID/Indonesia. The issues being addressed include: 1) recognition of land and tree tenure; 2) deregulating trade in agroforestry species; and 3) extension of more environmentally sound agricultural technology to farmers.

Implementation status

ICRAF is working collaboratively with USAID/Indonesia and other partners in Indonesia to develop a detailed proposal for this activity. Following the review and acceptance of this proposal by all parties, the USDA Forest Service will provide an implementation grant to ICRAF. Field work is expected to start by January 1999.

B. Improved fire prevention and fighting

USAID has two Interagency Agreements (IAA) to implement this component of the SEA-EI. One amends an existing IAA with the USDA Forest Service for (A) strengthening ASEAN fire/disaster response coordination, and a second is with the Department of Interior, Office of Surface Mining, for (B) building Indonesian and regional capacity to extinguish coal seam and peat fires.

B.1. Strengthening ASEAN fire/disaster response coordination

The USDA Forest Service is providing technical assistance and capacity building in support of the development of a coordinated fire disaster response system within the framework of the ASEAN Regional Haze Action Plan and the institutional mechanisms identified by the ASEAN Haze Technical Task Force and ADB Regional Technical Assistance (RETA) project. Activities will provide technical assistance with a focus on capacity building in developing appropriate mechanisms for coordinated and timely deployment of fire suppression resources.

Implementation status

The Forest Service has sent Deanne Shulman, a Fire Management Specialist, to work with the ASEAN RETA Project in Jakarta. Her primary tasks are to work with the RETA team providing technical expertise and to identify areas where the Forest Service could provide further assistance. Although Deanne is physically located in the Jakarta RETA office, she is not seconded to the team, but she serves as a technical advisor to the development of the National and Regional Haze Action Plans that RETA is also assisting. Deanne has been in Indonesia since September and will be there until the end of December.

In addition to the daily technical advice and input, the Forest Service took a lead catalytic role in building Indonesia's capacity for conducting a fire suppression capabilities assessment. The assessment team consists of Indonesian experts from the Ministry of Forestry and Estate Crops and the Ministry of Environment, and international fire experts from the United States, Australia, and Canada. Indonesia is tasked with the lead role for the mitigation component of the Regional Haze Action Plan, thus leaders of the assessment teams are Indonesian and international expert participants serve as mentors and advisors. The assessment is expected to be completed by late December. The information gathered from the teams will be used as a foundation for formulation of a regional mobilization plan and to further develop implementation items for the Haze Action Plans.

Another activity currently underway is assisting the RETA team in developing a framework for an ASEAN Regional Fire Suppression Mobilization Plan. Specific components of this framework will rely heavily on the information gathered by the teams regarding existing fire suppression organization structures, availability of fire personnel, equipment, and technology, and national level contingency planning. An additional Forest Service fire manager is working with Deanne Shulman and the RETA Fire Specialist to develop this framework which will be presented at the next ASEAN Haze Technical Task Force meeting scheduled for November 19th.

B.2. Building the capacity to extinguish coal seam and peat fires

The Department of Interior, Office of Surface Mining (OSM) is providing technical assistance to address peat and coal seam fires. This assistance includes:

- policy assistance to assign organizational responsibility for peat and coal fire suppression;
- development of an interagency mechanism for priority setting;
- identification of budget sources within Indonesia to provide a revenue stream to sustain coal and peat fire suppression;
- classroom and field training in fire site characterization, selection of abatement alternatives, development of construction designs, cost estimates, bid specifications, plans and drawings, contract management and field inspection of fire suppression contracts.
- demonstration projects on selected fires to illustrate containment and extinguishment techniques.

Implementation status

USAID executed an Interagency Agreement with the US Department of Interior for this activity in July 1998 and implementation of this activity is underway. The Office of Surface Mining (OSM) has designated Alfred Whitehouse as the resident Project Director for this activity, posted in the Indonesian Ministry of Mining and Energy.

In Malaysia, peat fire reconnaissance has been completed. The purpose of the reconnaissance was to assess the extent and severity of Malaysian peat fire problems. The Project Director made several suggestions following meetings with a number of Malaysian officials and a field site visit in Sarawak to observe peat fire problems. The Malaysian Fire and Rescue Department is acting on these, and the OSM is sending the additional information requested by the Department on remote stream gauge/water flow reporting systems in order to maintain water levels to prevent peat fires and also to warn of flood events. Two Malaysian participants will attend a training course development session in Pittsburgh, and space is also being reserved for Malaysian participants in the planned coal/peat fire suppression training in Jakarta scheduled for February 1999.

In Indonesia, the Minister of Mines and Energy (MME) requested the reconnaissance team to focus its efforts in East Kalimantan, around Bukhit Soerhato National Park and along the Balikpapan-Samarinda highway. The first phase of the reconnaissance is completed. Approximately 35 fires were located and 6 were characterized for training purposes. The total number of fires observed/recorded was 125.

The project purchased a soil drill for use in the training and for use by the East Kalimantan Regional (MME) Office, or "Kanwil." The MME Regional Office Director, Mr. Istiardja has been actively locating fires and involving communities. Other opportunities for coal seam fire identification and suppression activities were identified with several institutions including Mulawarman University Forest Research Station and the Warnariset Research Center. Forest concessionaires and mining companies are also expected to be involved in the fire suppression to work in cooperation with activities of the National and Regional Governments.

OSM Senior Fire Management Specialist, Dr. Bernard Maynard, assisted the MME and Kanwil with the reconnaissance and extended his stay in Indonesia to direct a fire suppression demonstration with the East Kalimantan Kanwil. The suppression demonstration was carried out successfully, saving three houses from burning and protecting the Balikpapan-Samirinda road. This demonstration also attracted important media attention for the programme.

Training course development is also proceeding with two Malaysians and four Indonesians planning to visit the US in November/December for an overview of the current ire suppression courses used by OSM and US State Regulatory Authorities, site visits to active coal mine fires, and meetings with OSM officials.

C. Improved regional climate-impact forecasting and environmental monitoring capability

USAID has several Interagency Agreements to implement this component of the SEA-EI. These will be for (A) for climate prediction and (B) environmental monitoring activities with the National Oceanic and Atmospheric Administration (NOAA), which was signed on September 30, 1998; (C) for environmental monitoring activities with the U.S. Environmental Protection Agency, which was signed on September 8, 1998; (D) for health impact monitoring with the Center for Disease Control (CDC), which was signed on September 18, 1998; and (E) for climate forecasting applications for disaster reduction by OFDA with the Asian Disaster Preparedness Center (ADPC) in Thailand, which was signed on September 30, 1998.

C.1. Climate prediction

The NOAA Office of Global Programs (OPG) is providing assistance to improve the infrastructure and capacity for establishing regional applications of global climate change models. The activity will assist research on both physical and socio-economic impacts of extreme weather events, vulnerability analyses within key sectors, and the development and use of improved assessment techniques and methodologies. The activity will also provide training, education, information dissemination and work with public sector institutions to support mitigation activities.

Implementation status

NOAA/Office of Global Programs is preparing an overall summary workplan for the first year which will identify specific activities, their timing,, implementation arrangements, expected outputs, and management actions required.

C.2. Programme to address ASEAN Regional Transboundary Smoke (PARTS)

The PARTS atmosphere monitoring contribution to the SEA-EI consists of transport modelling and model source term determination (atmosphere monitoring) and is being implemented by the US National Weather Service (NWS).

Implementation status

The draft framework implementation plan was prepared by the NOAA/National Weather Service (NWS) and sent to USAID in late September. It has since been revised incorporating comments. However, the basic elements, time frame and budget remain the same. The plan will be further refined by a proposed US Government PARTS coordination meeting which would bring together NOAA, EPA, USDA, CDC and other departments to develop the proper PARTS linkages, avoid duplication of effort and to make sure PARTS serves the interests of other SEA-EI activities.

For the implementation of PARTS, the NWS is developing a bilateral agreement with the WMO ASEAN Specialized Meteorological Center (ASMC) to facilitate resource, personnel and technology transfer and cooperation. The bilateral will accommodate any NOAA activity with the ASMC. The NWS is also working with the Department of Defence to make available in real time to the ASMC, through NOAA, VIS and IR navigated data for Southeast Asia (This is contingent on funding for the PARTS satellite component).

The NWS is still seeking funds for the PARTS satellite plan which supports early detection of forest fires and transport model source term determination (different but complementary to that of the atmosphere monitoring component). This element of PARTS is not yet funded, although interest has been expressed by the Australian Bureau of Meteorology, AUSAID, ESCAP, and ADB. The satellite component, if implemented, would greatly enhance the PARTS transport modelling component funded by SEA-EI. It would combine data from three environmental satellite platforms to provide what NWS believes would be the most accurate, comprehensive and economical early detection of hotspots compared to any other platform or system proposed for the region.

The schedule of activities is as follows:

November 98	- finalize PARTS monitoring proposal to USAID
November 98	- finalize PARTS satellite proposal - identify funds
November 98	- PARTS USG monitoring-satellite coordination meeting
November 98	- PARTS monitoring implementation / work plan
December 98	- PARTS satellite implementation plan (tentative date, depends on funding.)
January 99	- Present PARTS implementation plan details at 2nd ADB/RETA - ASEAN/RHAP Operationalization Workshop
January 99	- Commence PARTS monitoring implementation
Date TBD 99	- Commence PARTS satellite implementation

C.3. Environmental monitoring--Pollutant Standard Index

The U.S. Environmental Protection Agency (EPA) will provide technical assistance and training to the governments of the region in the development of an early warning system to predict air quality problems, including the development of a Pollutant Standard Index (PSI), which is a useful and much-requested activity in Asia. Such a system easily communicates air quality problems, builds public awareness of air pollution, links air pollution to everyday activities, and provides the public with simple actions they can take to reduce air pollution.

Implementation status

USAID executed an Interagency Agreement with the US Environmental Protection Agency (USEPA) on September 8, 1998 for assistance in developing better regional pollution measurement standards and monitoring systems. The USEPA is preparing implementation plans for continuing ongoing work already undertaken with national agencies in Malaysia and Indonesia. USAID is providing additional funding to include other ASEAN countries in this activity through its US-Asia Environmental Partnership (US-AEP) programme.

C.4. Health impact monitoring

In cooperation with the Ministries of Health (MOHs), the Malaysian Institute of Medical Research (IMR), and the Indonesian National Institute of Health Research and Development (LITBANGKES), the U.S. Center for Disease Control and Prevention (CDC) will investigate the risk factors associated with the adverse human health effects arising from air pollution resulting from the recent forest and peat fires in Indonesia. Presently, IMR and LITBANGKES are conducting morbidity and mortality surveillance. CDC, in conjunction with MOHs and the research institutions, would use this information to identify respiratory and cardiac conditions of significant public health impact to target for further investigation within each country.

Implementation status

On September 18, 1998, USAID executed an Interagency Agreement to provide CDC funds to conduct health impact monitoring under the SEA-EI. Although CDC did not receive additional funds to include a 3-year cohort study on health effects related to the haze and smoke in Malaysia, CDC feels that the current award is adequate to address the first component of the health assessment: evaluation of short term health impacts that will document in detail acute health effects over time. Specifically, these are activities related to surveillance of haze-related health outcomes using information routinely collected from health services, including mortality, outpatient visits, emergency room visits, and hospital discharges.

Since the date of the agreement, CDC has been noting the development of political events in Malaysia and Indonesia to determine a feasible time for initiating activities in those countries. On October 6-9, 1998, Dr. Josephine Malilay (Epidemiologist, Health Studies Branch, Division of Environmental Hazards and Health Effects (EHHE), National Center for Environmental Health (NCEH), CDC) and Dr. David Mannino (Medical Epidemiologist, Air Pollution and Respiratory Health Branch, EHHE, NCEH, CDC) participated as temporary World Health Organization (WHO) advisers in the Workshop for Health Guidelines for Forest Fires Episodic Events in Lima, Peru, sponsored by WHO. The purpose of the workshop was to formulate guidelines to address forest fire events by the health sector.

CDC awaits the arrival of Dr. Leela Anthony, Chief Assistant Director, Environmental Health, Ministry of Health (MOH), Malaysia, who will be spending her WHO/Pan American Health Organization fellowship on November 16-25, 1998 in Atlanta, hosted by EHHE, NCEH, CDC. Dr. Anthony is the primary MOH contact for activities related to haze and smoke in Malaysia, and who met Drs. Malilay and Mannino during the WHO Biregional Workshop on Health Impacts of Haze-related Air Pollution on June 1-4, 1998 in Kuala Lumpur. During Dr. Anthony's visit, CDC expects to discuss proposed activities in Malaysia and to determine a tentative schedule for field work.

C.5. Climate forecasting applications for disaster reduction

The USAID Office of Foreign Disaster Assistance (OFDA) is providing a grant to the Asia Disaster Preparedness Center (ADPC) in Thailand for improving access to climate related information to be used by decision makers, programme designers and implementers for improved disaster contingency planning. The activity includes the following:

a) The dissemination of climate forecast information, i.e., coordination of periodic regional climate fora;

b) the collection and dissemination of information on the impacts of the current El Niño (as well as past events) and actions taken to prepare for, prevent, reduce or mitigate them;
c) the collection and dissemination of information on the usefulness of climate forecast information; and
d) the development of training specific to climate variability impacts.

Implementation status

From October 19-20, 1998, ADPC held a two day strategy session in Bangkok to launch the Extreme Climate Event Program funded by USAID and NOAA. The meeting was attended by representatives from ADPC, USAID, NOAA, the U.S. Department of State, the ASEAN Specialized Meteorological Center (ASMC), La Red (a Latin American NGO), and delegations from the programme's three pilot target countries, the Philippines, Indonesia and Vietnam. These meetings were followed by a meeting at the Asian Development Bank (ADB) in Manila. Based on these meetings the following are summary accomplishments of the project to date. ADPC has:

- produced a report on the risks and opportunities in Indonesia presented by La Niña (NOAA's Administrator is making arrangements for this report to be sent to Indonesian President Habibie by President Clinton).
- completed a fifteen month programme design, including stakeholder input during the strategy session.
- participated in the October 13-15 ASEAN climate outlook forum in Hanoi, a step towards establishment of an end-to-end forecasting and applications system.
- secured the participation of ASMC in the programme as coordinator of regional forecast production and a locus for user feedback
- secured the active participation of the three pilot countries in a series of three national-level workshops to document impacts of previous extreme climate events and lessons learned from November-January
- secured participation of ASMC and the pilot countries in a 1999 regional meeting between climate forecasters and users to consolidate national-level findings and review forecast methods.
- was offered a follow-on grant by ADB and participation by ADB on an on-going basis, including in negotiations with national governments on follow-on activities.

Southeast Asia Environmental Initiative (SEA-EI)** - **summary budget

SEA-EI Activity	*SEA-EI*	*Other USG*	*Total*
A. Forest Management			
A.1. Causes and Impacts of Fires in Southeast Asia	700,000	80,000 (USDA/FS)	780,000
A.2. Reduced Impact Harvesting (USAID/Indonesia)	200,000	300,000	500,000
A.3. Alternatives to Slash and Burn Agriculture	650,000	---	650,000
B. Fire Prevention and Fighting			
B.1. Regional Fire Response Coordination	200,000	---	200,000
B.2. Coal and Peat Fire Suppression	1,000,000	---	1,000,000
C. Climate Prediction and Environmental Monitoring			
C.1. Climate Prediction and Environmental Monitoring	455,000	---	455,000
C.2. Programme to Address ASEAN Regional Transboundary Smoke (PARTS)	600,000	---	600,000
C3. Pollution Monitoring	300,000	50,000 (USAID/USAEP)	350,000
C.4. Health Impact Monitoring	270,000	---	270,000
C.5. Climate Forecasting Asia Disaster Preparedness Center (ADPC)	425,000	50,000 (USAID/OFDA)	475,000
TOTAL	**4,800,000**	**480,000**	**5,280,000**

Southeast Asia Environmental Initiative (SEA-EI) - Programme coordination and management responsibilities

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FIRE: THE UNDERLYING CAUSES AND IMPACTS OF FIRES IN SOUTHEAST ASIA

F.Stolle[33], W.Sunderlin[34], T.P.Tomich[35], R.Dennis[2], R Persson[2]
CIFOR-ICRAF-UNESCO-USFS Fire Project

INTRODUCTION

In 1997 extensive fires ravaged large areas of Indonesia, in particular Kalimantan, Sumatra and Irian Jaya. These fires and the accompanying smoke caused serious air pollution, damage to public health, loss of life, destruction of property and substantial economic losses in many parts of Southeast Asia. In East Kalimantan dry weather conditions have prevailed into 1998 contributing to fires of disastrous proportions and severe drought.

During the fires of 1997 several missions visited Indonesia and gave emergency assistance in fire suppression and social relief measures. In response to the fire problem post-fire studies were proposed by AsDB (Asian Development Bank), UNDP (United Nations Development Programme), WWF (World-wide Fund for Nature), and WRI (World Resource Institute). The scope of many of these projects is wide and the time frame is relatively short (up to 12 months). Given these limitations it is doubtful whether these studies will achieve a deep insight into the underlying causes of the fires, the key information for effective fire control and prevention. The situation was similar during previous fire years. The interest rapidly faded away after the rains came and the emergency was over. What currently remains in Indonesia, as a result of recent El Niño fire years (1991 and 1994) are four long term fire projects financed by JICA, EU, GTZ and ITTO.

CIFOR, ICRAF and UNESCO and the USFS will carry out a joint 3 year research project into the underlying causes and impacts of land and forest fires in Indonesia, with particular emphasis on Kalimantan and Sumatra.

BACKGROUND

During the fire event of 1997 several, often contradicting, reports about causes, which vegetation was burning, the extent of burned areas and stakeholders involved caused confusion and misunderstanding of the fire situation. The vast amount of projects and organizations which gave aid, sent aeroplanes, fact finding missions, consultancies and others further clouded the understanding of what was happening during the fire event.

CIFOR head-quarters and ICRAF 's regional centre, both based in Bogor Indonesia clearly felt the need to get a more accurate understanding on the *burning*' questions **Why**, **Who**, **Where** and **How much** did burn and What can be done to avoid a repeat of this environmental disaster in the future. The centres together with UNESCO's regional office joint their forces early September ' 97 to look into these questions, later followed by USFS with their expertise in wild fires and remote sensing.

This resulted so far in several outputs of which the main are:

- A report by Ms Dennis, tilted: ***A Review of Fire Projects in Indonesia, 1982-1998.*** A report with a summary of all fire projects with objectives and achievements so far.

[33] International Centre for Research in Agroforestry (ICRAF) - United Nations Educational Scientific and Cultural Organization (UNESCO).
[34] Center for International Forestry Research (CIFOR).
[35] International Centre for Research in Agroforestry (ICRAF).

- An overview of the fire problem in Sumatra, titled: **Fires, A review of the 1997-1998 fire event in Sumatra** (in press).
- Article on fire situation in Indonesia in Agroforestry today titled: **Indonesia's fires: smoke as a problem, smoke as a symptom** (Mar 1998).
- Several interviews in New Scientist, **Friendly Fire** (Nov 1997)**, Playing with fire** (Mar 1998), National Geographic **Indonesia's fires** (Aug 1998).
- Together with GTZ: **Air pollution from Large scale forest and land fires in Indonesia 1997/1998: Development and impacts** (in press).
- Co-organize with the World Bank a workshop titled: **Fire Hazards, Transboundary haze and Sustainable Forestry in East Asia and the Pacific** 5 -11 December 1998, Jakarta.
- Joint project proposal titled: **Fire: The underlying causes and impacts of fires in Southeast Asia.**

PROBLEM DEFINITION AND THEORY

The recent fires in Indonesia result from a combination of extreme drought and human activity, including traditional slash-and-burn agriculture, government subsidies for large-scale land clearing for industrial plantations and forestry practices that leave forests vulnerable to fire.

The causes of the fires are poorly understood and this is highlighted by the way that blame has been variously attributed to different groups, such as small farmers, agricultural land conversion schemes, forestry concessions, industrial plantation projects, indigenous peoples and other land users. The following critical questions still remain unanswered: how much land has been burnt; what was the previous land use; when did it burn; who has perpetrated the fires and why; what is the relative role of large holders and small holders in the fires; and what is the ecological impact of the fires on different ecosystems? This lack of basic information has contributed to a general sense of confusion regarding the nature of the fires, their causes, impacts and the likely areas to be at risk in the future.

The main questions remaining are:
1. Who caused the fires?
2. Why where there so many fires?
3. Where were the fires?

With their ongoing projects and research sites in Indonesia, the research partners understood that this fire event was not a one-time event with one specific cause. These partners are working on land use change in Indonesia on a long term basis (e.g. Alternative-to-Slash-and-Burn Programme, ASB) it is clear that this event was not just a accident caused by drought, but that drought was one factors among many. Factors which have to be taken into account are government policies on land allocation, land clearing techniques, transmigration of farmers to new areas, traditional land use, shifting cultivators, land tenure rights etc.

The question of deforestation, drought and its relation to fire is visualized in figure 1. The theoretical figure points at the confusion that exists between fires and deforestation. Fires used for agricultural clearing are a normal tool used every year by many stakeholders to clear unwanted residues. Fire can be used to clear forest as well. The extent that fire is used in a dry year (an ENSO, El Niño Southern Oscillation) and a normal year to clear land and to deforest will certainly be different, but even this has not been documented. The area burned will likely be less (circle of *Area burnt* on figure 1) but will the deforestation in a normal year (size of circle *Deforestation* in figure 1) be less or is there simply less deforestation by burning (size of the overlap in figure 1).

The quantification of the arrows, circles and overlays will be important to get the story right about fire, drought and deforestation.

Figure 1. Fire events in Enso and Non-Enso years

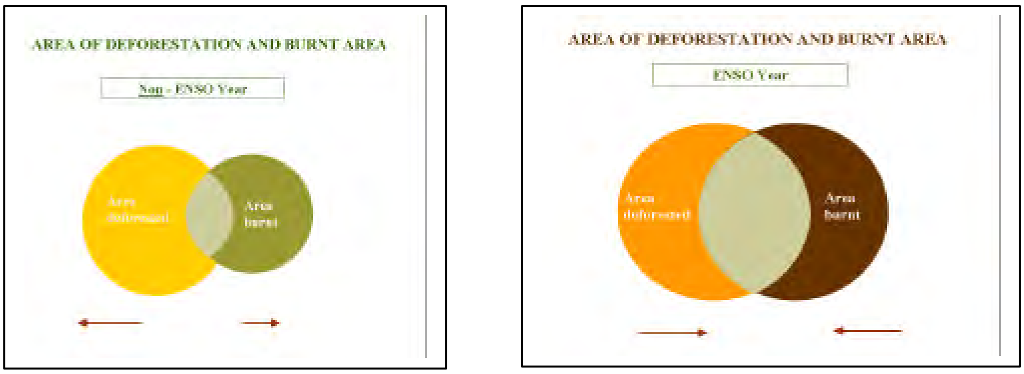


Figure 1 illustrates the confusion of deforestation and fires and the changes that might take place during a dry year (An ENSO year) and a normal year.

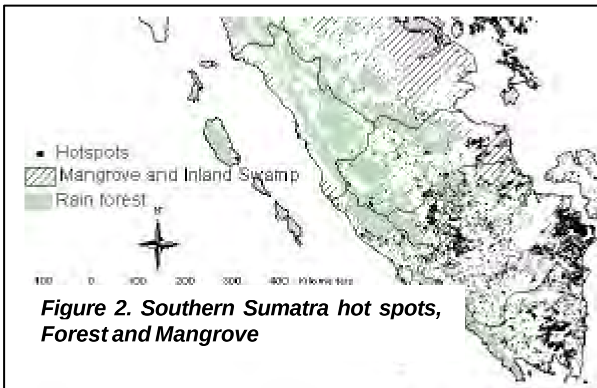


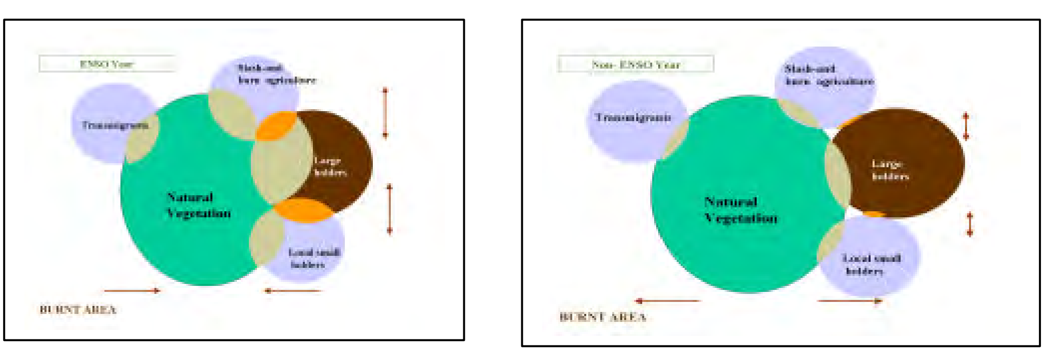
Figure 2. Southern Sumatra hot spots, Forest and Mangrove

The theory of figure 1 is supported by the data from Sumatra hot spots of 1997-1998. In figure 2 is shown that only part of the hot spots are The theory of figure 1 is enforced by the preliminary facts found in Sumatra. In figure 2, "hot-spots" and in primary forest (16% of the hot spots). Thus the relation between fires and deforestation so is not clear.

Nor is there data that suggest that in other years this was the case. At this moment it is not even clear if there where more fires in 1997-1998 than other years or *only* more haze because of atmospheric conditions.

The quantification of this behaviour will result in estimates of fires in different climatological circumstances and the threat to forest in different years. However the questions can be more specific, for example, which actors are likely to set more fire or deforest more land in a dry year? There are many reasons for smallholders to use fire as it is cheap and efficient. But will these actors behave differently when there are opportunities to clear more land in a dry year or will they be more careless and will accidental fires be a major factor? To use the same analogy as in Figure 1, figure 3 represents burning, deforestation by small and large holders and the likely land use conflicts.

Figure 3. Land use conflicts between large and small holders and natural vegetation and agricultural uses



Again the size of the arrows, circles and overlaps will give a lot of information about why, where and what burned. But in addition to the size of the overlap the cause of land use change will give a lot of information. Did area burn because of accidental fires, land clearing or because of land disputes set by arson? The quantification of the overlaps and its causes and the shift of size and causes in different years will be one of the outputs of this research. It is anticipated that some actors will have little change in dry and wet years while some will try to profit as much as possible.

METHODOLOGY

Data are needed about the extent burned, where it burned and what has burned over time to compare dry and normal years.

To achieve this the study will be done on three levels.

1. Island wide. For the islands of Sumatra and Kalimantan the hot spots, vegetation index, and the changes in land use cover over the last 10 years will be monitored. Correlations between fires and land use change, population densities, distance to roads and towns and others will be studied. Special emphasis will be given to the 1997/98 fire event.
2. On an intermediate level (province wide) more detailed land use changes and fires will be studied with especial concentration on causes which requires collecting social data
3. The most detailed level will focus on several small test areas where detailed socio-economical data and the relation between fires and local tenure, land use etc. will be studied.

CONCLUSION

By combining and integrating these studies the 1997/98 fire event can be put in a broader perspective of land use changes in the last decade. These land use changes and fires result from a number of factors like policies, land tenure insecurities, land conflicts and others. These factors are the centre of the fire problem. This study will emphasize the integration of social and economic information with the physical information on drought to study the central question of use of fire.

The institutions conducting this project work closely together with the Ministry of Environment of the Republic of Indonesia (Jakarta), Ministry of forestry and estate crops of Indonesia (Jakarta), EU-TREES programme (ISPRA), EU- Forest Inventory and monitoring programme (Jakarta), EU- Forest Fire prevention Programme (Palembang), GTZ-Integrated forest fire management (Samarinda), GTZ-Consultative Group for Indonesian Forestry (Jakarta), The World Bank (Washington), WWF-Indonesia (Jakarta), IUCN (Bogor), Impact Centre for Southeast Asia (Bogor), Biotrop (Bogor) and the Global Alternatives-to-Slash-and-Burn program.

Reunión Sobre Políticas Públicas Que Afectan A Los Incendios Forestales: Argentina

Ing. Ftal. Omar N. Tesolin[36]

ANTECEDENTES

En Latinoamérica los incendios forestales no ocurren de la manera que se describen en Estados Unidos y en Canadá. Generalmente aquí se producen enmascarando una problemática sociocultural en la mayoría de los casos. A diferencia del hemisferio norte de este continente (Americano) no son los rayos los principales causantes de los incendios de bosques, montes, plantaciones forestales y pastos.

Si bien es falso que no existan incendios producidos por rayos en el ámbito del territorio argentino, es el hombre con sus actividades culturales el factor desencadenante de las principales causas de generación de incendios forestales y pastizales. A modo de ejemplos se mencionan las prácticas más usuales de trabajo a campo, que ocasionan incendios cuando las mismas se realizan sin advertir las condiciones propicias del tiempo atmosférico para la propagación del fuego:

- Quemas de bosques degradados o de residuos del desmonte, previo a la preparación del terreno para la agricultura, la reforestación de especies exóticas o para la implantación de pasturas.
- Quemas de pastizales colindantes con bosques en procura del verdeo para los animales.
- Quemas del bosque con el fin de obtener leña seca eludiendo reglamentaciones restrictivas que la mayoría de las provincia tienen establecidas en sus reglamentaciones.
- Incendios producidos por cazadores furtivos con el fin de hacer salir las presas de sus madrigueras.
- La acción de los incendiarios que expresan su descontento o resentimiento a las medidas de gobierno vigentes.
- Negligencia de transeúntes o turistas en el encendido y/o apagado de hogueras, fogones y cigarrillos.

Algunos datos estadísticos de la superficie afectada por incendios

De las veintitrés provincias del país sólo diecisiete registran problemas de incendios en las dos últimas temporadas, en el resto aunque sabemos que ocurren los siniestros son poco frecuentes o de magnitudes pequeñas que no llegan alarmar a la población y las autoridades.

De las distintas regiones geográficas del país dos son las más importantes miradas desde un punto de vista forestal productivo. Una es la **región mesopotámica** integrada por las provincias: Misiones, Corrientes y Entre Ríos; que es donde se registran las plantaciones industriales de mayor magnitud de especies forestales introducidas.

La superficie quemada por incendios en 1996 es de 6.275ha de pastizales y monte, y 2.879ha de bosque nativo. Con respecto a bosques de cultivo, fueron afectadas 4.540ha.

El sector andino de la **región patagónica**, es la segunda en importancia, sobretodo en su área de transición entre la precordillera y la estepa; aquí es donde se le presta mayor atención al problema por motivaciones propias de la gente del lugar que disfruta de su naturaleza y fundamentalmente, **la**

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naturaleza es el atractivo más importante que tiene el turismo del lugar, uno de sus principales fuentes de ingreso. La temporada de incendio 1996/97 registró 35.435ha quemadas de pastos y montes, 318ha de bosques nativos y 537ha de bosques de cultivo.

En tercer orden se encuentra el área semiárida-subhúmeda del país constituyendo la **región centro y centro-oeste**. Aquí la actividad más importante es la ganadería extensiva realizada en un ambiente de monte y bosques xerofíticos. También existen en esta tercera región polos de desarrollo forestal de bosques de cultivo principalmente pinos, y salicáceas en zonas bajo riego. En 1996 la superficie quemada de bosques nativos fue de 59.920ha y 32.470ha de pastizales y montes. En bosques de cultivo las pérdidas por el fuego sólo fueron de 35ha.

El noroeste argentino es la cuarta zona con problemas de incendios forestales. Pero, como en el resto del país, ha tenido temporadas muy suaves últimamente motivo por el cual no se registran datos.

No obstante, periódicamente se presentan temporadas donde los problemas que generan los incendios pueden calificarse de graves a muy graves. Un ejemplo de ello fue la temporada 1986. En todo el país se quemaron 2.140.269ha de montes y pastos, 1.880ha de bosques nativos y 6.179ha de bosques de cultivo. Y en el año 1988 la superficie incendiada de montes y pastos fue de 1.545.682ha, 216.932ha de bosques nativos y 6.587ha de bosques de cultivo.

En quien recae la responsabilidad de presupresión y supresión de incendios

La responsabilidad del control y el combate de los incendios en la República Argentina corresponde en primer grado a las provincias pues como políticamente este es un país federal la nación no tiene superficies de bosques en sus jurisdicciones con excepción de la Administración de Parques Nacionales que sí tiene bosques y que por ende son de jurisdicción nacional. Asimismo hay algunas pocas dependencias del Estado Nacional que poseen establecimientos o propiedades agropecuarias con alguna parcela de bosques pero en porcentaje de la masa forestal total pueden considerarse esas superficies como insignificantes o despreciables.

En segundo grado de responsabilidad se encuentra la Secretaría de Recursos Naturales y Ambiente Humano que depende de la Presidencia de la Nación, a nivel nacional es quien atiende el problema. A su vez, bajo su jurisdicción se encuentra la Administración de Parques Nacionales.

La Secretaría de Agricultura, Ganadería, Pesca y Alimentación -SAGPyA- no tiene incumbencias sobre el control y combate de los incendios. La misión y función se circunscribe a la promoción del acrecentamiento del capital forestal a través de bosques de cultivo con el objeto de procurar el abastecimiento industrial de materia prima. La Dirección de Forestación es la dependencia de la SAGPyA que instrumenta el Régimen de Promoción de Plantaciones Forestales desde 1992 entregando una ayuda económica no reintegrables a toda persona física o jurídica que realice forestaciones. Además desde 1995 se subvenciona de manera similar las actividades de poda y raleo para mejorar la calidad de las maderas.

Cómo enfoca la Secretaría de Agricultura, Ganadería, Pesca y Alimentación la problemática de los incendios en plantaciones forestales comerciales

Las pautas técnicas que todo forestador debe adoptar para ser considerado dentro del régimen, prevé en materia de presupresión de incendios en primer lugar el diseño de calles cortafuegos de un ancho no inferior a 15 metros y los cuadros forestados en bloque que no superen las 20 hectáreas en macizo. El diseño de los cortafuegos en su conjunto debe considerar una superficie del 10% de lo total forestado.

En segundo lugar, es requisito a cumplir por todo forestador poseer un equipamiento mínimo para proteger su propio capital forestal, consistente en herramientas manuales adecuadas para equipar una cuadrilla de cinco combatientes cuando la superficie a forestar sea entre 50 a 400 hectáreas.

Cuando la superficie de la solicitud sea entre 400 a 700 hectáreas además del equipamiento anterior se requerirá además una motobomba de alta presión, tramos de manguera y un carro aguatero. En los casos de planes de forestación que superen las 700 hectáreas se requerirá la presentación de un plan integral de manejo de fuego que describa las actividades de a)presupresión: diseño de la plantación, actividades de silvicultura preventiva(plan de poda y raleos en áreas de máximo riesgo y aledañas a las calles y cortafuegos), prevención (carteles, convenios de ayuda mutua con vecinos, municipios, etc.), capacitación del personal, b)supresión: diseño de la detección, alarma, primer ataque, ataque ampliado y equipamiento específico para cada actividad.

En tercer lugar se aconseja a los particulares que cuando realicen las prácticas culturales de poda y raleos que son materia de subvención por parte del Estado el material combustible que queda yacente sea acondicionado de forma tal que no incremente el riesgo de incendio en épocas críticas.

En consecuencia, y con el propósito de transferir conocimientos a los productores forestales y a los profesionales independientes que asesoran a los forestadores, se ha iniciado una serie de cursos de capacitación en el uso prescrito del fuego como herramienta eficaz y barata.

Dentro del marco del Proyecto Forestal de Desarrollo que la SAGPyA cofinancia con el Banco Mundial se realizaron y se continuará en los próximos años con el dictado de talleres de capacitación donde el participante incorpora conocimientos teóricos y prácticos sobre el comportamiento del fuego, el uso prescrito del fuego y las distintas técnicas de quema. El propósito es sensibilizar al productor que la acumulación de combustible muerto debajo de sus forestaciones no debe superar un determinado tonelaje por hectárea, para lo cual uno de los conocimientos adquiridos en los talleres es precisamente, metodología de inventariación de cantidad de combustible muerto.

Conclusión

Como en toda sociedad cada actor debe cumplir un rol, cuando se habla de prevenir incendios los propietarios del recurso amenazado son los primeros que deben intervenir acondicionando sus bosques de forma tal que de producirse un fuego los caminos de acceso estén transitables, los cortafuego estén limpios de todo combustible y los combustibles muertos yacentes se encuentren reducidos lo máximo posible, al igual que los combustibles de continuidad vertical.

Sabemos que de los límites de la propiedad hacia adentro cada propietario debe estar preparado para resolver el problema cuando el mismo se presenta y su estado es de pequeñas dimensiones. Y cuanto mejor esté preparado en el interior de la propiedad mejor podrá aprovechar la ayuda externa cuando el siniestro por su envergadura deba ser controlado por una organización local, provincial o nacional.

Es con este criterio que la SAGPyA actúa, advirtiendo del problema y transfiriendo conocimientos directamente al productor. Mucha de esta actividad se realiza a través de los seis Núcleos de Extensión Forestal del Proyecto Forestal de Desarrollo SAGPyA/BIRF que tiene alcance en todas las áreas forestales del país.

PLAN NACIONAL DE MANEJO DEL FUEGO: REPÚBLICA ARGENTINA

Roberto Heredia[37]

El Plan Nacional de Manejo del Fuego fue creado en el año 1996 por orden del Presidente de la Nación en respuesta al incremento de los incendios rurales registrados en todo el territorio de la República.

El PNMF, dependiente de la Secretaría de Recursos Naturales y Desarrollo Sustentable - Presidencia de la Nación -, es responsable de la coordinación de las acciones a nivel nacional tendientes a disminuir las pérdidas económicas y los efectos ambientales y sociales provocados por los incendios rurales.

El PNMF tiene bajo su órbita tanto los aspectos de supresión, en colaboración con las distintas autoridades jurisdiccionales, como todas aquellas áreas relacionadas con la presupresión y la prevención de los fuegos rurales.

Dentro de las áreas a proteger en este sistema nacional se encuentran importantes superficie dedicadas a las actividades forestal y agrícola, con una gran influencia en la economía nacional.

Las hectáreas afectadas por incendios rurales pasaron de un promedio de entre 800,000 a 1,000,000 hasta el año 1996 a 600,000 en el año 1997.

El plan nacional manejo del fuego: una organización nacional

Su prioridad estratégica es definir los recursos, jurisdicciones y responsabilidades que afectan a la presupresión y supresión de los incendios rurales en el pasado reciente.

El Plan establece una sola cadena de organización, conducción y responsabilidades. Cada provincia debió nombrar un Referente provincial antes de poder formar parte del Plan, el que se transformó en único vocero válido para las autoridades nacionales.

Responsabilidades

Debido al carácter federal del ordenamiento constitucional del país, y tomando como base jurídica la Ley Nº 13.273 de Defensa de la Riqueza Forestal, la responsabilidad primaria de cada incendio rural recae sobre la institución municipal, provincial o federal que ejerza la jurisdicción sobre el área siniestrada. El Plan interviene sólo a requerimiento de los responsables primarios del incendio.

El PNMF brinda asistencia técnica y operativa a las provincias, responsables tanto de la detección como del ataque inicial de los fuegos en sus respectivas jurisdicciones y de la legislación sobre su uso, y coordina todos los recursos de que dispone el país para prevenir y combatir incendios rurales. Para su aplicación ha requerido la adhesión de las provincias a través de convenios individuales con la SRNyDS.

A fin de evitar los inconvenientes burocráticos para la movilización de medios aéreos y fuerzas federales que ocasionaban demoras y costos perjudiciales para un eficaz combate del fuego, la

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SRNyDS ha firmado convenios con la Fuerza Aérea Argentina que permiten que el Jefe de Incendios locales pueda ordenar, con la aprobación del Coordinador Regional y del Coordinador de Medios Aéreos del PNMF, la movilización y operación de las aeronaves necesarias. En el mismo sentido se ha acordado la firma de convenios con Gendarmería Nacional y el Consejo Nacional de Bomberos Voluntarios.

POLÍTICAS ADOPTADAS POR EL PNMF

Organización

Para ganar en eficiencia, el PNMF planteó una organización de mando único y gestión descentralizada. Por lo que se crearon seis regionales, cada una con un coordinador, un responsable técnico y una dotación de combatientes estable durante la época de mayor riesgo.

Además de la Brigada dependiente directamente de la Central Regional, el PNMF gira los fondos para la contratación por parte de cada provincia de una brigada, que actúa bajo las órdenes de los referentes provinciales del tema.

Supresión

Cada central regional cuenta con una brigada de 21 personas contratada durante las épocas críticas, que bajo la aprobación del coordinar regional podrán ponerse a órdenes del Jefe de Incendios local. A su vez, cada provincia tiene bajo su órbita una brigada de las mismas características solventada por el PNMF. El equipamiento de estas brigadas es responsabilidad del Plan.

La política del Plan en el área de la supresión es promover la creación en cada provincia de un organismo específico abocado a los incendios rurales.

La provincia de Corrientes representa un buen ejemplo de esto. Con una Reglamentación Provincial de Manejo del Fuego que contempla la creación de un Servicio Provincial de Lucha Contra Incendios Rurales y de un Plan de Manejo del Fuego local, cumple con la base organizacional para una buena gestión de los fuegos rurales.

El Plan cuenta con una estrategia de gestión de incorporación modular

Primer nivel

En todos los casos de ocurrencia de incendios de bosques o campos declarados en Territorio Provincial o de Parques Nacionales, las responsables de la atención del mismo serán las Autoridades Jurisdiccionales Específicas en la materia. El sistema de detección (alerta temprana), despacho y ataque inicial de incendios, serán incumbencia y responsabilidad de cada administración específica local.

Segundo nivel

Si con los medios locales afectados a un incendio este continuara sin control, y frente al requerimiento de la autoridad jurisdiccional , el Centro Regional puede ya sea brindar apoyo al Jefe de Incendios Local, o hacerse cargo de la Jefatura del Incendio, si así es solicitarlo.

Tercer nivel

De persistir el siniestro en niveles de peligrosidad que comprometa el accionar de las fuerzas regionales, el Centro Nacional puede disponer la movilización de la Reserva Federal .

Cabe destacar que el Jefe de Incendio Local mantendrá la conducción específica de las tareas de supresión.

Prevención

En un territorio tan amplio y con idiosincrasias tan distintas en la población, la política del PNMF en el área de la prevención es focalizar regionalmente las causas de los incendios, para así, desde ese punto base, diagramar estrategias locales apuntando al tipo de uso que los pobladores den al fuego.

Así, cada región del país desarrollará, con el soporte técnico de la Central Nacional de Plan, campañas de prevención y concientización más eficaces.

Capacitación

La creación de un Plan de Capacitación tanto de combatientes como de mandos medios y superiores en el área de los incendios rurales es una de las prioridades estratégicas del Plan Nacional Manejo del Fuego.

Para la concreción de dicho objetivo, el PNMF cuenta con técnicos experimentados en el área de la capacitación. Además, se han comenzado contactos con agencias internacionales de primer nivel para la realización de pasantías en el exterior de personal tanto del Plan como de las provincias y el dictado de cursos en nuestro país, por parte de expertos internacionales.

Sumado a la capacitación, el PNMF se encuentra abocado a la diagramación de un sistema de Certificación Nacional para los combatientes en todos sus estratos. Esto permitirá contar con personal calificado disponible en todo el país, creando así una unificación de criterios para las características de los mandos medios y superiores en las acciones de supresión.

Investigación

No es política del PNMF convertirse en ejecutor directo de las líneas de investigación en lo que a manejo del fuego se refiere. Resulta más eficaz la utilización de las estructuras ya existentes, como universidades nacional, institutos tecnológicos agropecuarios, instituto de investigación forestal, etc.

El Plan delimita, en colaboración con los institutos de investigación a nivel regional, las líneas de investigación a seguir, proponiéndole a las distintas organizaciones técnicas la participación como ejecutores de los proyectos ha realizar.

Medios aéreos

Los medios aéreos con que cuenta el Plan Nacional de Manejo del Fuego son provistos por la Fuerza Aérea Argentina, dentro del marco de un convenio celebrado entre la Secretaría de Recursos Naturales y Desarrollo Sustentable y aquella institución.

Del mismo modo, pero en forma independiente, el Plan Nacional de Manejo del Fuego contratará aeronaves de pequeño porte y reducido costo operativo para tareas de observación , patrullaje y dirección de incendios.

Con los medios existentes, el P.N.M.F. puede desarrollar las siguientes tareas:

1. Lucha directa contra el fuego con aviones hidrantes y con equipos helitransportados.
2. Transporte de personal y material.
3. Patrullaje.
4. Patrullaje ofensivo.
5. Observación y reconocimiento directo y/o con asistencia de equipos técnicos especializados (FLIR).
6. Búsqueda y Salvamento.
7. Traslados sanitarios.
8. Lanzamientos de personal y carga.
9. Obtención de imágenes.

La decisión sobre: sistemas a utilizar; cantidad de aeronaves por cada sistema; oportunidad de empleo; lugares de despliegue; disponibilidad en cada lugar (100% disponibles en sitio establecido, en alerta a tiempo determinado, en pasiva a requerimiento, etc.), depende de la relación entre presupuesto y situación imperante, circunstancias particulares, incidencia de riesgo por región y estado estructural y de alistamiento de los responsables primarios a quienes se les brinda apoyo.

Equipamiento

Durante los años 1996 y 1997 el Plan Nacional de Manejo del Fuego adquirió bienes de capital por un monto de 1.250.000 pesos. Estos equipos se destinaron a las brigadas provinciales y regionales contempladas en el accionar del Plan, como apoyo directo a las estructuras provinciales específicas.

Automotores, herramientas manuales y mecanizadas, equipos de agua y mantenimiento fueron algunos de los ítems contemplados. En general, la planificación de las compras se basa en el equipo específico standarizado de lucha contra incendios necesario para las actividades de supresión, tomando en cuenta los regionalismos que condicionan la utilización de algunas herramientas dependiendo de la disponibilidad de agua, las características del combustible, la topografía, etc.

Legislación

Este Centro Nacional se encuentra abocado en la búsqueda de antecedentes tanto a nivel nacional como provincial de toda legislación reglamentada que se encuentre bajo la órbita del manejo del fuego.

La tarea de investigación surge de la necesidad de desarrollar y presentar por los canales correspondientes un proyecto de ley sobre manejo del fuego en la República Argentina que sirva como soporte de la Organización Nacional para la presupresión y supresión y regule el uso del fuego en nuestro país.

Relaciones internacionales

Conociendo la gran experiencia acumulada por distintas agencias alrededor del mundo en el área del control de los incendios forestales y el manejo del fuego en general, el Plan Nacional de Manejo del Fuego fijó como prioridad el contacto con los organismos líderes en el tema, para así poder adaptar y adecuar los nuevos avances y técnicas para el combate de los incendios forestales.

De esta manera, se iniciaron tratativas con organizaciones de países como Canadá (British Columbia Forest Service, CIFFC, Ontario Aviation, Flood and Fire Management Branch, etc), EEUU (USFS), Chile (CONAF), España (EGMASA - Junta de Andalucía), Uruguay, México (SEMARNAP), Australia (NSW Rural Fire Service), etc.

Cabe destacar los trabajos que el PNMF se encuentra desarrollando en conjunto con el British Columbia Forest Service y la Junta de Andalucía.

En el primer caso, se ha desarrollado una propuesta para el Fondo de Transferencia de Tecnología entre Canadá y los países del Cono Sur administrado por la Canadian International Development Agency, para un proyecto de dos años de duración que involucrará todos los aspectos del manejo del fuego.

En el segundo caso, se ha acordado la firma de un memorándum de entendimiento tendiente a compartir conocimientos, tácticas y técnicas de las organizaciones de combate de incendios forestales.

A su vez, se han iniciado gestiones ante el Ministerio Federal de Cooperación Económica y Desarrollo de la República Federal Alemana para el desarrollo de un proyecto de Investigación sobre la Caracterización de las Condiciones Ambientales Asociadas a los Incendios en el Noroeste del Chubut para Mejorar la Lucha contra el Fuego.

En el aspecto Regional, y luego de la experiencia de la misión argentina en la República Federativa del Brasil con motivo de los incendios en la Amazonia, surge la necesidad del tratamiento de la problemática de los incendios rurales en forma regional. Cabe la importancia de un tratamiento general, debido a la repercusión que éstos tienen en forma global. Es por esto que ya se están realizando reuniones en el ámbito del Subgrupo 6 de Medio Ambiente del Grupo de Trabajo Mercosur.

PUBLIC POLICIES AFFECTING FOREST FIRES IN BRAZIL

Paulo Cezar Mendes Ramos[38]

1. HISTORICAL ASPECTS OF FIRE IN BRAZILIAN ECOSYSTEMS

The history of the forest if well understood is a history of exploitation and destruction. Man turns the natural world into “landscape” – domesticated and molded to some practical use or to a conventional aesthetics – or also which is more frightening, into a “space” – desert plains flattened by road rollers over which the extreme narcissism of the specie is consecrated by buildings. Human expectations are rarely realized by its interventions. Its fields become poorer, pasture become thinner and woody and the cities collapse. In disagreement with human desires but as a consequence of its actions the natural world is simplified and converted into an enormous mourning cosmopolite brush.

Forest Fire in Brazil is an ancient practice maintained by the unsustainable way of land use of modern man. It is important an historical overview about the gradual changes imposed to the Brazilian natural ecosystems by man.

Atlantic forest

The advent of agriculture radically transformed the relationships between man and forest. What had been a residual resource, inferior product for hunters-collectors, burnt by accident or incautiousness when hunting, turned into his principal habitat. The “cerrado” soils were recognized as poor in nutrients, acid and Aluminium saturated. The forest soils were more feasible for agriculture. Since the beginning agriculture at Atlantic Forest region – in fact in all flattened low lands of the continent – determined the forest sacrifice. Technique was extremely simple: at the end of the dry season, the bush of a strip of forest - one hectare more or less – was slashed and let dry, and using stone axes cutting a ring on the bark of big trees. Then, before the rain season the area was burnt, providing a big amount of nutrients present in the biomass of the forest fall as ashes in the ground.

Slash and burn agriculture was extremely reductive. Almost every thing living in the interior of the burnt area turned into ashes and only the ashes were used. Probably some burnings episodes escaped of the control, as could occasionally happen on dryer years at the most humid areas at windward of the Atlantic Forest and usually on dryer sites of the forest. It is possible that the resting periods permitted to the bush to recover to its original aspects. However, agriculture should reduce the complexity and biomass in considerable areas of Atlantic Forest during more than thousand years of practice before the arrival of the European.

The process of slash and burn was intensified with the arrival of the Portuguese. ”Terra Brasilis” as was known the new colony had its original name related to the exploitation of brazil-wood and however to the beginning of the destruction of the Atlantic Forest, which covered at that time about 1.1 million km^2, 12 percent of the country.

However, the deforestation was not maintained limited to the extractive processes of the principle of the colonization: the process continued, in the Northeast with the establishment of the sugar cane factory. In the Southeast with large deforestation areas for pasture, coffee plantations and settlement of colons.

Fire was the tool of destruction of the forests in the process of occupation and still is used for the maintenance of the transformed areas such as pasture, sugar cane and for clean crop debris, being a potential risk for the 8 percent left of the Atlantic Forest (Câmara, 1991).

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"Cerrados" (Brazilian savannas)

The end of the last glaciation 60,000 AP was characterized as a cold and dry period, when the only cause of the wildfires were lightning, which associated to a low availability of combustible thanks to a dryer climate and to the presence of big herbivorous, permit us to foresee a very low frequency of wildfires, concentrated in the wet season (Ab'Saber, 1977; Absy et al., 1993).

Between 60 to 13,000 years AP followed a period characterized by the presence of pleistocenic megafauna hunters. Those used fire to cook and probably to hunt, living in a low population density. There the regime of fire can be described as of low frequency, because of the megafauna control over the ground layer vegetation.

At the end of the Pleistocene with the extinction of the megafauna a great change can be expected specially for the herbaceous layer, and however increasing the availability of combustible, which associated with the fire used by primitive hunters certainly provided a higher frequency of wildfires.

The end of Holocene, between 4,000 and 2,000 AP, was marked by the arrival of tribes of agriculturist and hunter Indian of the linguistic group "macro-jê". Those tribes with dense populations (0.3 to 1.2 hab/km2) and bigger Indian settlement increase the frequency of fire by the slash and burn agriculture.

The territorial expansion of the European over Central Brazil begun on XVII century, and is characterized by a dependency on extractive processes and low life quality until the beginning of XX century. Burnings for renew pasture became usual increasing the frequency of wildfires in Central Brazil.

The last 40 years Central Brazil had a great increase of population density mainly after the capital establishment at Brasília, which brought an important expansion of the agriculture for the region, where pasture burnings remains as the first cause of the wildfires regimen.

Amazon forest

The main reason for fire occurrence in the Amazonian Tropical Forest is related to forest clearing for agricultural use and forest management. Three types of forest clearing by fire are distinguished:

- Shifting agriculture (slash-and-burn agriculture), where land is allowed to return to forest vegetation after a relative short period of agricultural use;
- Temporary complete removal of forest cover for preparation of forest plantations (monocultures);
- Permanent conversion of forest to grazing or crop land, as well other non forestry land uses.

In all cases, clearing and burning follows initially the same pattern: trees are felled at the end of the wet season, and the slash is left for some time to dry out in order to obtain best burning efficiency.

Shifting agriculture systems in their early practices and extent were largely determined by low human population pressure on the forest resources. They provided a sustainable base of subsistence for indigenous forest inhabitants, and their patchy impacts had little effects on overall forest ecosystem stability.

In addition to shifting cultivation, large forest areas are converted for permanent crop and grazing lands.

Taxa Média de Desflorestamento Bruto (Km^2/ano)

**Média década **Biénio 92/94*	*78/88**	*88/89*	*89/90*	*90/91*	*91/92*	*92/94***	*94/95*	*95/96*
Acre	620	540	550	380	400	482	1,208	433
Amapá	60	130	250	410	36	-	9	-
Amazonas	1,510	1,180	520	980	799	370	2,114	1,023
Maranhão	2,450	1,420	1,100	670	1,135	372	1,745	1,061
Mato Grosso	5,140	5,960	4,020	2,840	4,674	6,220	10,391	6,543
Pará	6,990	5,750	4,890	3,780	3,787	4,284	7,845	6,135
Ronónia	2,340	1,430	1,670	1,110	2,265	2,595	4,730	2,432
Roraima	290	630	150	420	281	240	220	214
Tocantins	1,650	730	580	440	409	333	797	320
Amazónia Legal	21,130	17,860	13,810	11,130	13,786	14,896	29,059	18,161

Forest clearing fires, however, often escape. Recent observations of the impact of drought and fires in 1998 on the tropical rain forest of Roraima have shown that undisturbed perhumid rain forest biomes may occasionally become flammable and that escaped forest clearings and farm burnings lead to large-scale wildfires.

2. WILDFIRE AND THE INSTITUTIONAL INVOLVEMENT

Burnings for forest clearings, for crops and grazing are cultural and are the principal causes of wildfires.

Wildfires worried society and Brazilian govern since XVII century, as can be shown by the Regiment about "Pau-Brasil" of 12 of December of 1605, which prohibited the use of fire on forests where occurred that three specie.

The first forest legislation "Código Florestal" established by the Decree n. 23.793 of 23 of January of 1934, prohibited the use of fire on grassland, pastures and for crops without previous permit of the forest authority.

The present forest legislation, established by the Law 4.771 of 15 of September of 1965, maintained the same restrictions of the 1934 Decree.

The Decree 84.017 of 21 of September of 1979, the National Parks Regulations prohibit actions that could cause fire on national Parks, but permit the use of fire as a management tool.

CONAMA Resolution n. 11/1988, of 4 of December of 1988, regulated the uses of fire as management technique.

However, was since the eighties that the federal authorities gave more attention to the problem of wildfires and burnings. Before that time wildfires on protected areas were prevented and combated depending on the efforts of its chiefs, without a central structure able to organize a national coordination to lead with those problems.

After 1987, with the advent of daily termal images of the satellites of series NOAA which make possible the detection of hot points in real time, the Brazilian society became astonished with the alarming number of hot points detected.

The effects of the great number of burnings were very important with economical losses for the farmers, about 10 percent of their production, airport operation impediment, respiratory diseases etc.

Hot points/year for Brazil Fonte: MCT/INPE e MMA/IBAMA/PREVFOGO

	June	*July*	*Augost*	*September*	*Total*
1996	1,075	3,300	12,776	16,371	33,522
1997	812	3,589	17,542	20,469	42,412
1998	3,489	7,316	33,229	33,861	77,895

Information about hot points in Brazil, detected by satellite NOAA-14oru NOAA-12 access INPE at the address: http://condor.das.inpe.br/prod.htm

Worried about those numbers of hot points, was established the Forest Fire Prevention and Combat National Commission – CONACIF on 25 of August of 1988.

Based on the experiences of CONACIF, the Government establishes the Forest Fire Prevention and Combat National System – PREVFOGO, through the Decree n. 97.635, on 10 of April of 1989. PREVFOGO

This system has the following aims:

- Education and Campaigns
- Fire Management on Protected Areas
- Meteorological and Hot Points Monitoring
- Training
- Wildfire Prevention and Combat

All these activities have been implemented through partnership with many National and International Institutions.

Along the years of existence of PREVFOGO, many has been made to minimize the effects of the great amount of agricultural burnings and wildfires. Various training courses were organized to form brigades and experts on the determination of origin and causes of forest fires

Equipment was acquired to increase the capacity of the brigades to be able to carry with the demand of combat wildfires on protected areas.

Despite the efforts of PREVFOGO to minimize the problem, we are aware that the causes of wildfire and farm burnings transcend its frontier, which have been taking us in the search for partnerships to lead with the problem.

3. INTERAGENCY IMPROVEMENTS

3.1 PROARCO

Solutions to minimize the effects of the burnings and wildfires depend on the actions of different institutions, at different levels of govern (federal, state and municipal) and also on the participation of the society.

After the big wildfire in Roraima, and with the potential risk of occurrence of big fires in other parts of the Amazon region (El Niño), Brazilian government decided to implement an emergency Program for Prevention and Combat Forest Fire at the Arc of Deforestation of Amazon – PROARCO, involving the following components:

- Meteorological and Hot Spots Monitoring
- Enforcement on deforestation and burnings
- Publicity Campaign
- Rural extension (controlled burnings)
- Training for the State Bombeiros
- Municipal brigades establishment

- Forest Fire Combat and Task Force

This Program involves IBAMA, State Environment Organizations, Civil Defence, Bombeiros, Municipal brigades, the Army and Air Force.

One of the most important PROARCO goal is the improvement of the relationships between different institutions, which participated in the formulation of State Action Plans for Forest Fire Prevention and Combat.

An Alert System was established and depending on the area and the combat capacity, the Municipal brigade, the State Bombeiros or the Task Force can be putted in action.

Task Force is the mobilization capacity of a combatant contingent (500 bombeiros of Brasília) in which the logistic is provided by the Army and the troops transport is made by the Air Force.

Another important action of the Program is the training courses for Familiar Agriculture teaching them how to make a community controlled burning with a neighbourhood participation. This action was carried by a partnership between IBAMA and Group of Amazon Work - GTA, a non-governmental organization.

All these efforts were made as an emergency programme to prevent and combat forest fires in the Amazon. The Deforestation and Burnings Monitoring and Control Project - PRODESQUE is being developed and will be a complement to PROARCO. PRODESQUE is a pilot project which will deal with the root causes of deforestation and fire in the Amazon. Its also aimed at improving the monitoring and enforcement systems on a descentralized basis .

Other government actions

As soon as the causes of wildfires are related with the forest clearing processes and uncontrolled burnings, the government established important new actions which will help to minimize the problem:

IBAMA

- Law n. 9.605 of 12 of February of 1998 – Law of the Environmental Crimes
- Decree n. 2.661 of 08 of July of 1998 – establishes rules about the agriculture, grazing and forest fire uses

INCRA (National Institute of Colonization and Agrarian Reform)

- Programme of training courses for settled agriculturist (environmental education; how to make a controlled burnt
- Lumiar Project – Technical assistance to settled agriculturist
- Improvement on the rural territorial tax which considers the forest as productive. This will help to maintain many forest areas safe from deforestation.
- New colon can not be settled in areas of Legal Reserve, areas of Permanent Preservation or in forests subjected to a Sustainable Forest Management.

PÓLITICAS Y ESTRATEGÍAS DE PROTECCIÓN CONTRA INCENDIOS FORESTALES EN HONDURAS

Miguel Angel Salazar[39]

INTRODUCCIÓN

Honduras cuenta con la mayor superficie de vocación natural forestal (87%) de CENTROAMÉRICA, la cual a pesar de recibir una constante presión, por diferentes actividades agropecuarias, aun representa el principal potencial para el desarrollo económico del país. Estos bosques tropicales, constituyen una enorme riqueza ecológica, hídrica y de biodiversidad genética, que a través de su manejo sostenible, puede contribuir en el mejoramiento social y ambiental de Honduras. No obstante en los últimos 40 años, se ha perdido el 46% del bosque siendo él más afectado el bosque latifoliado.

De todos los problemas que han venido incidiendo en los bosques, los incendios forestales en la Región Centroamericana y específicamente en Honduras, en los últimos años, han alcanzado niveles evidentemente críticos y de mucha preocupación porque estos, influenciados por factores climáticos tales como altas temperaturas, baja humedad relativa y largos periodos secos, han favorecido la propagación e intensidad de los incendios, causando mayores daños en el bosque pinar que es el ecosistema que por su naturaleza es más resistente al calor del fuego.

En el recién pasado verano, la presencia del fenómeno de El Niño dejó al descubierto la capacidad de atención que se tiene para enfrentar el problema de los incendios, porque, a pesar de las condiciones climáticas adversas que diera lugar a un verano intenso, la ocurrencia y el área quemada no fue tan alta, comparado a lo ocurrido en otros años pico, debido a los esfuerzos hechos para contrarrestar los efectos del fenómeno con apoyo de Proyectos y otras instituciones, sin embargo, fue notorio la presencia de fuegos en los bosques latifoliados (núcleos de áreas protegidas) y los daños dejados por los incendios que fueron más severos.

La información de la presencia del fenómeno por los diferentes medios nacionales e internacionales despertó mayor conciencia en las autoridades gubernamentales de todos los países dando como resultado una serie de eventos relacionados con el problema de incendios forestales dentro del marco Institucional, de la Comisión Centroamericana de Ambiente y Desarrollo(CCAD), Consejo Centroamericano de Bosques y Áreas Protegidas (CCAB/AP), Foro Regional en México, hasta considerarse como tema central para ser discutido en la XX^{ma} Cumbre de Presidentes de Centroamérica, el cual tendrá lugar en Antigua, Guatemala en el mes de Noviembre de 1998.

Las nuevas políticas en Honduras dentro de la Agenda Ambiental requieren de la AFE/COHDEFOR una mayor modernización del sector forestal, compartiendo responsabilidades mediante alianzas estratégicas con sectores involucrados (Gobierno central, Comunidades, Gobiernos locales, Organizaciones no gubernamentales, sector privado) en la aplicación de medidas preventivas y combativas o reparadoras, para el cumplimiento de la normativa para el manejo de los bosques.

ANTECEDENTES

A principios del presente año, el Sr. Presidente de la República, Dr. Carlos Roberto Reina, emitió el Acuerdo Ejecutivo 004-98 mediante el cual la AFE/COHDEFOR tomó las primeras medidas con las Regionales Forestales para contrarrestar los efectos del fenómeno de El Niño.

[39] Administracion Forestal Del Estado, (AFE), Corporación Hondureña De Desarrollo Forestal (COHDEFOR).

Luego el nuevo Presidente de la República, Ing. Carlos Roberto Flores, nombró una Comisión Gubernamental Preventiva bajo la Coordinación de la Secretaría de Recursos Naturales y Ambiente para tomar las precauciones necesarias en mitigar los efectos del fenómeno en cuanto a Salud, Seguridad Alimentaria e Incendios Forestales, procediéndose de inmediato a gestiones de apoyo de organismos internacionales, obteniéndose respuesta por parte de la Agencia Canadiense de Desarrollo Internacional (ACDI) con asistencia técnica, contribución con equipo y capacitación por un monto de 5 millones de Lempiras.

Igualmente hubo respuesta de los Proyectos actualmente en ejecución, como los Proyectos PDF/USAID, USAID/OFDA, Proyecto de Administración de Áreas Rurales (PAAR) y Proyecto de El Cajón.

Como resultado de los esfuerzos de protección en aquellas áreas forestales más importantes, en el recién pasado verano fueron involucradas 2346 personas para la protección intensiva de 1,159.574 Hectáreas en donde ocurrieron 3,127 incendios forestales, de los cuales solamente se lograron combatir 2,260 incendios con un área quemada de 96,628 Hectáreas. Las regiones más afectadas fueron La Mosquitia, Olancho, Fco. Morazan y Comayagua. Para la detección de los incendios, fueron habilitadas 31 torres de observación.

Al finalizar la temporada de incendios en un taller de trabajo con personal de larga experiencia se analizó el problema central de la alta incidencia de incendios, identificándose entre las causas más importantes las siguientes:

- Falta de un Programa de Protección Permanente
- No hay un ordenamiento territorial en el país
- Falta de coordinación interinstitucional
- Falta de educación forestal en la población hondureña
- Persistencia en la población de prácticas tradicionales agropecuarias
- Falta de medios logísticos e infraestructura adecuada
- Resentimiento social en la población
- Falta de incentivos por la protección del bosque.

Como medida inmediata, la AFE/COHDEFOR para dar mayor autoridad y beligerancia en las acciones de Protección, creó el Departamento de Protección Forestal, con el apoyo del Proyecto de Desarrollo Forestal USAID. Además, con el apoyo del Grupo Militar de USA con sede en Panamá, USAID/OFDA con sede en Costa Rica y el PDF/USAID se ha estado desarrollando un programa de capacitación, mediante el cual se estará conformando un equipo de instructores (30) para el entrenamiento básico de personal en combate de incendios forestales.

EL PROBLEMA

Más del 40% de la población hondureña está asentada en las áreas forestales, equivalentes al 53.2% del territorio nacional. En estos no hay conciencia forestal debido a la formación que reciben en los centros de enseñanza y de sus padres; por lo que para muchos de ellos, los árboles son un obstáculo (agricultura migratoria) y no un medio de desarrollo. A esta situación, además de agregarle efectos de aplicación de políticas inadecuadas en los aprovechamiento forestales, los campesinos han visto hacer explotaciones forestales que solamente les ocasiona daños en las fuentes de agua, en la fauna, en el clima y en el medio ambiente en general.

También las oficinas forestales, en la atención del público (campesinos) para resolverles problemas domésticos, no han sido lo mejor, causando en los demandantes cierto resentimiento que se refleja en la indiferencia por la protección del bosque. Permitiendo que los incendios, descombros y los cortes clandestinos continúen sin ningún control.

La misma falta de educación forestal en todos los estratos de la sociedad hondureña, ha hecho que las actividades de protección forestal, aunque éstas son parte de los planes de manejo, no han sido importantes para los propietarios de los bosques, a pesar de los beneficios económicos directos que reciben de éste.

La AFE/COHDEFOR, a pesar de enfrentar el problema de la alta tasa de DEFORESTACIÓN no ha prestado en los años anteriores, la atención que se ha requerido, minimizando las actividades de Protección que son la base fundamental para sustentar los Planes de Manejo, reduciendo a niveles críticos los medios y recursos humanos y económicos para mantener un programa permanente de Protección Forestal.

POLÍTICAS ACTUALES

1. Mejorar y maximizar la operatividad de acciones mediante la creación del Depto. de Protección Forestal
2. Mantener un Programa de Prevención de Incendios durante todo el año
3. Fortalecer las acciones de Protección en los bosques nacionales
4. Responsabilizar a los Propietarios de Bosques con dominio pleno y Corporaciones Municipales de la protección de sus áreas forestales
5. Combatir los incendios forestales en todas aquellas áreas que son altamente susceptibles y en aquellas áreas que, por sus funciones, necesitan ser protegidas, tales como: las áreas con Regeneración Natural, Microcuencas y Áreas Protegidas
6. Mejorar el Sistema de Detección de Incendios Forestales
7. Intensificar acciones de Educación Forestal
8. Capacitar y entrenar a los cuadros de Protección tanto en la Prevención como en el combate de Incendios Forestales
9. Fomentar los servicios privados para la Protección del Bosque con las Corporaciones Municipales y Comunidades Forestales
10. Investigar las causas de los Incendios Forestales
11. Investigar los daños causados por los incendios Forestales
12. Organizar la lucha contra los Incendios Forestales
13. Mejorar el Registro Estadístico como base fundamental de la Planificación

ACCIONES ESTRÁTEGICAS PARA 1999

1. Estructurar el Depto. de Protección Forestal con personal técnico capaz de planificar, asistir y ejecutar la protección de las áreas forestales de todo el país
2. Analizar los municipios forestales, para establecer prioridades en el desarrollo del programa de prevención
3. Producir material didáctico educativo para potencializar el trabajo de Prevención
4. Planificar acciones con los Deptos. de Fomento y Extensión y Áreas Protegidas
5. Mapeo de las áreas bajo manejo para identificar los bosques nacionales
6. Elaborar planes y ejecutar la protección de las Áreas Nacionales
7. Mapeo de las áreas bajo manejo por Unidad de gestión y a nivel Regional
8. Revisión, aprobación y supervisión de ejecución de los Planes de manejo
9. Establecer convenios con las Corporaciones Municipales
10. Mapeo de las áreas forestales, identificando las áreas prioritarias
11. Reparación y construcción de Torres de Observación
12. Establecer convenio con MARENA de Nicaragua para obtener información de Satélite NOAA
13. Establecer convenio con la Secretaría de Educación Pública para mejorar los Programas curriculares en la educación formal y no formal
14. Capacitación de acuerdo a los niveles que conforman la estructura organizativa de protección forestal
15. Identificar comunidades forestales con las municipalidades para estudiar las posibilidades de establecer convenios de protección contra incendios forestales
16. Capacitar al personal de combate de incendios para que procedan a investigar las causas de los incendios forestales
17. Coordinar con la Policía Nacional, Fiscalía y ONGs, mediante la aplicación de algunos procedimientos, las causas de los incendios forestales
18. Establecer convenios con los centros de educación forestal superior para investigar los daños causados por los incendios forestales

19. A través de Comisión Permanente de Contingencias (Copeco) se organizará la lucha contra los incendios forestales (Comités Regionales de Protección)
20. Se revisarán los formatos establecidos para el registro de información
21. Se diseñará una base de datos para el registro de información de incendios por los diferentes niveles que atienden el problema

PROPUESTAS

Nacional

Honduras cuenta, desde el punto de vista económico, social y ecológico, con uno de sus mayores recursos como lo es bosque, el cual, bajo el proceso de manejo sostenible, puede convertirlo en el país de mayor importancia de Latinoamérica dada la diversidad existente en sus ecosistemas naturales.

Por consiguiente se hace necesario:

- Conocer el valor de los diferentes ecosistemas
- Evaluar los daños causados por incendios y plagas forestales
- Manejar al fuego como una herramienta silvícola
- Manejo de información climatológica para calcular índices de peligro de incendios

La información anterior será la base de justificación en la planificación del programa de Prevención, mediante el cual podamos:

- Educar forestalmente a los niños y jóvenes
- Organizar a las comunidades para la protección del bosque
- Establecer convenios o contratos con comunidades y empresas consultoras
- Desarrollar un Programa de Difusión y divulgación con información real y objetiva

Regional

En el marco del Foro Regional, que se realizó en México y en el cual participaron 13 países, se llegó a las conclusiones siguientes:

- Promover la creación de un Comité Regional de Prevención de Incendios Forestales
- Crear un Fondo Regional destinado a la operación del Centro Regional de Prevención y Combate de Incendios
- Destinar recursos financieros nacionales e internacionales para reforestación
- Restaurar las áreas afectadas por los incendios forestales
- Promover proyectos de cooperación técnica
- Fomentar la educación ambiental, enfatizando en la prevención de incendios
- La tenencia de la tierra es un factor que incide en el problema de incendios
- Promover la conservación de germoplasma de especies de alto valor

Se espera obtener de la XX^{ma} Cumbre de Presidentes de Centro América, a realizarce en Antigua, Guatemala, las resoluciones siguientes:

- Reconocer en las Estrategias y Planes de Trabajo, la prevención y combate de incendios desarrollados por los países de la región como una herramienta para contrarrestar este tipo de desastres
- Oficializar ante los ministros de Ambiente, Agricultura, Educación, Gobernación y otras instancias de interés, dichas estrategias y planes de acción de manera que se operacionalice en una estructura permanente en cada país que permita atender tal problemática
- Desarrollar campañas de Prevención de Incendios Forestales e introducir en la curricula formal el tema de vulnerabilidad

- Realizar gestiones para el saneamiento de la tenencia de la tierra, como fundamento en la productividad, agrícola, ganadera y forestal
- Desarrollar la capacidad competitiva de los recursos naturales de la región, a través del pago, de los beneficios ambientales (agua, suelo, belleza escénica, biodiversidad y otros)
- Crear un Fondo Financiero Centroamericano de Desarrollo Limpio que permita financiar actividades tendientes a mitigar las emisiones de carbono, aprovechando como fondo base el 20% de la factura petrolera, el producto de las negociaciones de fijación de carbono, el pago del agua y de la belleza escénica como parte de los servicios ambientales, así como otras fuentes de cooperación internacional
- Crear un Centro de Monitoreo y Teledetección de incendios forestales que permita implementar estrategias de prevención y control de incendios con mayor efectividad
- Consolidar el Comité Técnico Centroamericano de Manejo del Fuego
- Orientar acciones financieras que permitan apoyar aquellas actividades tendientes a la restauración económica, social y ambiental de las zonas afectadas por incendios.

ANEXOS

1. Mapa de la situación de incendios en Centro América
2. Mapa de uso de suelos de Honduras
3. Situación de incendios en los últimos 5 años en Honduras

MEETING ON PUBLIC POLICIES AFFECTING FOREST FIRES: MEXICO

Victor M. Villalobos Arámbula[40]

First of all, I would like to thank FAO for convening this meeting, which gives us the opportunity, for the first time, to discuss questions related to Forest Fires at the global level and, at the same time, to hear the opinion of experts in this area. As it has been pointed out in this meeting, during 1998 Mexico has faced the most difficult season of forest fires in history.

This year Mexico has suffered difficult climatic conditions throughout most of the country, with extreme temperatures from minus 15 degrees centigrade and up to 35 degrees centigrade during the day, with snow in cities in which never had a similar phenomenon, like Guadalajara and Aguascalientes. Another clear example is Mexico City where the thermometer registered a temperature of almost 35 degree centigrade, the highest in 50 years.

In February our Ministry adopted concrete measures to face this dramatic problem and elaborated immediately a strong programme in which the President instructed us to support actions established in the programme.

The results of the programme have been published. The programme covered 14 thousand fires, affecting almost to 600 thousand hectares.

Despite the fact that the number of fires increased by one hundred percent compared to the previous year, the affected area stayed within the normal range as had been recorded in the severe seasons in the 80's and 90's.

This was possible because "SEMARNAP" (Ministry of Environment, Natural Resources and Fisheries), at the end of 1997, at the regional level, implemented a preventive programme to provide information and guidance on physical actions in risk areas, such fire cutting trenches and controlled burning.

SEMARNAP's actions were taken in coordination with other significant governmental bodies including the Ministry of National Defence, Navy Ministry, Interior Ministry, Agricultural, Livestock and Rural Development Ministry and the Transport and Communication Ministry. Furthermore SEMARNAP carried out coordination with various state and local governments, as well as with local non-governmental organization.

We also recognize and want to thank countries such as Spain, Canada and United Kingdom that supported us with training programmes. A special thanks to United States of America that provided us with technical support, equipment and financial resources which allowed us to control the fires successfully in Chimalapas in Oaxaca at the end of the period.

Damages were of different levels, from moderate caused by superficial fires with smaller damage to the ecosystem, as well as fires up to the canopy level of the forest with serious damage to the surrounding of the ecosystem. These more serious fires had been present in different areas in 10 of the 32 States of Mexico.

We do not wish to minimize the seriousness but the results of the damages would have been more severe in the absence of a serious and responsible approach by the Government and its partners.

Tragically, 70 people lost their lives directly of indirectly as a result of the fires.

[40] Subsecretario de Recursos Naturales, Secretaría de Medio Ambiente, Recusos Naturales y Pesca (SEMARNAP) Mexico.

The 1998 season had left us with the lesson that we have to evaluate and strengthen our approach with preventive actions. Above all, we need actions that allow us to develop viable and realistic solutions which can be translated into jobs or socio-economic options that can resolve the serious problems of subsistence agriculture and damaging practices such as clear cutting by burning that are common in our tropical areas.

With the arrival of rain and by the national reforestation programme (El Pronare), we gave ourselves a task of recuperating the areas severely damaged by the fires, and to limit changes of land use in the affected areas.

This process has been intensified with the reforestation programme, which will reforest 185,000 ha, distributed in 85 recuperation zones.

I would like to mention that his programme has been directed by the President of Mexico in June with the declaration of ecological recuperation zones, avoiding the changes of land use in forested areas.

Mexican society was alarmed by the fires and thus we started different consulting for a, trying to identify solutions to avoid or mitigate the forest fire problem in the near future.

From May to October, seven national meetings were held in Mexico, at the end of August one regional conference was hosted by my country. This event that was supported by FAO, 13 countries participated from Central and South America as well as the U.S.A.

The main conclusion of these meetings was that we have to work cooperatively to avoid repetition of the grave forest fire situation of 1998. Society and Governments must collaborate together to find solutions to minimize the number of forest fires as much as possible, including their negative social, economic and environmental effects.

For these reasons, we consider that this meeting must analyze the direct experiences of participants and the results of the previous meetings. It would be valuable for us to agree on international strategies to prevent and combat forest fires, as well as to protect the environment.

In giving this year’s severe forest fires events, we must find effective short and long term strategies to combat forest fires.

Considering the ecological impact of forest fires, mainly atmospheric pollution, we are sure that we will come to a positive conclusion to successfully coordinate our activities. Forest Fires don’t recognize boundaries. They affect all of us. It is for these reasons that we have to find the best solution to prevent and combat them.

We support that FAO, though its regional commissions on forestry, continues to play a significant role in this field in order to elaborate strategies for preventing and combating forest fires.

In November, Mexico will host the meeting of the North American Commission on Forestry. One of the most important topics that will be discussed is precisely our topic of discussion here today. We intend to report in our November meeting in Mexico the conclusions and recommendations that we will adopt here today.

RESULTS OF MEXICO'S 1998 FOREST FIRE CAMPAIGN

Oscar Cedeño Sánchez[41]

I. BACKGROUND

1. Characteristics of the fires

Mexico has 56 million hectares covered by forests and jungles (National Forest Inventory, 1994). Also, of 84 million hectares of forests areas not covered (heaths, chaparral, etc.).

These forests resources are annually affected by forests fires. The fires are determined for the heat, the presence of fuel and the wind. The forests fires in Mexico are mainly surface fires (in a 90 percent).

The natural phenomena like the hurricanes could also produce great amount of fuels and propitiate fires of big magnitudes. The last of them was the hurricane "Paulina," that affected around 70 thousands of hectares in Oaxaca, in 1997.

The forests fires are an important cause of the degradation of the forests resources. However, their contribution to the annual deforestation is not very significant (2 percent), in comparison with the forest slash that they are the cause of this in more than the 90 percent.

The forests fires cause diverse temporary or permanent impacts. Fortunately, most of they are of the first type, since they generally affect grasses and heaths, that they recover in a short period of time.

2. Historical data

In Mexico, every year comes with forests fires of diverse magnitudes, in accordance with the climatic and meteorological conditions. From 1980 to 1997, 6,837 forests fires have occurred annually on the average, with a surface affected of 223,114 hectares (around 33 hectares for fire). Fortunately, more than 80 percent corresponded to bushes and heaths, vegetation that is renewed quickly.

Critical years

1988. In September, the pass of the Gilberto hurricane gave rise to an intense drought that contributed to the proliferation of fires. That year 10,492 fires happened and were affected 518 thousand hectares.

1989. The conflagrations damaged 507 thousand hectares. Only one, occurred during the drought of this year, reached 135 thousand hectares of forest.

1993. The 10,251 fires affected 235,020 hectares.

[41] Director de Protección Forestal, SEMARNAP, México.

Forests fires in Mexico (1980-1997)

Year	*Fires*	*Affected Surface (ha)*	*Indicator Surface/Fire (ha)*
1980	4,242	110,709	26
1981	2,740	67,228	25 *
1982	5,599	137,669	25 *
1983	6,087	272,000	45
1984	6,120	236,032	39
1985	4,386	152,224	35
1986	8,482	290,815	34
1987	9,263	287,347	31
1988	10,942	518,286	47 **
1989	9,946	507,471	51 ***
1990	3,443	80,400	23
1991	8,621	269,266	31
1992	2,829	44,401	16 *
1993	10,251	235,020	23
1994	7,830	141,502	18
1995	7,860	309,097	39
1996	9,256	248,765	27
1997	5,163	107 845	21 *

* El Niño, ** Higher total affected surface, *** Higher fire surface/ha
Source: Subsecretaría de Recursos Forestales Dirección General Forestal.

3. International frame

During the period 1989-1994 were improved the indexes of efficiency in the suppression, occurring 7,153 fires that affected 213,010 hectares, indicating a surface affected of 28.9 hectares per fire. The above-mentioned locates Mexico in similar circumstances to countries like Spain, Yugoslavia, France, Greece; countries like Canada and the old USSR surpass these amounts: 181.2 and 58.1 hectares/ fire.

II. RESULTS AND EVALUATION OF 1998

1. Climatic analysis

During the last semester of 1997, the presence of rains registered above of the historical record of the last 56 years, due for the presence of the climatic phenomenon of the "El Niño," which generated a great accumulation of fuel material on the forest areas from Mexico.

On the contrary in 1998 values of minor precipitation to the record of the last 56 years, and in months like April and May practically near to 0.0 mm. of precipitation, which generated a severe drought that exposed to almost all the forests areas of the country in imminent risk of being affected for the fires.

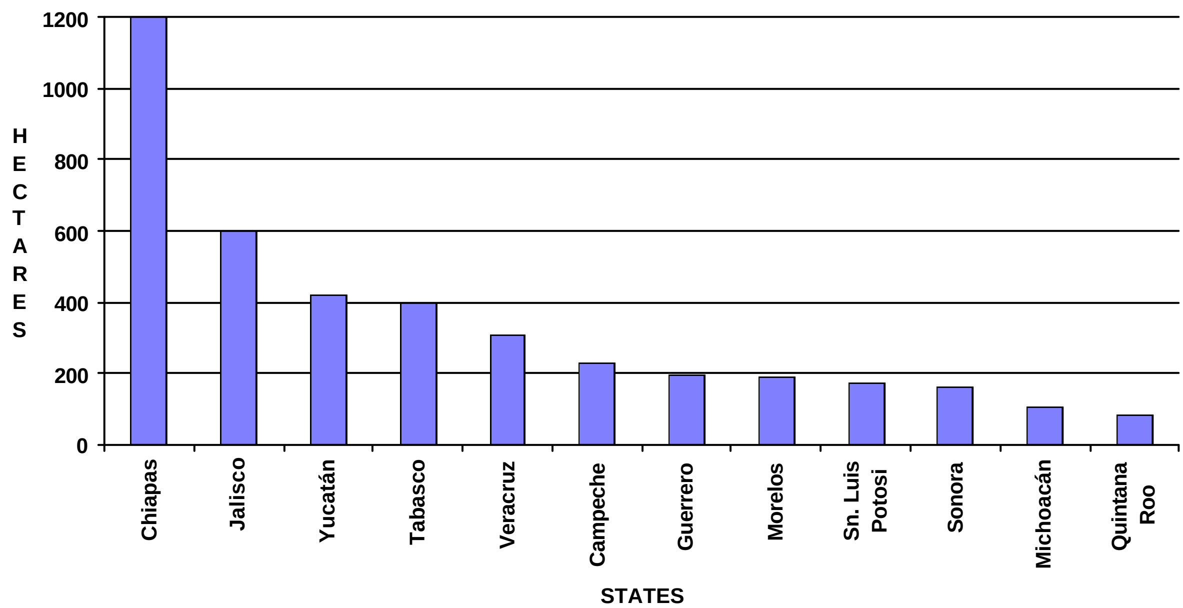
Likewise the values of temperature were registered like "breaking record" in the hottest months of the year, with historical values for many places of the country. Besides in December of 1997 and the first two months of 1998, they registered intense ice and snow storms, with extreme values of minimum temperatures. Conditions that together with the drought propitiated an unprecedented drying of the vegetation in the country.

So against, what many people thought, the possibility of predict these conditions were practically impossible, since it was argued that with single knowledge that came the phenomenon of the "El Niño" in 1997, it automatically should sense that this year would be dry, which not necessarily happens, if it is considered the historical registrations of the occurrence of this climatic phenomenon that is totally aleatory and their severity could not be foreseen.

The causes reported by the fires in this year, according to the type of condition of the forests areas, they were: The 35.3 percent forests zones not covered; the 28.2 percent in commercial forest without uses; the 19.6 percent forest not commercial without uses; 14.9 percent forest and jungles with forest exploitation and 7.4 percent en protected natural areas.

The causes of the forests fires vary for regions of the country. In the central zone the main cause is the burn of grasses and the bonfires. In the Southeast the practice of the "Roza-Tumba y Quema" and the changes of use of land. Most of the fires originate for an inadequate use of the fire in the agricultural areas. The state of the country in which they registered a major number of agricultural burns was Chiapas, that coincides with the State of the country in which it was registered a larger surface affected by the fires.

States with higher number of agricultural burns



TOTAL SURFACE OF AGRICULTURAL BURNS: 4'288,670 HA

Results of 1998

To July 31 of 1998, occurred 14,242 fires that affected a surface of 582,857 hectares, and with an average of surface per fire of 40.9 hectares, superior figures in 99 percent. 225 percent and 63 percent, respectively, to those of the annual average of 1970-1997.

Average 1970-1997 vs. 1998

	1970-1997	*1998**	*Difference (%)*
Fires	7,157	14,242	99
Affected area (ha)	179,594	582,857	225
Average (hectares/fires)	25.09	40.9	63

*data at July 31st

Likewise the season of this year is the most serious if it is considered that the resulting figures were the higher than the highest registered previously.

	*1998**	*Minimum previously registered*	*Average 1992-1997*	*Maximum previously registered*
Fires	14,242	2,740 (1981)	7,198	10,942 (1988)
Affected Area	582,857	44,401 (1992)	181,103	518,265 (1988)
Affected area per fire	40.93	15.65 (1977)	25.16	51.02 (1989)

*data at July 31st

In 1998, the 73 percent of the affected areas have been of grasses and heaths. The indicators of efficiency indicate that the time of detection and duration of the fires has increased in 11.9 percent and 78.1 percent respectively, concerning to the period of 1992-1997, and only the time of arriving decreased in 4.8 percent.

Indicators of efficiency per year 1992-1997 Vs. 1998

	*1992-1997**	*1998**	*Difference (%)*
Detection	1:07	1:15	11.9
Arriving	1:24	1:20	-4.8
Suppression	9:17	16:32	78.1

*data at July 31st

On the other hand in this year with those severe forests fires, the 85 percent of the total of the fires had a minor duration to 24 hours, and the 83 percent registered an affectation of 25 hectares or less.

The increment of the number of fires and the affected area are due to the simultaneous presence of diverse climatic adverse factors, such like: rains in 1997 that produced the growth of grasses and herbs that constitute a great amount of potential fuel; precipitation of January to June was inferior to the historical record of 1941 to 1997; presence of freezes that dried up the combustible material; as well as high temperatures at noon, relative humidity very low and strong winds in many zones of the country.

PROGRAMME AND ACTIONS IN 1998

According to the Organic Law of the Public Administration, the Forest Law and the Internal Regulation of the SEMARNAP, correspond to this Secretary coordinate and execute the "National Campaign against Forests Fires." For this, a organizational structure is had in the national and state level, in order to coordinate the efforts of the institutions, levels of government and the social and private sectors.

The actions of the Programme against Fires is assembled in three slopes: In prevention matter are carried out: public acts, messages in radio and TV, distribution divulgative printings, construction of fire lines, controlled burns, training courses, integration of voluntary groups, coordination and agreement of actions with the diverse participants; and the emission and application of the Mexican Official Standard of the Use of the Fire in the field.

In order to detect the fires they are carried out: terrestrial and air journeys, operation of towers of observation and centres of control. For the suppression: operation of specialized brigades in order to support the fire suppression, and operation of air equipment for transport of personnel and drop water and chemicals.

Given the high danger of the fires of this year and the difficult conditions for their suppression, unfortunately until now had died 70 persons:

Casualties

Instance	*No.*	*%*
SEDENA	27	39
SEMARNAP	3	4
State Governments	12	17
Volunteers	28	40
Total	70	100

Crashed helicopters

Instance	*No.*
SEDENA	1
State Governments	1
Leased	2
Total	4

<u>Air equipment in detection and suppression of forests fires in 1998</u>

Operated 57 aeroplanes and light planes (2 of the SEMARNAP and 55 of the SEDENA) during the campaign for detection of fires. They incorporated in order to support the actions of suppression 25 medium helicopters (2 SEMARNAP, 16 leased by SEMARNAP and 7 SEDENA); 3 helicopters type "Sky Crane" and 1 amphibious aeroplane, leased also by SEMARNAP.

With the support of this equipment, it was achieved the opportune detection of fires, the transport of 16.785 fire-fighters to the areas of the fires with difficult access and the application of 15.3 million of litres of water, foams and chemicals on the most critical fronts of the fires.

In total the airships flew 3,554.5 hours in 25 States of the country, with a cost of 8.65 million of dollars.

Air equipment used in 1998

Use of the air equipment of 1995 to 1997 (Average)				
Type	*Number*	*Transported Personnel*	*Water drops & chemicals*	*Flight hours*
Air Planes for detection	3	0	0	229:33
Helicopters.	6	4 165	383 (306 400 litres)	432:58
Total	9	4 165	383 (306 400 litres)	662:31

Use of the Air equipment in 1998				
Type	*Number*	*Transported Personnel*	*Water drops & chemicals*	*Flight hours*
Air planes for detection	57	294	0	315:49
Helicopters.	25*	16 785	3 702 (4 442 400 litres)	2,689:42
Amphibious plane CL-415	1	0	383 (2 365 025 litres)	159:35
"Sky Crane", with 7,600 litres tank capacity.	3	0	1 967 (8 325 197 litres)	389:52
Total	86	16 979	6,052 (15,325,622 litres)	3,554:58

* Include 7 helicopters MI from SEDENA

The SEDENA is the main support for the detection and the fire-fighting, particularly when the fires could not be controlled for their characteristics or magnitude for the permanent brigades of the SEMARNAP, Governments of the States and other organizations.

In 1998, the SEDENA has contributed 141.519 military troops, applying 358.589 days/ man, in order to assist 3.086 fires of characteristics of high risk in 31 states of the country. They have also supported with air equipment for detection and for the fire-fighting: 7 for the fire-fighting and 57 for the detection.

Budget and resources for the protection against the forests fires of 1998

The basic available resources for the suppression of the forests fires in this year had to increase, in order to assist a difficult season in an efficient way, in comparison to which the assigned in a normal season.

This infrastructure and resources consisted of: 611 brigades of SEMARNAP and other instances (around 6,846 specialized fire-fighters), 207 camps, 122 towers of observation, 36 centres of control, 552 vehicles, 1,425 radios, 44,390 tools and 6 thousand garments of protection, besides the air equipment.

Also, in 1997 the SEMARNAP had acquired 2,150 garments of protection, 123 radios, 83 trucks of 3 ton, 8.700 tools and equipment, in order to be used in the campaign of 1998.

The budget of 1998 had an important increment of the 194.8 percent in comparison to the annual average of the period 1993-1997, upon passing form 6.258 to 18.45 million dollars.

On the other hand the budget originally authorized for 1998 that was about 9.29 million dollars, had an increment of the 98.6 percent upon authorizing 9.16 million dollars more, in order to execute the Programme of Reinforcement to make a front of the forests fires, that in this year presented the most serious season of the last 30 years.

The composition of the budget in expenses of operation and personal services (wages for fire-fighters) are pointed out in the following graph:

Budget of the programme against forests fires of the SEMARNAP in 1998

Concept	*Millions of dollars*				
	Average 1993–1997	*Original 1998*	*Reinforcement 1998 (1st Phase)*	*Reinforcement 1998 (2nd Phase)*	*Total 1998*
Expenses of Centralized operation (for lease of air equipment and acquisition of equipment, wardrobe and tools for the Delegations)	17.16	33.0	28.4	43.0	104.4
Expenses of operation in the delegations (fuels, spare parts and travel expenses).	4.42	11.9	12.3	--	24.2
Personal services (Wages of the brigades).	41.00	48.0	7.9	--	55.9
Total	62.58	92.9	48.6	43.0	184.5

Note: In 1997 it was acquired equipment for 2.19 million dollars for 1998

Also, due to the so critical situation that generated the fires, from February of this year, additional actions with diverse dependencies were suited. The SEDENA supported with helicopters type MI-8 with bambi buckets. Also with 55airships with flights of detection daily in all the country. A basic force of 30 thousands of elements was provided of the army in order to support the fire-fighting, increasing to 141,519 military troops to July 31 of this year.

The SEMAR supported with air equipment, the SEGOB with the coordination through Civil Protection of the State and Municipal Governments, the SAGAR with air equipment and prevention of the use of the fire in agricultural lands, likewise diverse supports of other institutions were offered like: SCT, PGR, CONAGUA, SECTUR, Firemen, ASA, CFE, SEDESOL, CORENA.

Diverse actions with groupings of producers, ONG's, (UNECOF, PROFOAGREMEX, Red MOCAF, Confederation of Small Rural Proprietors, GEA Group, Commission of Forests and Forests of the Camera of Deputies, Civil Council for the Forestry, INIFAP, Division of Forests Sciences of the UACh and National Academy of Forests Sciences) were also concerted, in order to reinforce diverse activities of detection, prevention and suppression of the forests fires.

IV. INTERNATIONAL COOPERATION.

International supports were received in Mexico for the attention of forests fires in 1998:

EUA- AID
Zone of work with large fires: Chimalapas, Oaxaca and The Ocote, Chiapas.

Action	*Quantity or Amount*
DETECTION:	
Sending of air planes for infra red photographs	2
SUPPRESSION:	
Sending experts to give technical assistance to support the suppression of the fires:	69
Days of work:	45
Mexican Technicians Trained:	328
Topics of technical assistance and training,:	
Use of air equipment: Coordination of helibases and flights with helicopters; estimate of loads and weight; signals on earth for helicopters; use of accessories for external load; security in the use of helicopters. Installation and use of team of radio communication. Training courses in the use of GPS. Use of power saws, motor pumps and portable tanks. First aids.	
Donation of tools, garments of protection and team for the firefight:	3,000 persons
Donation of foams for the forest fires suppression:	8,000 litres
Economic support for the lease of 5 helicopters type II (medium) and 1 helicopter type I "Crane":	US$2.4 millions
Estimated total cost of the support:	US$5 millions

US- Forest Service

Action	*Quantity or Amount*
SUPPRESSION:	
Training of Mexican experts for 4 months on helitack crews.	2 experts US$8,000
Support with resources for the attendance of a Mexican technician to the I South American Seminar of Forests Fires:	US$2,500

US- Bureau Land Management (BLM)

Action	*Quantity or Amount*
SUPPRESSION:	
Training of Mexican technicians for 2 weeks in the NIFFC in Boise, Idaho and to Arizona:	2 experts
Training of Mexican technicians for 2 weeks in the NIFFC in Boise, Idaho and to California:	2 experts
Visit of Mexican officials for 1 week in the NIFFC in Boise, Idaho:	3 functionaries
Technical attendance of two specialists from USA for 2 weeks in order to support the handling of the fire in tropical areas:	2 experts
Technical attendance of two specialists from USA for 2 weeks in order to support the handling of the fire in areas of heaths:	2 experts

Lowrance electronics

Action	*Quantity or Amount*
SUPPRESSION:	
Donation of specialized equipment to Pronatura A.C., for their subsequent delivery to the social organization "Maderas del Pueblo", in Chimalapas, Oax.:	US$1 896

United Kingdom

Action	*Quantity or Amount*
SUPPRESSION:	
Donation of resources for the construction of a camp of prevention and suppression of forests fires in the North of the State of Puebla:	$38 100 Pnd US$62 865

Spain

Action	*Quantity or Amount*
PREVENTION AND SUPPRESSION:	
Scholarships for the attendance of Mexican technicians to the XIV Iberoamerican Advanced Course for the Protection against Forests Fires:	6 trainees

Conclusions

In Mexico, every year occur forests fires of diverse magnitudes, in accordance with the climatic and meteorological conditions. From 1980 to 1997 have occurred 6,837 forests fires annually on the average, with a surface affected of 223,114 hectares (around 33 hectares for fire). Fortunately, more than 80 percent corresponded to bushes and heaths, vegetation that is renewed quickly.

1998 registered 14,242 forests fires, that affected a total surface of 582,857 hectares, with an average of surface for fire of 40.93 hectares, these figures had increments of the 99 percent. 225 percent and 63 percent, respectively in comparison to the annual averages of 1970 to 1997.

From the total affected surface the 73 percent corresponded to grasses, bushes and heaths (425,850 hectares) and the 27 percent affected covered areas (157,007 hectares).

The anterior statistical results had their origin in the climatic and meteorological conditions of the first semester of 1998, that was particularly critical; in fact, have been the most adverse of the last seventy years.

The plentiful rains of 1997 propitiated the accumulation of fuels in the forests.

The freezes of principles of 1998 dried the vegetation. An atmospheric peculiar phenomenon was the freezes and snowy from the 12 15 of December of 1997 in diverse states of the country.

The winds of February and March were intense and durable. Besides vivifying the fire, these winds made difficult the operation of the air equipment.

The rains of February and March went down to half of the average of previous years.

The phenomenon of "El Niño," that affected to vast regions of the planet, propitiated diverse anomalies that ended in one of the most severe droughts of the present century, with temperatures that reached unprecedented historical registrations in the north-west, centre and south of the country. The closing of "El Niño," with an intense drought, constitute an unusual circumstance, that has come a single time in the last half of the century.

The high temperatures that came this year constituted another risk factor for the forests fires. Just in Veracruz, April 16 was had a historical registration of 49°C. In Mexico City it was registered the highest temperature of the last years: 34.7°C. In diverse points of the Republic higher than to 35°C temperatures have been suffered for several days.

Almost the entirety of the fires (97 percent) obey to human causes, either for accident, intended or negligence.

Near 50 percent of the forests fires has their origin in the use of the fire with agricultural purposes. The practices of the rural population in Mexico incorporate ancestral activities of handling of the fire. They come to take place accidental conflagrations upon cleaning the parcels of agricultural residuals and of vegetation, as well as upon promoting the reborn of forages in areas of extensive shepherding in forests zones. In years of intense drought, these practices determined the multiplication of focuses of simultaneous fires.

In order to make a front of the situation of the forests fires of 1998, Mexico has mobilized an unprecedented capacity, like sample in the following figures:

In the campaign of 1998, the number of fire-fighters was superior in 86 percent to the annual average of 1992-1997.

The cost of the campaign against the forests fires of 1998 almost has quadrupled the annual average corresponding to the period 1993-1997.

The average of surface affected by fire of January 1° to July 31 of 1998 was from 40.9 hectares. The average of the last 18 years were from 33 hectares.

The average of duration of the fires for the same period was from 16:32 hours. is favourable, compared with the benign previous season of 1997, that it was from 17:10 hours.

In the year in course, the 85 percent of the registered fires were extinguished in less than 24 hours. Only 15 percent of the same required more than one day for their extinction.

Spite the fact that the climatological conditions have been worst in 1998 that in 1989, the affected surface was lightly superior to the reached then, thanks to the intense mobilization and to the renovated capacity in order to make in front of the forests fires.

In the frame of the Regional Forum, that took place the days 26th - 28th August of 1998 in Mexico City, the representatives of the following countries: Argentina, Brazil, Costa Rica, Colombia, Chile, United States, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama and Venezuela, gathered in four tables of work, they presented their recommendations, which are integrated in the following conclusions:

1. Promote the creation of a Regional Center of Prevention of Forests Fires that is mainly in charge of:
- Design and execute programmes of training on prevention and managing of forests fires.
- Support in the elaboration of national plans of medium term on managing of forests fires.
- Advise in the joint administration of institutions among and between the countries.
- Strengthen and enlarge a net of immediate detection of forests fires with the use of satellite images and maps of risk.
- Elaborate plans of protection for specific ecosystems, considering that it is impossible to eliminate the fires.

2. Create a Regional Fund destined to the operation of the Regional Center of Prevention of Forests Fires.

3. Destine financial national and international resources for reforestation with preference in compacted surfaces of the affected areas.

4. Restore the affected areas for accordingly to necessities and objectives that respond to the politics of sustainable management of the natural resources like the programmes of productive conservation of natural resources, especially lands and water.

5. Make known the conclusions of this Forum in the Meeting of the FAO on forests fires, the next month of October.

6. Promote regional Projects of Technical Cooperation (TCP/ FAO) in order to lead to the practice actions you specify that they are derived of the recommendations of each table.

General

1. Foment the environmental education and the culture toward the prevention of fires and reforestation of affected areas.

2. Recognize that the holding of land is a factor in the related problems with the forests fires.

3. Regeneration with native species, because the forest doesn't is protected with economic ends solely but also environmental, we should promote the natural restoration of the affected areas avoiding the change of use of the Land.

4. Promote the conservation of germplasm of strategic species, establishing national systems and reinforcing regions in order to safeguard the genetic resource and make it available when it is necessary.

POLICY ISSUES AFFECTING THE FOREST FIRE SITUATION IN SOUTH AFRICA

C. Kromhout[42]

A forestry policy revision commenced in South Africa in 1995. It's products were a green paper, a white paper, a National Forestry Action Programme and finally, the complete revision of forestry legislation in 1997 and 1998. The process included splitting the veld and forest fire legislation from the general forests legislation.

Veld is the word used in South Africa for grassland and other vegetation types that are suitable for stock grazing. Rangeland is probably a synonym for the word veld.

I think that because forests, and especially plantations of trees, are most vulnerable to damage and loss because of wildfires, the legislation to deal with wildfires was assigned to Government Forestry for design and administration. The legislation does not distinguish land cover types.

A great deal of thinking and consultation has gone into the compilation of the National Veld and Forest Fire Bill and it is about ready to become an act. I have brought some copies. Those policy issues that may be interesting to the participants include the following:

1. The landowner is largely held responsible for preventing a wildfire from spreading from his/her land to neighbouring land. The definition of owner is very wide.

   The landowner must contain fire on his land by preparing firebreaks on his property boundaries, by maintaining equipment reasonably required in his circumstances for putting out a fire, by training staff, by ensuring that, if he is not on his property himself, another responsible person will act for him to extinguish a fire or to contain it. He may appoint an agent to do what is required of him.

2. With the recent constitutional development in South Africa, local authorities became responsible for districts. Previously, local authorities were in general only responsible for fire services in cities, towns and villages. Clearly, local authority fire services cannot reach all parts of districts in time to put out fires, whether in buildings or in the veld or forests. The relationship between local authority fire services and the landowners and their associations must be developed. The fire services have their own Fire Brigade Service Act. Once fire services and landowners have developed a satisfactory working relationship, it may be possible and desirable to consolidate the legislation.

3. Landowners who suffer damage and loss because of fire spreading from adjoining land onto their land, can and do claim against their neighbours. The claimant has to prove that the fire spread from a neighbouring property and that the defendant wrongfully caused loss resulting from that fire. In that case the defendant is presumed to have been negligent until the contrary is proved.

4. Government encourages the formation of fire protection associations through financial assistance (still to be designed), the lifting of the presumption of negligence if the defendant is a member of a fire protection association in the area where the veldfire occurred and administrative assistance.

5. The system described makes it not necessary to provide officials to enforce the law regarding the responsibilities of landowners.

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6. The Government undertook to involve itself in determining fire danger rating and communicating such rating to the public. This is a new field that has to be developed.

7. One of the duties of fire protection associations is to provide management services, training and support for communities who occupy land as a group. This is a recurring attribute of present policy, aiming at empowering population groups that had been unfairly discriminated against in the past.

COMMUNITY-BASED MANAGEMENT OF FIRE: LESSONS FROM THE WESTERN PROVINCE IN ZAMBIA

Peter G.H. Frost[43]

INTRODUCTION

Biomass burning is common and widespread throughout the tropics. Wildfires, started either by people, for a variety of reasons, or by lightning, are frequent and extensive. Fires fuelled by wood, charcoal or agricultural residues are the main source of domestic energy for cooking and heating. Fire is also used to remove biomass from land being cleared for agriculture or, afterwards, for getting rid of unwanted agricultural residues. About 1.7 million km^2 (17 percent) of sub-equatorial Africa is estimated to be burnt annually (Scholes *et al.* 1996). Together, these fires are a significant source of trace gases and particulates to the global atmosphere. Current estimates of the amount of biomass burned each year globally amount to 6,230-8,700 Tg[44] dm yr^{-1}, about 87 percent of which is calculated to occur in the tropics. Of this, almost half (49 percent) is considered to be due to savanna burning, including both wildfires and management fires. Burning of fuelwood, agricultural residues, and slash from deforestation comprise the balance, in about equal measure. Within the tropics, 42 percent of emissions are estimated to come from Africa, 29 percent from Asia, 23 percent from South America, and 6 percent from Oceania (Andreae 1991).

Central government control of burning, regulated through laws designed to prevent uncontrolled use of fire by making it illegal to burn vegetation without authority, has conspicuously failed to achieve its aims. Perversely, it may have even increased the incidence of uncontrolled burning by discouraging people who light a fire, for whatever reason, or who might come across one burning uncontrolled, from attempting to control it, for fear of being identified as, or thought to be, the person who started the fire. Given the ease with which fire can be started, and the enormous area of fire-prone vegetation across Africa, it is patently impossible for central governments to exercise control. That control, if at all possible, can only be achieved with the consent and cooperation of those using fire on a daily basis. Over much of Africa, where communal land tenure is the tradition, this means that responsibility for controlling the use of fire has to be vested in the community at large.

This paper describes the concept and history of one such community-based fire management programme, based in the Western Province (formerly the Kingdom of Barotseland), Zambia, and the initial steps taken to implement the programme. Where possible, lessons are drawn from this experience and, more generally, from other initiatives to foster community-based management of natural resources in southern Africa.

ENVIRONMENTAL AND SOCIO-ECONOMIC BACKGROUND

The Western Province of Zambia covers over 121,000 km^2 of woodlands, groundwater forests, grasslands, plains and wetlands in the extreme west of Zambia on the border with Angola. The areas is bisected by the Zambezi River which annually floods the Bulozi Plain, an area 4,270 km^2 in extent. Much of the region is underlain by extremely nutrient-poor Kalahari Sand or, in the east, only slightly less infertile soils derived from granites of the Basement Complex. The soils are generally excessively well drained but, because of the very flat topography, much of the water draining below the rooting zone of the plants eventually drains out laterally into the Zambezi via large, oligotrophic tributaries such as the Luena, Lueti, Lui, Luanginga, and Lungwebungu. The area is dotted with numerous circular pans and dissected by broad, flat linear subsurface drainage lines (*dambos* in the vernacular)

[43] Institute of Environmental Studies, University of Zimbabwe, Zimbabwe.
[44] 1 teragram (Tg) = 10^{12}g = 10^6 t, 1 gigagram (Gg) = 10^9 g = 10^3 t.

that are either perennially or seasonally wet, due to the combination of incident rainfall and the generally high regional water table beneath the Kalahari Sands. Approximately 37 percent of the area lies in these ‘lowland’ landscapes; the rest lies in the ‘uplands’ (a relative term given the general lack of relief).

The climate is strongly seasonal with more than 93 percent of the annual rainfall occurring during the period November-March (van Gils 1988). A marked rainfall gradient occurs from south to north, ranging from 730 mm mean annual precipitation at Sesheke (coefficient of variation: 32 percent) to 1,021 mm per annum at Lukulu (CV 17 percent). Mean annual temperatures range from 20.8° (Kaoma) to 22.2° C (Mongu).

The vegetation has been described by Fanshawe (1971), van Gils (1988), and Jeanes and Baars (1991), among others. Woodlands cover about 63 percent of the area, with grasslands and bushland covering the rest. Kalahari Sand woodland is the dominant vegetation formation, covering almost 56,180 km^2 (46 percent of the province), mainly in the contact zone between Kalahari Sand and adjacent soil types. The woodland is confined to soils of intermediate depth, gradually being replaced by Zambezi teak (*Baikiaea plurijuga*) woodland as soil depth and drainage increases. The woodland is dominated by *Erythrophleum africanum*, *Burkea africana*, *Terminalia sericea*, *Guibourtia coleosperma* (mzauli) and *Pterocarpus angolensis* (mukwa). Many of these trees are valuable hardwood timber species. The region supported a large commercial timber industry in the past, based mainly on the extraction of Zambezi teak, mukwa and mzauli. Widespread and apparently unregulated extraction continues today. Other woodland types include miombo (*Brachystegia speciformis*, *Julbernardia globiflora*), mopane (*Colophospermum mopane*), munga (*Acacia* species), and dry evergreen forest dominated by *Cryptosepalum exfoliatum*.

Small-scale, largely subsistence, agriculture is the principal form of land use in the province. Cassava, sorghum, millet, maize and rice are the main crops, grown on small plots in moist soils in the lowlands (small grains, maize, and rice) or in fields cleared in woodland (cassava). Most families own some livestock, with cattle being the dominant species. The province is one of the main centres for cattle production in Zambia. About half the cattle population is transhumant, being moved seasonally from the uplands to the lowlands to make use of the better grazing in the lowlands during the dry season, then returning to the uplands when the lowlands become too wet during the rains. Many of the fires in the province are associated with burning to provide protein-rich forage for cattle when the grass regrows after fire.

Other land uses include small-scale extraction of timber (though this is becoming increasingly commercialized as timber merchants from neighbouring countries and elsewhere in Zambia move in to exploit the remaining timber resources); harvesting of a wide range of non-timber forest products (thatch grass, fuel wood, honey, wild animals, fruits, medicinal plants); and fishing. Levels of poverty and unemployment are high.

CONCERN ABOUT UNCONTROLLED BURNING

Widespread burning occurs during the dry season in the rangelands of the Western Province of Zambia (Jeanes and Baars, 1991). Most of them are uncontrolled and burn large areas of both lowland grasslands and upland woodlands. Some of these fires are started deliberately, for example by livestock owners seeking to promote a green flush for their animals; by rodent hunters clearing vegetation to make it easier to find and catch their prey; by people creating firebreaks around their homesteads or seeking to improve visibility; or even by individuals playing with fire recreationally. In other cases, the fires are ignited by people clearing land for cultivation, smoking out beehives, making charcoal, cooking, or trying to keep warm while waiting at the roadside for transport, from where the fires spread accidentally into the surrounding bush. Most fires are allowed to burn uncontrollably, with the result that they often burn themselves out some distance from the point of ignition, usually in a different vegetation type for which they were started (Frost, 1992b).

Whereas the lowlands seem to be able to sustain regular burning, many of the woodlands are beginning to show signs of damage due to too frequent and intense burning. This is exacerbated by timber extraction which is opening up the woodland canopy and allowing more light to reach the herbaceous layer, thereby promoting increased production of grass and fire-resistant shrubs that fuel the fires. These in turn kill the more fire-sensitive trees and suppress the regrowth of the more resistant species, thus preventing re-establishment of the woodland canopy, which would suppress herbaceous production, fuel loads, and fire frequency and intensity.

In addition to being technically illegal, this widespread and uncontrolled use of fire poses a number of potential problems for resource managers: shortages of fodder for livestock in the late dry season that may more than offset any benefits derived from having access to smaller amounts of higher quality forage; progressive declines in woodland cover and productivity; and the destruction of timber, fuelwood, thatching grass and other resources on which many people of the Western Province depend (Jeanes and Baars, 1991; Frost, 1992a).

While recognizing the benefits of burning to produce a green flush of grass for cattle, researchers and agricultural extension workers seeking to enhance cattle production and quality considered that too frequent and extensive burning was reducing the amount of forage for cattle in the late dry season. Consequently the Rangeland Management Team of the Livestock Development Programme, a joint Dutch-Zambia initiative, decided to commission a review of the existing information and insights on savanna burning, to provide a framework for the development and implementation of a revised policy on burning, if one was needed. The review considered the fire regimes of the Western Province; ecological aspects of fire in southern African savanna ecosystems, including beneficial and adverse effects; fire behaviour and the factors affecting this; the use of fire in rangeland and woodland management; legal provisions then in force regarding burning; and a synthesis outlining the framework for an enhanced fire policy in the Western Province (Frost 1992a). This review was then followed by a draft policy for fire management (Frost 1992b) that was subsequently adopted at provincial level and implemented.

FIRE MANAGEMENT POLICY

A policy of planned and controlled burning of selected rangelands in the Western Province was proposed (Frost, 1992b). The policy sought to trade-off the need for cattle to have an adequate supply of fodder of acceptable quality throughout the dry season, and the need to ensure that other users of the woodlands and rangelands of the province could continue to derive benefits from the natural resources therein. In short, the aim of the policy was to maximise the benefits and minimise the drawbacks associated with the use of fire.

Controlled burning in this context requires decisions on where, when and how to burn; what preparations are needed to control the fire; coordinated actions to control the spread of the fire when burning; and cooperative management of the post-fire regrowth. Burning for the production of high quality fodder should be confined to those vegetation types, mostly the lowland moist grasslands, where there is a reasonable prospect of sustained dry season regrowth of the grasses even under grazing. In contrast, the upland woodlands should be protected from destructive late dry season fires through a programme of planned early burning, where this does not conflict with the interests of other users of the woodlands (Frost, 1992b).

Three policy options were available: (1) to do nothing, on the grounds that there is no problem or that the problem of the use of fire is too complex; (2) to discourage the use of fire, on the grounds that the disadvantages far outweigh any possible benefits; or (3) to develop a programme of planned and controlled burning that is aimed at maximizing the benefits and minimizing the drawbacks. The first option was not considered useful as it failed to address the concerns identified earlier. Moreover, there is sufficient technical knowledge about fire which could be used to improve present practices. The option was rejected.

The second option was also rejected because it was impractical and because it failed to address the problem adequately. People currently use fire extensively because they perceive benefits in its use. The problem arises because of the lack of control of fires, not because they are not useful. Therefore any attempt to restrict the general use of fire will fail because people will simply use it covertly and hope they do not get caught (the chances are that they will not).

Option 3, a policy of planned and controlled burning in selected rangelands of the Western Province, was considered the only viable option. It recognized that the use of fire has both advantages and disadvantages, and it aimed to influence people to use fire in a more controlled and beneficial manner.

The principal rangelands to which controlled burning should be applied are the more moist grasslands of the lowlands. These areas have the greatest potential for sustained regrowth following fire. They are also the areas where most of the cattle are concentrated during the dry season. This policy will contribute to achieving Objective 1 above.

Burning was not recommended for all areas of the province. Frequent dry season fires are known to be detrimental to the woody component of savannas. Even though most savanna trees are adapted to some extent to repeated burning, repeated fires can alter the structure, composition, and productivity of the woodlands, particularly if these occur during the late dry season. A reduction in tree cover represents a loss of resources to a wide variety of people; the production of timber, fuelwood, charcoal, traditional medicines, fruits, honey, and caterpillars, among others, all decline. At the same time, the nutritional quality of the grass cover declines; the increased grass production that accompanies the reduction in woodland cover provides generally poor quality forage for animals for all but a limited period at the start of the rains. Regrowth after fire is insignificant because of low soil moisture levels.

A policy of protecting the woodlands from frequent burning was therefore deemed appropriate. There are practical problems, however. Complete protection of extensive tracts of woodland from fire for long enough to achieve natural fire suppression through the development of the woodland canopy and a corresponding reduction in grass growth is almost impossible under present climatic conditions. An accidental or lighting-induced fire is inevitable. Given the build-up of fuel that occurs naturally in the early years of protection, the resulting fire could have disastrous effects on the trees. This predicated a second policy prescription, one of early burning of woodlands. Early dry season fires are less destructive than late dry season fires. They also burn more unevenly, thereby creating a mosaic of burnt and unburnt patches. Early burning would therefore limit both the occurrence and spread of later fires. This policy is in line with that being adopted by the Forestry Department and should contribute to achieving Objective 2 above.

The proposed policy is somewhat pragmatic. Attempts to ban the use of fire outright will almost certainly fail because of the difficulty of enforcing such orders, particularly if a ban is imposed externally. Many of the fires appear to originate accidentally from fires put in deliberately by people to achieve particular ends (for example, the use of fire to clear vegetation in fields and to improve soil fertility). People will continue to use fire as long as they perceive that the benefits of doing so outweigh the personal costs and risks associated with its use. Accepting this reality, while at the same time recognizing the desirability for more controlled burning, predicates the need for a positive view of fire and its potential value in rangeland management.

STRATEGY FOR IMPLEMENTATION

A strategy for implementation was proposed, based on a number of guiding principles. The main one is that any programme of controlled burning has to be planned with, and supported by, the community concerned. Secondly, because different people burn vegetation for different reasons, the issue of burning cannot be isolated from the circumstances surrounding its use. As such, controlled burning must be integrated into an overall land-use and resource management programme.

A strategy for implementing the above policy therefore needed to address the following questions.

a) What level of control is required to achieve the anticipated benefits and to restrict potential detrimental effects of burning?
b) Who should be responsible for exercising this control?
c) How can this responsibility be instituted?
d) How much and what kinds of technical advice are required to support the practice of controlled burning?
e) What is the most appropriate framework for promoting this strategy of controlled burning?

There are three elements to controlled burning: **preparations prior to burning**, to decide upon and demarcate the areas to be burnt, and to take actions (e.g. building fire-breaks) to limit the fire to the area concerned; **control of the fire during burning**, to ensure that the fire burns the area required but does not escape into surrounding areas; and **post-fire management of the regrowth** in relation to grazing and other forms of land use, to prevent overgrazing. All three require coordinated action by individuals for greatest effect. The members of a community must be party to decisions on the need for burning and its control. They must be responsible for determining which areas can be burnt, when, how, and by whom., and they must also be able to delegate these responsibilities. This emphasises the need for an integrated approach to the problem of burning among land users and cooperation at all stages. The role of technical assistance in this regard is to facilitate decision-making by the community, not to dictate the decisions.

People generally use fire as a tool in the management of natural resources, not as an end in itself. The use of fire is also not confined to any one group within a community; different people light fires for different reasons. Moreover, not everybody benefits from the occurrence of a fire (e.g. burning is likely to diminish the availability of thatch grass and timber). Any attempt to institute a programme of controlled burning within a community will therefore need to be broad-based and will have to address the reasons why people use fire; what they seek to gain through its use; and what the consequences might be of changing the pattern of use. In short, a strategy for controlled burning will have to be developed within a broader land use and resource management programme.

Community-based natural resource management programmes require the devolution of responsibility from government to local organizations. In the case of fire management a mechanism for this already existed. The Natural Resource Conservation Act (Cap 315, No. 53 of 1970) provides for the appointment of a Fire Authority for an area. One of the functions of the Fire Authority is to prepare and adopt a fire control plan for an area, provided that this is approved by the Minister and has the support of the occupiers of more than half the land concerned. The plan must include details of the construction and maintenance of firebreaks, and where and when controlled burning will be carried out. The District Natural Resources Conservation Committee usually serves as the Fire Authority but the Act provides for the Minister to appoint other bodies instead.

Communities need to be encouraged to formulate fire management plans for their areas and seek the necessary authority to implement them. The local institutions capable of undertaking this task first had to be identified and strengthened, or developed. External assistance was considered be crucial in facilitating this process, both in helping develop the required managerial capacity and in providing the necessary technical information underpinning the decisions to be taken.

The strategy for implementing the proposed policy can therefore be summarized in the following principles:

1. Externally imposed controls on the use of fire will fail; a programme of controlled burning must be planned with, and supported by, the community concerned.
2. For best results, controlled burning requires decisions on where, when and how to burn; what preparations are needed to control the fire; coordinated actions to control the spread of the fire when burning; and cooperative management of the post-fire regrowth.
3. Different people burn vegetation for dfferent reasons; the issue of burning therefore cannot be isolated from the circumstances surrounding its use.
4. Controlled burning must be integrated into an overall land-use plan and resource management programme.
5. To be effective, authority for control has to be vested in the community.
6. Government will need to devolve the appropriate authority for control to local institutions.
7. Where functioning local institutions do not exist, they will have to be revitalized or set up; this will require developing local managerial capacity.
8. The role of technical extension is primarily to support decision making by the community.
9. The pace of development will large be set by the community; implementing the strategy is likely to take time.
10. Implementation is likely to work best with community groups that are small, cohesive, relatively homogeneous, and have a strong popular leadership.

Such a programme will not done overnight; it will be a slow and uncertain process.

To give effect to the policy, the Range Management Team of the Livestock Development Project initiated a series of District-level workshops between December 1993 and June 1994 to develop appropriate action plans. The objectives of the workshops were to formulate a policy (guidelines) for controlled burning in the district; and to work out recommendations for an action plan to implement this policy. Workshops were held in five of the six districts of the province (Sesheke, Senanga, Kaoma, Lukulu and Kalabo) but there was apparently little interest on the part of the Mongu District Council to host a workshop in their district. Although the workshops were initiated by the Rangeland Management Team (RMT) of the Livestock Development Project, the meetings were held under the auspices of the local District Council and chaired by the Council Chairman, thus making them official activities of the District Councils. Participants in the workshops included district councillors, members and representatives of the Barotse Royal Establishment, farmers, local officials of government departments, and other interested parties. These workshops served to introduce the issues to these stakeholders. During the workshops their responses and ideas were solicited, to form a basis for further action.

Each workshop lasted two days. Proceedings started with a series of presentations to provide a basis for subsequent discussions in the workshop. These included an introduction covering the background and objectives of the workshop (District Planner or RMT representative); regulations and by-laws currently regulating the use of fire on rangelands (District Natural Resources Officer or District Secretary); an historical background about traditional burning practices and controls (Royal Establishment); the Forestry Department's policy and strategy (District Forestry Officer); and technical recommendation for cattle keepers on the burning of rangelands in the district concerned (RMT representative). Other presentations, given at specific workshops, included explanations of local fire management activities (Masese Agricultural Project, Sesheke District) and district natural resource policies and strategies (District Planner, Senanga District).

Following the presentations, participants were organized into working groups to discuss two sets of questions arranged within two themes: local burning practices and how they can be improved; and, what are roles of specific authorities. Participants were also asked to map one of their areas, showing the plains, uplands, villages and any other important features. The specific questions that the groups were asked to address were:

Local burning practices

1. Are the current burning practices beneficial?
2. If not, how can they be improved?
3. Where, when, how, and by whom should burning be controlled?
4. Who should supervise and deal with culprits?

Roles of specific authorities

1. Who at District level should be responsible for overall implementation of the policy?
2. How can those given the authority to carry out controlled burning be supported legally and technically at local and District levels?
3. What measures need to be put in place to ensure effective implementation?

Summary of working group deliberations

There was general agreement at the workshops that current burning practices are not beneficial because vegetation is destroyed, resulting in the loss of natural resources such as timber and building materials; the amount of fodder for livestock is reduced; and the soil becomes denuded and prone to erosion. The uncontrolled and uncoordinated nature of burning, and the lack of technical know-how on the part of people setting fire to the vegetation, were cited as reasons for these negative effects.

Suggestions on how current burning practices could best be improved included involving traditional leaders in decision-making; education on the responsible use of fire; the introduction of financial incentives; and improved management of fire. Responsibility for controlling burning used to be vested in traditional leaders - chiefs, *indunas*, and headmen - who derived their authority from the Royal Establishment. Persons who violated local laws were prosecuted in traditional courts. Current legislation makes no direct provision for this community control. All the workshops strongly recommended greater involvement by communities, through their traditional leaders, together with government officials such as Natural Resources and Forestry Officers, in decisions on the use and control of fire.

The need for an educational campaign to be carried out in rural areas was emphasized. Again, the involvement of local authorities - councillors, chiefs, *indunas*, and village headmen - was specified. This willingness to become involved may in part be motivated by an expectation of payment for such services. The issue of payment was frequently raised at the workshops. Although the desire to earn money through involvement in fire management is understandable, the reality of this happening in the current economic climate is limited. It was suggested that finance generated from penalties imposed on people found breaking the law should be shared between the government and traditional leaders. It is doubtful whether this would amount to much, if anything at all. Moreover, if local control of burning was effective, the number of fines issued would be minimal. There was also the question of whether fining offenders is the best way to encourage compliance, though it was the done traditionally in the past.

Suggestions for improved burning practices were largely limited to emphasizing the use of early burning of woodlands to prevent their gradual destruction by late-dry season fires. Some working groups mentioned the use of mid- to late dry-season fires in the lowlands, to enhance the quality of grazing, but it is unclear whether this reflects local knowledge of the effects of differences in the time of burning in different vegetation types and landscape units, or whether it originated in the earlier presentations.

Where, when, how and by whom should burning be controlled? Again, the overwhelming response was that local communities, in conjunction with government officials and other with technical knowledge and experience, should be responsible. More specifically, it was suggested that Ward Natural Resource Committees should be formed or revived to draw up fire management plans for their areas, including decisions on the optimum time for burning particular vegetation types or areas. Although individuals clearly have the right to determine when they can burn their fields, the need for coordination within a village or other community unit in regard to burning of firebreaks and preventing fires getting out of control was recognized. Responsibility for this coordination should be vested in the village headman assisted by a village management committee.

All workshops took a hard line on the question of how to deal with people who started fires without permission. Most suggested either harsh fines (unspecified) or terms of imprisonment (up to three years was recommended by one working group!). Offenders would be dealt with either by village courts, local courts manned by *silalo indunas* (ward heads), or even by the Royal Establishment, depending on the severity of the case. Concern was also expressed about where the fines should go; retention by the local authorities was widely favoured. Cases would need to be dealt with quickly.

The question of how compliance with the law can best be enforced is perhaps more difficult than reflected in the discussions held at the workshops. Existing legislation already makes provision for stiff penalties, albeit administered by Central Government, yet by all accounts the legislation is not enforced. In part, this reflects the difficulties of apprehending and prosecuting lawbreakers; in part, it reflects a concern that heavy punishment could be counter-productive, for example, through revenge arson attempts. Perhaps a more useful approach is one that emphasises education and responsibility, including community service, with fines and imprisonment being reserved for persistent offenders.

Legal and technical support will be needed by whichever individual or institution is granted appropriate authority for controlling burning. The District Council is obviously important as the institution able to formulate the necessary by-laws but these are merely an instrument to give effect to overall policy; they are part of the strategy of implementation. It is important that a District Council is clear in the fire policy that it wishes to adopt, and the overall strategy that it intends pursuing, **before** by-laws are drawn up.

Given the wide range of issues that the District Council has to deal with at any one time, it is perhaps unrealistic to expect the councillors alone to formulate a policy, strategy, and action plan. The districts have District Natural Resources Committees, at least on paper, although most of these are currently non-functional and would need to revitalized. The constraints, such as the non-availability of funds to cover sitting and transport allowances for members, that have caused them to cease working, need to be overcome. Technical support for these committees would need to be provided by the departments of Forestry, Natural Resources and Agriculture.

The membership of the District Natural Resources Committees is broadly representative including local farmers, the District Council (usually the Chairman and Secretary), traditional leaders, government departments such as Natural Resources, Veterinary and Tsetse Control Services, Forestry, and Agriculture, and NGOs concerned with the management of natural resources. In addition to their statutory responsibility to make recommendations to the Provincial Natural Resources Committee, the district committees should advise the District Councils and assist ward-level committees on issues relating to the management of natural resources, including the use of fire.

The working groups agreed that for effective implementation of the policy, action was needed at three levels. The District Councils have the responsibility for drawing up an overall policy and strategy of implementation in their districts, and for drafting the necessary by-laws to effect the policy. Organization is also needed at sub-district level (ward or *silalo*) to provide local coordination among the communities involved. A committee comprising the local ward Councillor, the *silalo induna*, government field officers and others could be responsible for identifying the various vegetation types or management units in their area; establishing what natural resources are present in these management units and who uses them; and deciding on the appropriate objectives of fire management in each unit and how best these can be achieved. The responsibility for actually carrying out burning in an area should rest with the village headman assisted by a village committee comprising those who regularly use fire.

Workshop recommendations

Six key recommendations arose from the workshops.

1. Responsibilities for the management of natural resources should be decentralized. At present, local communities do not participate actively in the management of these resources because this responsibility was taken over by government after Independence. In some cases this has negatively affected the status of the resources. People do not believe that they derive any benefit from revenues generated from the National and Local Forests (even though they may obtain resources from them in ways that are technically illegal). They thus lack the incentive to conserve these resources.

2. Wherever possible, government officials should involve local leaders when addressing natural resource management issues. In particular, officials should work closely with the Royal Establishment to ensure fuller understanding of the issues.

3. Community involvement is essential to achieve a better and more organized use of fire. District Councillors, the Royal Establishment, and indunas should all be actively involved in planning the use of fire at district and ward/silalo level with the technical assistance of government officers. The responsibility for organizing specific burning should be devolved to the village headmen.

4. The regulations and by-laws governing the use of fire generally already exist, although not always in a form that is readily accessible or comprehensible to local people. Wherever possible, therefore, the use of fire should be in accordance with the existing regulations. In some cases, the regulations are not effective and need to be revised (no specific examples were given).

5. The district natural resource committees need to be revitalized. In terms of the Natural Resources Conservation Act (Cap 315, No. 53 of 1970) these committees are normally the designated Fire Authorities for a district and, as such, already have a number of statutory powers under the Act. These committees should be encouraged to come up with a fire control plan (or plans) for their areas.

6. Community awareness needs to be enhanced. Education and extension programmes should be developed for the different levels within a district. In this regard, traditional leaders can assist in getting information to the people. Consideration should be given to the development of training programmes for committee members and villagers.

The need to involve local leadership at all levels of decision-making was a pervading issue at all of the workshops. In particular, the role of the Barotse Royal Establishment in determining many aspects of peoples' lives is central to understanding traditional burning practices in the Western Province. The sentiment was widely expressed that people understand and respect local leaders more than government officials from outside the province. Although the Royal Establishment at present has no statutory powers, there was the sense that it ought to be consulted at all levels, at least in matters relating to the management of natural resources.

CONCLUSION

Effective control of burning requires that authority be vested in the community; externally imposed controls on the use of fire have failed and will do so again. By seeking to institutionalise the responsibility for burning within a community, it was anticipated that a more restrained and accountable pattern of use would emerge. The weakness of local institutions, however, generally makes it difficult for communities to implement and maintain appropriate policies and practices in relation to sustainable management and use of natural resources, particularly the integrated approaches needed for effective management of common-property resources. In part this is because governments have over the years appropriated responsibility for these resources without really having the capacity to manage them (Murphree 1991). The provisions made for such management have tended to rely more on restrictions and coercion than on incentives and encouragement.

Governments therefore should devolve appropriate authority for fire control to local institutions, where these exist. Where they do not, or are non-functional, they will need to be established or revitalized and the capacity of communities to make their own decisions strengthened. In this regard, extension should be aimed at supporting decision-making within a community rather than trying to dictate it. Because the pace will be set largely by the communities themselves, implementation will take time, although progress is likely to be faster with small, cohesive groups with a strong popular leadership.

Resource management entails considerable costs in terms of time, energy, money and materials, costs that may become onerous for impoverished rural people. In general, they will only invest in natural resource management if they expect a clear improvement in their livelihoods or if it will reverse a situation that threatens their livelihoods. Experience elsewhere in southern Africa suggest that for community-based natural resource management institutions to be both functional and robust they need to fulfil most of the following criteria (Murphree, 1991):

- Those who manage the resources must have a vested interest in the outcome. This means that the resource managers must be the landholders and primary beneficiaries.
- There must be a close and proportional link between management inputs and benefits.
- The benefits must be tangible and immediate.
- There should be local autonomy in decisions making, both in regard to management and the distribution of benefits.
- The resource user group should be small enough to be cohesive and to lower transaction costs, but not so small that it becomes exclusive and wholly self-serving.
- The leadership must be accountable, transparent, and broadly representative of the community it serves.
- Responsibility at different scales should be nested to give effect to the principle of subsidiarity.
- The boundaries of the management units should be distinct and exclusive.
- Political and administrative boundaries of these management units should coincide broadly with the biophysical ones.

The last of these is often problematic because the political-administrative and biophysical boundaries seldom coincide. Given that it is impractical to re-orient the biophysical boundaries, this implies that in some case the administrative and institutional landscape will need to be re-negotiation and re-structuring. The difficulties of doing this democratically and fairly should not be underestimated.

Identifying discrete units of social organization that can exercise these rights and responsibilities is a particular challenge. Whereas local communities might be considered to be the obvious appropriate institutions for natural resource management (Murphree 1991), it is often not clear just what constitute a 'community'. Theories of collective resource use, such as common-property theory, are often based on the assumption that communities are bounded and homogenous entities. In reality a 'community' is made up of diverse groups with different interests and concerns, overlapping but not wholly concordant memberships and jurisdictions, and varying degrees of association within and among them. Their constituents are also heterogeneous, in terms of ethnic composition, socio-economic standing, livelihood strategies, power relationships, preferences, interests, and the politics of affection. Moreover, this diversity occurs at a range of scales, and the groups can act both independently and interactively within the broader social and political units in which they are nested (Frost and Mandondo in prep.).

It is also commonly but wrongly assumed that groups of people with the potential to manage natural resources collectively are congruous with sub-district administrative institutions. The reality is different. Within a ‘community’ there are many institutions exercising various kinds and degrees of control - political, social, spiritual, developmental, and others. Moreover, these institutions are not static but are constantly shifting to accommodate opportunities and constraints as these arise. Overall, this diversity and associated dynamics poses a significant and ongoing challenge to those trying to facilitate the establishment of robust institutions for community-based natural resource management.

The shortage of accurate information on the state and dynamics of the natural resource base or, when available, the inadequate use of such information when making decisions, adds to the problem. In this regard, the development of a data base of the seasonal occurrence, locations, causes, size, and observed effects of fire in the various vegetation types of the Western Province was considered a necessity, but one that has still not materialized.

It is perhaps too early to tell if the present initiative will be sustained. The Livestock Development Programme under which the initiative was launch has largely ended, so the external technical support and commitment is no longer there. Of course, to be sustainable in the long term, such initiatives have to become independent of external support, or at least not dependent on it. In other words, the initiative has to become internalized and institutionalized within the community. What it takes to achieve this remains to be discovered.

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THE FIGHT AGAINST FOREST FIRES IN ITALY

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There are approximately 8,675,100 hectares of forests in Italy, covering 29 percent of national territory. The conservation of these forests is threatened by many adversities, from those of a physical nature, such as irregular precipitation, snow, ice and wind, to those of a biological nature, but above all by those damages caused by human activity and fire.

The problem of fires has been increasingly worsened by the economic and social transformations faced by our country in the last decades.

In the absence of silvicultural practices, terrain has become increasingly dense and full of combustible material, mainly vegetation killed through natural selection which is of small dimension and highly flammable.

With the abandonment of forests and many marginal agricultural lands which have subsequently been invaded by shrubs and bushes, the spread of fire has become increasingly easy.

It has become increasingly difficult to defend forests due to access difficulties and to the limited local manpower available to intervene in a timely manner.

Industrialization, increases in tourism and in the mobility of citizens have excessively increased the risk of fires.

The evolution over the last decade of the forest fire phenomenon gives an indication of how the phenomenon is worsening. In fact there are on average 11,800 forest fires per year affecting an area of approximately 54,800 ha per year.

During 1998 and up to September 30, 1998, the National Forestry Corps has registered 10,314 forest fires, that have affected a total area of 140,843 ha, of which 63,145 ha wooded, with an average range of 13.7 ha/fire, considerably higher than the average of the previous 10 years (10.5 ha/fire).

Such negative value is to be attributed primarily to the unfavourable weather conditions that prevailed at the end of June and the beginning of July. In fact, the prolonged absence of rain, the high temperatures, and the strong winds manifested the problem in all its seriousness, especially in the south of the country.

The regions most struck were, in order and by areas affected by fire, Calabria (14,699 ha), Sicily (13,330 ha), Sardinia (11,870 ha) and Liguria (3,444 ha).

The greatest number of fires was registered in Sardinia (2,328), Campania (1,644), Calabria (1,198), Tuscany (644), and Latium (628).

Individual fires had an average total range (of woodland and otherwise) of 48.5 ha in Sicily, 31.3 ha in Calabria and 27.4 ha in Abruzzo.

It is a matter of very high values, clearly higher than the national average of 13.7 ha and the values registered in past years. Equally high is the average range of forest areas struck by fire which is 20.1 for Sicily, 15.4 for Abruzzo and 12.3 for Calabria.

In the remaining regions, the average total area (wooded or otherwise) per fire is equal or inferior to the national average (Liguria 13.4 ha, Sardinia 12.6 ha, Lombardia 11.6 ha, Puglia 10.5 ha, Basilicata 10.4 ha).

In the same period, January 1 to September 30, 1997, the regions most struck were, in decreasing order, Calabria (10,247 ha), Sicily (8,742 ha), Lombardia (5,351 ha), Liguria (5,042 ha), Sardinia (5,041 ha), Latium (4,689 ha), ampania (4,616 ha), Piedmont (4,016).

In southern Europe, the phenomenon of forest fires occurs with similar effects in terms of decay and destruction of natural environment and each country is touched by the problem in similar ways.

The data available for 1998 up to September 30 shows that in terms of area struck by fire, whether wooded or total, Italy is the country most hit.

As for specifically preventative activity, it is necessary to stress the importance of initiating correct forest management, through well-known measures. An effective information and awareness programme aimed at the general public, and in particular at youth, by means of specific information campaigns through the media is equally indispensable.

With the aim of seeking to break the vicious circle of more-fires-more-investment-in-fighting-fires, a system could be experimented that would call for economic ways and incentives in favour of stand-by personnel that could be based on the lack of fire outbreaks.

Tax incentives could also be foreseen for owners who undertake the maintenance of their forests and who show that in the preceding year there were no fires.

Another serious problem is the fragmentation of responsibility for the fight against fires.

At the moment various entities are charged with responding to forest fires: the State Forestry Corps, Firemen, the Region; and thus the Ministry for Agricultural Policy, the Interior Ministry, civil protection agencies and, as required, even the Environment Ministry.

The need to address the issue of intervention coordination has been stressed with insistence for some time and by various sources.

It would be desirable to establish by law, in a clear and definitive manner, the roles and responsibilities of each entity, i.e. who is to coordinate operations, who is to make decisions, to which administrations are financial resources to be allocated.

Therefore, it can only be hoped that legislators provide quickly for a relevant simplification of the sector's norms to allow easier and more productive operative contributions to be made by all concerned.

Table 1- Forest fires in ITALY in the 1988 - 1997 decade

Year	Fires n°	Area hit by fires			
		Wooded (ha)	Not wooded (ha)	Total (ha)	Average (ha/fire)
1988	13,558	60,109	126,296	186,405	13.7
1989	9,669	45,933	49,228	95,161	9.8
1990	14,477	98,410	96,909	195,319	13.5
1991	11,965	30,172	69,688	99,860	8.3
1992	14,641	44,522	61,170	105,692	7.2
1993	14,412	116,378	87,371	203,749	14.1
1994	11,588	47,099	89,235	136,334	11.8
1995	7,378	20,995	27,889	48,884	6.6
1996	9,093	20,329	37,659	57,988	6.4
1997	11,612	62,774	48,456	111,230	9.6
Average	11,839	54,672	69,390	124,062	10.5

Table 2 - Number of fires and area hit by fires in the period 1.1.1998 - 30.09.1998

NUMERO INCENDI E SUPERFICIE PERCORSA DAL FUOCO NEL PERIODO:

1 GENNAIO - 30 SETTEMBRE 1998

REGIONE	Numero incendi	Superficie boscata (ha)	Superficie non boscata (ha)	Superficie totale (ha)	Superficie media (ha/inc.)
1 VALLE D'AOSTA	120	59	20	79	0,66
2 PIEMONTE	393	1.616	1.451	3.067	7,80
3 LOMBARDIA	285	2.624	676	3.300	11,58
4 TRENTINO A. A.	84	123	28	151	1,80
5 VENETO	109	325	168	493	4,52
6 FRIULI-V. GIULIA	84	368	257	625	7,44
7 LIGURIA	411	3.444	2.052	5.496	13,37
8 EMILIA-ROMAGNA	190	420	336	756	3,98
9 TOSCANA	644	2.879	994	3.873	6,01
10 UMBRIA	356	648	456	1.104	3,10
11 MARCHE	77	578	81	659	8,56
12 LAZIO	628	2.287	2.379	4.666	7,43
13 ABRUZZO	79	1.220	947	2.167	27,43
14 MOLISE	237	157	853	1.010	4,26
15 CAMPANIA	1.644	2.776	3.445	6.221	3,78
16 PUGLIA	422	2.454	1.959	4.413	10,46
17 BASILICATA	363	1.268	2.506	3.774	10,40
18 CALABRIA	1.198	14.699	22.770	37.469	31,28
19 SICILIA	662	13.330	18.764	32.094	48,48
20 SARDEGNA	2.328	11.870	17.556	29.426	12,64
Totali	**10.314**	**63.145**	**77.698**	**140.843**	**13,66**

DATI PROVVISORI SUSCETTIBILI DI VARIAZIONE A SEGUITO DI VERIFICHE
(Provisional data subject to possible modifications)

Table 3 - Forest fires in the Southern European Countries - 1.1.1998 - 30.09.1998

Country	Fires n°	Area hit by forest fires			
		Wooded (ha)	Not wooded (ha)	Total (ha)	Average (ha/fire)
Grecia	190	1,098	306	1,404	7.4
Italia	10,314	63,145	77,698	140,843	13.7
Francia	8,370	-	-	16,538	2.0
Spagna	11,828	24,780	36,302	61,082	5.2
Portogallo	20,283	16,570	18,492	35,062	1.7
Total	50,985	105,593	132,798	254,929	5.0

FOREST FIRES AND FIRE MANAGEMENT POLICIES IN TURKEY

Dr. Ertugrul Bilgili[45]

ABSTRACT

Forest fires are a recurring phenomenon in, and has always had a pervasive influence on Turkish forests. With its complex social, economical and environmental aspects, Turkish forestry presents great challenges to the society in general and the forest service and fire researchers in particular. This report presents and discusses the current status of the forest fires and associated fire management policies in Turkey.

INTRODUCTION

Turkey is a country with a land mass of 77,079 million hectares, of which 20,749 million hectares is forested, representing about 26 percent of country's total land area. About 12 million ha of forested lands is subjected to and under the threat of forest fires. Most fires occur where Mediterranean climate with high temperatures and low to non-existent precipitation during fire season is predominant in the southern and western Anatolia. In the period 1937-1998, a total of 63,804 fires burned a total of 1,477,186 hectares of forest land. This represents 1,046 fires on 24,210 hectares annually with an average area burned per fire of 21 hectares. Although there has been a gradual increase in the number of fires in recent years, due to the increased and effective use of technology in transportation, communication and fire suppression, area burned has been cut by half and kept at 12,000-14,000 range (Mol and Kucukosmanoglu 1997) on average. This is especially apparent in the last four year's figures (Table) with an exception of the 1996 fire season in which a single fire consumed over 7,000 ha.

Table. Number of fires and area burned in Turkey between 1987 and 1998

Years	*Number of fires*	*Area burned (ha)*
1987	1.310	10.746
1988	1.372	18.210
1989	1.633	12.610
1990	1.725	13.000
1991	1.453	7.590
1992	2.110	12.312
1993	2.547	13.734
1994	3.221	20.982
1995	1.768	4.790
1996	1.645	14.922
1997	1.339	6.316
1998[1]	1.761	5.938
Total	21.884	141.150

[1] 1998 figures are as of October 10, 1998.

[45] Karadeniz Technical University, Faculty of Forestry, 61080-Trabzon, Turkey. This report is a condensed and revised version of another report published in International Forest Fire News (IFFN), July 1997 issue.

FIRE CAUSE

Majority of forest fires in Turkey are caused by people. People-caused fires account for 97 percent of all fires, while lightning is responsible for the rest 3 percent. Of the people-caused fires 23 percent was classified as arson, 27 percent as negligence and carelessness, and 50 percent as unknown (Mol and Kuçukosmanoglu 1997). "Unknown" fires are the fires for which no known cause could be determined. However, it is very likely that the shares of the first two categories of fire causes (i.e., arson, negligence and carelessness) in unknown causes are similar to that of the known causes. In this case, arson accounts for about 35 percent of all fires, which is a little over the average value (32 percent) found in temperate forests of the northern hemisphere (Mol *et. al*., 1997). This is for sure a very large proportion and is seriously taken into account in the process of fire prevention, presuppression and suppression planning.

Arson fires are set for several reasons. About 8.8 million people live in 17,445 thousand villages in or near forests (Anon. 1991). Socio-economic life standards of most of these people are well below the national average. People with low income and low life standards see the forests as an earning ground for their sustenance. So, people set fire in the forest to create jobs that will earn them some provision or manipulate vegetation to improve and produce useful plants for their animals to graze. Personal conflicts between people and forestry officials or between shepherds or different villagers have also been reported to have been a cause for fires.

Borders separating public and private lands are not completely drown in Turkey. Only in the 30 percent of the country's total area are the ownership boundaries delineated. So, there is always ownership disputes and conflicts in and around forests and protected areas.

Majority of fires, however, are often caused by people through sheer inadvertence or accident. These types of fires usually occur in and around recreation areas and camp sites, at urban/forest interface or along major highways. In 1996, for example, the greater Marmaris forest fire which burned over 7,000 hectares had its origin at a camp site near Marmaris. Fires of this kind are usually caused by people who are unaware of the dangers of forest fires or with low conscience of the value of forests.

FIRE MANAGEMENT

Fire management in Turkey is a federal responsibility. Duties are carried out by the state forest enterprises functioning under regional directorates. Fire control policies have been developed around a strong emphasis on total fire control as a response to destructive fires. Regardless of the high costs involved, it is the forest service department’s responsibility and policy that all the required activities are planned and implemented immediately. In no time, however, have the beneficial use and ecological role of fire been incorporated in fire management planning process. So, fire management deals mainly with fire prevention and control activities.

Fire prevention programmes deal with all activities concerned with minimizing the incidence of forest fires. In this regard, determining and analyzing the cause of fires (i.e., who is starting the fires, where and when they are starting and, to the extent possible, why they are starting) are considered to be the first step to justify and allocate budged for prevention and presuppression. For this reason, the Fire Fighting and Forest Protection Branch of General Directorate of Forestry has put more emphasis on the determination of fire causes and the inclusion of the findings in fire report files. A national database on forest fires is being created containing information on all aspects of forest fires. Information gathered on the location and cause of fires are used to develop fire prevention techniques and prevention planning. In this regard, many techniques are being used to reduce people-caused fires which fall under two general categories, risk abatement and hazard reduction.

Risk is associated with ignition, and risk abatement involves raising the level of awareness of general public and various responsibility groups to the dangers of ignition and subsequent forest fires through education and enforcement. It is of the opinion of the forestry service that a strongly favourable public opinion is a vital necessity in any effort to reduce the number of people-caused fires. All the available communication avenues have increasingly been utilized for this purpose. These involve the utilization of the mass media and local media outlets of radio, television, newspaper and magazines, education programmes in the schools, military bases, service clubs, signs, and personal contacts. Also, fire law enforcement has been a potentially valuable technique for forest fire prevention since the laws have a potential to educate the public as well as deter the negligent or malicious from destructive behaviour.

Given that majority of fires are caused by sheer inadvertence and accident, no matter how good the education and enforcement activities may be, some fires will always be unpreventable. These causes can be reduced only through modifications of the ignition sources or the fuels that act as ignition receptors. Many forms of fuel modifications have been practised in all fire prone areas.

Despite the high cost of construction and maintenance, fire breaks (fire safety roads) and fuel brakes have been widely used to brake the continuity of forest fuels. It is mostly practised along and around the high risk areas such as camp grounds, disposal sites, settlements, major highways and railroads. Although it is very labour intensive, the practice of clearing and burning surface fuels within 15-20 m on each side of forest stands along major highways is a usual one.

As a general rule, fire breaks are constructed in plantation and naturally regenerated areas, and are supported by some fire resistant species (especially *Cupressus sempervirens* var. *pyramidalis*). These species are planted along the fire breaks with upto five rows. In areas close to settlements or critical areas, such species as stone pine (*Pinus pinea*) have been heavily utilized (planted) in place of other species. The local people look after these areas by pruning the trees and cleaning underneath and harvest their cones. Not only this practice help maintain an important fire resistant zone but also provide for the local people an opportunity to make a living. One other activity worth mentioning concerning fuel modifications is the charcoal production using some bush species that would not normally be harvested or utilized (Serez *et. al*., 1997). Those who produce charcoal purchase the wood they cut for a very low price (about 1/10 of what they sell charcoal for). Again, this benefits both forests and people.

FIRE PRE/SUPPRESSION

Fire management relies on early detection, fast initial attack and powerful suppression. Each region has been provided with sufficient resources and man-power to combat forest fires. Available resources include 208 fire trucks, 12 helicopters, 11 aeroplane, 882 fire look-out towers, 8,472 radio, 650 initial attack crews (of 12-15 men), and 120 standby forces (of 40-50 men). As needed new resources are being added and new technologies adopted. These forces are allocated to each district based on fire danger levels and area in question. One example of this is the mobile motorbike teams that regularly check the areas of high fire danger during the fire season.

Overall, 71 percent of fires are controlled at less then 5 hectares and account for only 8 percent of the area burned. In contrast, only 1 percent of fires exceed 200 hectares in size, but these fires account for 37 percent of the total area burned (Kucukosmanoglu 1986).

FIRE RESEARCH

Fire is one of the areas that received the least attention in Turkey. There has been no major studies concerning fire behaviour, fire ecology or the role of fire in Turkish forest ecosystems. Recently, however, attempts have been made to establish a national fire danger rating system. Initial work has been completed and weather measurements started. Based on the litter moisture and weather measurements in a standard fuel type (red pine, *Pinus brutia*), Turkish Fire Weather Index System will be developed. Fire behaviour experiments are being planned. Results of the experiments will constitute the first steps towards achieving the goal of the development of fire behaviour prediction system. Also, the use of Geographical Information Systems in fire management is being increasingly utilized.

CONCLUSIONS

Forest fires are a recurring phenomenon in and have a major impact on the sustainability of Turkish forests with complex social, economical, ecological and environmental aspects. Yet, fire policies were formulated in such a way as to exclude fire on the assumption that it is always bad. Currently practised total fire control policy has been followed by some successes with prospects. But it may not be as proper and appealing as it is thought, considering the large fires of recent history have been a result of the policy of total fire exclusion in those areas. In addition, pressures brought about by certain realities of ecology and economics, and our increased demands for multiple resources require the development of new policies and attitudes toward fire. At the same time, increasing complexity and sustainable forestry will require a deeper understanding of fire and development of more effective management systems. Effective management systems will not prove successful in any place unless they include the demands and acknowledge the role of the fire and society on forests, and Turkey is not an exception.

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FOREST FIRE PROTECTION IN POLAND

Tomasz Zawila-Niedzwiecki[46]

Poland's geographical location in a zone influenced by both maritime (mild-humid) and continental (severe-dry) climates result in completely different weather elements. The country is situated at the edge of the range of several tree species: fir, beech, yew, spruce, sessile oak and lime. Soils in most areas are poor: mostly podsolic, pseudopodsolic, turf-podsolic and turf-brown. All these factors combine to make poor natural conditions for forestry especially when we add to this accumulated air pollution originated in neighbour countries and in Poland as well.

Given the situation, the introduction of monoculture in large areas has facilitated the occurrence of insect pests, sometimes spread over thousands hectares. Secondary invaders as well as parasitic fungi have often attacked impaired forest stands. Moreover, additional deterioration of natural conditions resulting from economic activity can be an essential factor in reducing further the condition of stands and in increasing fire risk.

Poland's total forest area is about 8,780,000 ha (only 17 percent is private), what means that 28.1 percent of the territory is covered by forests. This is less then the mean coverage for Europe, and it is less then optimal for our type of geographic zone. In optimal conditions one third of the country should be forested. Coniferous forests occupy about 6,788,000 ha or 78 percent of forested area, resulting from the fact that conifers thrive on the poor soils found in Poland.

The age of tree stands is not optimal. The second and third age classes (that of 21-40 and 41-60 years) prevails (accordingly 25 percent and 22 percent of forested area), while there is a deficit of the first, fourth and fifth age classes. This is the result of both post-war afforestation of poor soils that were inadequate for agriculture and afforestation of wasteland.

The assessed timber value is some 1,572 million cubic meters, meaning 183 cubic meters per hectare on average. The rate by means of which one can estimate the productivity of forests is a mean annual increment estimated at 5.22 cubic meters/ha/year.

In Polish conditions forests are characterized by quite high rate of fire risk. Annual average number of forest fires is about 3,500 and they affect more than 5,000 hectares. Especially dramatic was 1992 when 11,858 fires and 43,755 burnt hectares were recorded in Poland. The most sensitive to fire are the young, pine stands growing on poor sites. In Poland poor stands cover 55 percent and young stands - 45 percent of forested areas.

It has been suggested that in some regions of Poland forest fires are a result of the simultaneous existence of at least three unfavourable phenomena: drought, high tourist traffic in forests and effect of air pollution. Air pollution cause decline and decay of trees, formation of loose canopy, lush growth of grasses; all resulting in large amount of flammable material in the forests.

Almost 20 percent of total number of fires noted in Poland happen in forests. Our forestry distinguish four types of forest fires, according to forest storey affected with fire: (I) underground fire (peat-boggy), (II) surface fire, (III) crown fire and (IV) fire of individual tree. About 75 percent of forest fires noted in Poland are surface fire. Average area of single surface fire is about 1 hectare, but at the same time distinct increase of large (in Polish scale) forest fires can be observed.

As far as forest fire protection is concerned, Forest Service activity is concentrated on:

- Categorization of forest areas according to fire risk,
- Daily fire risk forecast during flammability period (which lasts 200-240 days a year),
- Organizations of fire alert system.

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Taking into account environmental information and multi-temporal statistics concerning forest fires, Polish forests (managed by State Forests organization as well as National Parks) were divided in three categories of fire risk. According to this classification particular Forest Districts and National Parks are obliged to perform special organizing activities concerning fire protection and fire suppression.

During flammability period, every day fire risk is forecasted. Four categories of fire risk forecast are in use: 0 – no risk, I – slight risk, II – high risk, III – very high/catastrophic risk. Present method of fire risk forecast bases on calculations according to forest duff moisture and meteorological parameters measured twice a day (at 9 a.m. and 1 p.m.) at permanent plots (Karlikowski, 1981).

During cloud free weather condition additionally NOAA-AVHRR data is used to support fire risk forecast (Karlikowski et al. 1997). Satellite images are used to calculate radiative temperature, evapotranspiration as well as vegetation indexes describing the changes of spectral characteristics of forests in relation to ground and meteorological parameters characterizing flammability of forest stands.

Apart from mentioned activities, forest fire protection system consists of fire alert and suppression system, which is composed of (statistics from 1996):

- 385 watching point (230 watching towers and 155 TV towers),
- 674 telecommunication points,
- 2,830 patrols (including plane patrols),
- 5,782 water reservoirs,
- 21 forest airfields,
- 18 patrol planes,
- 44 suppression planes,
- 14 helicopters.

Forest Districts and National Parks are additionally responsible for infrastructure connected with fire protection, like roads, specialized trucks and other technical facilities. For instance: Forest District of I category of fire risk is obligatory equipped with: fire suppression truck, and several hand foam extinguishers. Forest Service is responsible for alerting and first stage of suppression, before arriving of fire brigade.

Reasons of forest fires are multiple; they have various implications. So, works on modelling fire risk, its origins, development and consequences have been started recently. Spatial information systems are the great help in creating these models. They enable analysis of different data, which influence fire risk and its consequences. The main elements of the models are: types of stands and species composition for particular forest storey, archived forest data, topographic data, relief, and climatic conditions - one of the most important elements of the system. In Poland this system is being built in Forest Research Institute on the basis of Forest Fire Database (FFD). FFD stores 32 types of information about forest conditions of burnt stands, meteorological conditions during fire, type and acreage of burnt area, characteristic of fire and fire-suppression action. These data are used for analysis of forest susceptibility to fire and for analysis of reasons of their arising, depending on natural conditions. This information, assembled with forest maps is the beginning of GIS for fire management purposes. GIS datasets were used to evaluate the forest fire hazard in different parts of Poland but it is especially useful when evaluating the losses and preparing recultivation and reforestation activity.

Very important element of forest fire protection is education and publicity. Classes organized for the pupils and students, radio and TV programmes, as well as posters give a special opportunity to educate people and by this way influence on safety of forests.

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MAKE ALL SOCIETY PREVENT FOREST FIRE, POLICIES OF CHINA IN LAST DECADE

Wang Dong[47]

Before 1988, the annual average of burned area of forest fire over 40 years is 971,000 ha in China, and the average of that in last decade is 52,170 ha, decreased by 95 percent. This is due to the changes of the forest fire control policy system in accordance with the original objective 'minimizing the losses caused by wildfire', and the direction 'setting priority and emphasis on prevention and acting sufficiently on suppression'.

Country	*The Annual Average of the Forest Fires*	*The annual average of burned area(Ha)*	*The average annual accurrence rate (time/100000 ha)*	*The damage rate(%)*	*Burned Area for Each Fire Ha*	*Statistical Period*
Total of World						
Europe	35,600	574,000			16.4	1981-1983
Former Soviet Union	28,000	1,640,000	3.7	2.1	73.6	1989
Canada	7,162	891,330	1.6	2	121.6	1970-1980
United States	117,724	1,840,495	38.6	6	15.6	1970-1980
Australia	1,772	360,070	7	1.4	203.2	1970-1980
Japan	4,807	4,887	19.7	0.2	1	1972-1981
China	15,930	971,000	13.9	8.5	61	1950-1987
China	6,992	52,170	5.7	0.41	7.5	1988-1997

MAIN CHANGES

The basis for forest fire management has been changed. It was remarkable of the year 1987 when China bore a very serious fire situation. A huge forest fire in Northeast China burned out over 1,000,000 ha forest and made over 200 lives lost. This bitter lesson made Chinese government pay much more attention in this area and make a major decision to strengthen fire control.

Management Method Change from the simple administrative method to the integral management package of legislation, administration, economics, science and techniques. During the last decade, the national 'FOREST FIRE PREVENTION ACT" was issued, the local government's regulations to carry out the ACT were published, many kinds of means for economic rewards and punishment were used, and the standards of equipment for fire control were much improved. Organization for forest fire control were established from the central government to the locals all over the country. According to the statistics by the end of 1997, there are 3,006 governmental forest fire control headquarters and 3,069 executive offices through of China. Functions of coordination between the governmental agencies were set up not only responsible for fire suppression but for prevention. The responsibilities for other agencies involved in wildfire control, e.g. communication, transportation, civil aviation, weather forecasting, medical treatment have also been made clear in the ACT, and the army should be called to suppress fires in emergency based on the ACT. The above improved works offered the basic environment horizontally for all sectors to participate the forest fire prevention and control.

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The responsibility for forest fire prevention and control has been changed. Before 1987 the forest fire control system was totally in the sector of forestry. After that year, the responsibility were moved to the authorities of governments at all level. The result of the change makes all level of the administrative authorities shared the responsibility in his own territory, and thus makes all resident being under obligation to prevent fire from forest. In China now the local government administration authorities must be responsible for fire prevention, suppression according to “FOREST FIRE PREVENTION ACT”. This ACT also regulated details on the right for governments to make fire season restriction, establish fire control organization, construct wildfire control facilities, approve the use of prescribed fire, educate the publics. The above improved works offered the basic environment vertically for all parts of the residence to participate the forest fire prevention and control.

The way of fire prevention has been changed. Forest fire prevention was not generally taken seriously in forest region especially in north provinces such as Heilongjiang and Inner Mongolia since 1987 huge fire. According to statistics,

The main socio-economic causes of forest fires

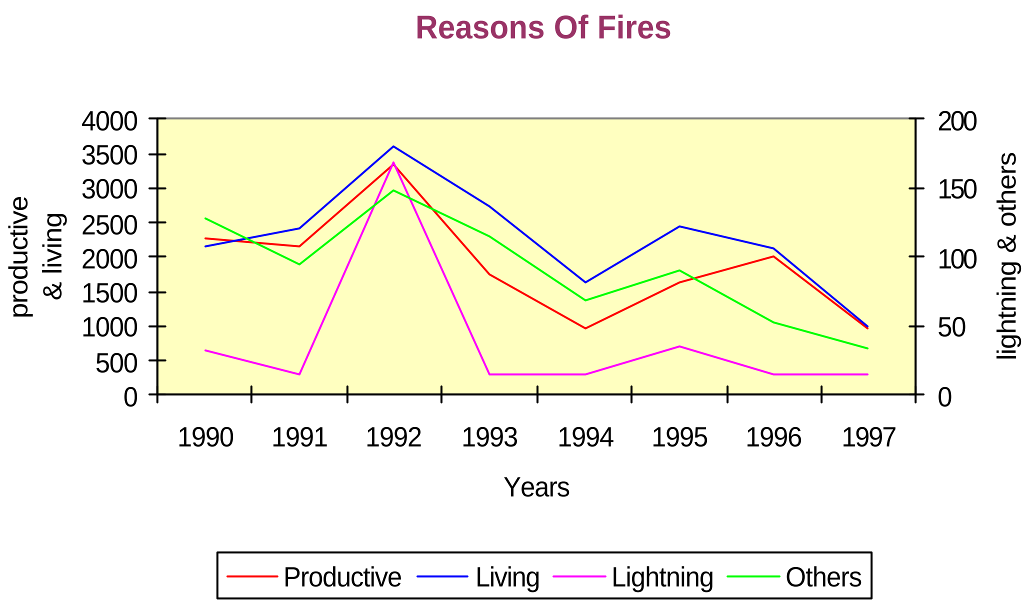
Year 1990-1997	*Total*	*Man caused fires*	*Other*	*Lightening*
All Country		33,264	314	728

The main social-economic causes of fires (over 95 percent of the total fires) are man caused fires for agriculture clearance and camp fire in forest for hunting, mining, collecting, road and railroad etc. About over 840 million peoples are leaving in countryside and 60 million in moving, which means a very heavy work for the prevention of man caused fires. Lightening is a frequent fire cause in the end of spring fire season in north forest region especially along the border with Russia. To prevent man caused fires, great efforts have been devoted including many effective measures carried out according to the “FOREST FIRE PREVENTION ACT”. Before fire season in each year of the last decade, the local government announces the beginning date of the fire season and the ban periods. When the fire season start, at almost every entrance of forest region, the fire prevention checkpoint check the permit and inspect matchboxes and lighters carried with people, and see if a fire spark arresters were installed on automobiles. During fire season, each train going through forest region must have a watch guard on tail car and in some danger places such as at down slops where trains often produce sparks due to braking, ground patrollers are arranged to prevent fire ignition. Any wild fire uses will not be allowed in the ban period no matter what reason. A multilevel fire detecting system were established during the last decade, including satellite monitoring system covered all over China, aerial detection in the main forest zones, lookout towers through general forest regions. A Lightening locating system importing from the U.S. was established in Da Xing An Ling mountain forest region to detect lightening fires after a huge fire in 1987. Only in Northeast China we have over 2,000-km boundaries with Russia and Mongolia. For recent years China embarrassed fires entered from Mongolia (e.g. in 1996) and Russia because of the seasonal winds direction in spring being always to China. To prevent wild fires come into or go out off China, China-Russia have already sign an agreement on forest fire prevention and suppression in cooperation and Chinese central government allocates a special fund to build fire breaks along the border with Russia and Mongolia.

In the main forest zones, a very important element for fire-fighting is the forest police, they are the professional fire brigades for 50 years up to this year. Equipped with good training, advanced transporting methods e.g. all road vehicles, helicopters, most wild fires were put out by them on the quick response. Aerial fire-fighting is absolutely necessary in large especially remote forest zones. Now in Northeast and Southwest China there are 18 airfields running for fire-fighting, and about 70-80 airplanes were employed each year. For recent years, air tankers and dumping buckets were developed for fire suppression except fire detection and transport. A national fire information system based on computer network and intranet software has already been put into use and fire images received from NOAA weather satellite can be transmitted from national office to over 300 terminals through out all country. The fires spreaded in the country’s border zone are quite serious problems, a special fund has been provided from the central government each year to build fire breaks along the border, the use of prescribed fire is one of the methods for the fire break construction.

PROBLEMS

The control of mankind fire source is becoming a more and more difficult task. With the rapid economic and social development in China, roads and travel conditions have been much improved, and the people entered the forest for production, recreation are increasing. China has over 800 million people leaving in countryside, and it is almost equal of the population of Europe and North America (SOFO 1997). How to keep the fires not go rising is quite a problem. In 1996, the productive fire (red line) was increased along with the more fire uses on land clearing for the simple reason of the price rising of grain.



The forests are becoming more and more danger with afforestation and forest fuel accumulation. China now has the largest area of the planted forest in the world, which occupies 40 percent of total that in the world (SOFO 1997), and these forest will continue to keep high fire hazard until they become crowned. The forest fuel accumulation is another problem because of fires not burn for many years.

COUNTERMEASURE

Forest fire has the characters of nature and society. Control of the fire must be through an integral methods of legislation, administration, economics, hardware construction, science and technique and so on, as a fire control polices package which should be strong enough to keep the three side of the fire triangle not to meet. Different countries may adjust the proportions of the methods within the package in response to the different environment and background of each country.

This publication contains the proceedings of the Meeting on Public Policies Affecting Forest Fires, convened in Rome in October 1998. Part I contains the five regional analyses of the socio-political situation of forest fires in the Americas and Caribbean, Asia and the Pacific, the Mediterranean basin, Africa and Europe and temperate/boreal Asia. It includes the main measures adopted to prevent and reduce the impact of these fires and presents the themes on which the experts focused their discussions as well as the main conclusions and recommendations of the meeting. Part II is a collection of the technical papers contributed by participants to the meeting and by the global fire community. The proceedings comprise the work of 71 participants, drawn from 33 countries and 13 international organizations and representing many different sectors, including the private sector and NGOs as well as a wide range of land use and other related disciplines.

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