UNITED NATIONS
ECONOMIC COMMISION FOR EUROPE

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

# INTERNATIONAL FOREST FIRE NEWS

**No. 26 – January 2002**

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All IFFN contributions published between 1990 and this current issue are accessible through 61 country files and other special files on the GFMC website.

**Call for contributions**

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

The deadlines for submitting contributions to the bi-annual issues are: **15 May and 15 November.**

# EDITORIAL

In the Editorial of International Forest Fire News No. 24 (April 2001) the rationale and a short overview of the *FAO Global Forest Fire Assessment 1990-2000* within the *Forest Resources Assessment 2000* (FRA) has been presented. Most of the country contributions that include statistical wildland fire data and narrative information regarding the fire situation in the 1990s have been prepared for publication in IFFN and the FAO report. This special issue of IFFN includes national fire reports from Asia and the Pacific. Meanwhile the FAO "FAO Global Forest Fire Assessment 1990-2000" has been published in full length on the internet. The website address on which the report can be downloaded (PDF; size: 6 MB) is:

http://www.fao.org:80/forestry/fo/fra/docs/Wp55_eng.pdf

Based on the country reports and the IFFN archive the FAO has put the most important fire information in the country profiles. Forestry and fire information can be navigated by country:

http://www.fao.org/forestry/fo/country/nav_world.jsp

Through a cooperative arrangement with the Global Fire Monitoring Center (GFMC) more country profiles will be added successively to the FAO website.

Australia's *Christmas Fires* of 2001-2002

During the preparation of this IFFN issue Australia's C*hristmas Fires* burned between end of December 2001 and mid of January 2002. Some media called this fire episode as Australia's "worst fire disaster in history." However, when the fires were terminated by rains by mid January 2002 the losses were less severe than anticipated. About 600,000 hectares had been affected by wildfires, a total of 120 houses burnt down, 3000 sheep were killed. These damages should be compared with the impacts of the *Ash Wednesday Fires* of 1983 that occurred during the drought caused by the extreme El Niño of 1982-83. At that time the human death toll was 75, a total of 2539 houses burned and about 300,000 domestic livestock were killed y the fires. Satellite-derived burned area assessments included in the Australia country report in this issue of IFFN reveal that in the two fire seasons 1998-99 and 1999-2000 a total of ca. 345,000 wildland fires were recorded in the whole of Australia affecting 31.2 and 71.2 million hectares respectively.

It is well known that Australia's ecosystem are well adapted to fire. Human-caused fires have been documented for the last 60,000 years. Natural- and human-caused fires of varying intensities and severities are inherent elements of ecosystem dynamics. Apparently the impacts of the 2001-02 fires in Australia were relatively small compared to earlier extreme events or averages of vegetated area affected by fire. Why were these fires considered a major disaster?

First, the fires burned at the wildland-urban interface. This interface is a broad belt of urban development sprawling into the surrounding bush and forests. Similar to the exurban trends in North America the Australian cities expand horizontally rather than vertically. The highly flammable properties of Australia's bush and forest vegetation in which suburban houses are embedded represent an extremely high hazard for these houses, especially considering the fact that the houses are often wooden constructions.

Second, prescribed burning as a standard fire management practice in Australia is difficult to apply in this intermix situation. Prescribed burning aims at reducing fuel loads (combustible materials) on the forest floor and understory under controllable conditions in order to reduce the energy potential and to avoid high-intensity fires that are difficult to control.

Third, the Christmas Fires of 2001-2002 were caused by an unprecedented amount of arson. What was new in the situation was the high share of young people setting these fires purposely. The assumption that urban kids living in the exurban environment and not being aware of the consequences of their doing because of a lack of environmental awareness and responsibility, however, must be proved.

The coincidence of weather conditions favourable for the spread of large, high-intensity fires, and the above-mentioned circumstances reveal an increased vulnerability of the post-modern society, especially those living at the edge of or within a system in which fire is a common and needed natural phenomenon.

Freiburg, January 2002 Johann G. Goldammer

# ASIA AND OCEANIA FIRE SPECIAL

## AUSTRALIA

### Fire Situation in Australia

**Introduction**

This report describes the environments of Australia, points out the variety that exists in fire regimes, and provides statistics on the occurrences of fires. It also notes some of the social impacts of wildfires in recent years, presents an outline of the agencies involved with fires and touches on the community policies and infrastructure that have developed in response to fires. To keep the report brief, comprehensive referencing has been foregone. General Australian references to fires and their effects are: 'Bushfires in Australia' (Luke and McArthur 1978); 'Fire and the Australian Biota' (Gill et al. 1981); 'The Ecology of Fire' (Whelan 1995); and, the forthcoming book 'Flammable Australia: the Fire Regimes and Biodiversity of a Continent' (Bradstock et al. in press).

**Fire environment, fire regimes and ecological role of fire**

Australia is a large, geographically diverse continent straddling the tropic of Capricorn. It is relatively flat, dry and warm although it also has mountains of moderate height (particularly along the eastern seaboard), rainforests and ski-fields - as well as a large arid and semi-arid zone. This report covers the Australian mainland and its largest offshore island, the State of Tasmania. Australia has an area of 7.9 million $km^2$ (Luke and McArthur 1978).

Across the tropical north is a large savannah region with a monsoonal (wet-dry) climate. In the southwest is a region of eucalypt forests, woodlands and shrublands with a largely Mediterranean climate. In the southeast, including Tasmania, there are forests and woodlands, but the climate there is quasi-Mediterranean with the dry summer conditions due to high evaporation rather than low rainfall. A large area of the continent is arid and semi-arid, both tropical and temperate, and is dominated by hummock grasslands and *Acacia* shrublands. Prominent, species-rich woody plant genera in Australia are *Acacia* and *Eucalyptus.* Among the vertebrate animals, marsupials are particularly noteworthy.

Australia is a fire-prone continent. Fires occur in rainforests and in deserts. Its people have ignited and lived with landscape fires for perhaps 60 000 years, the current antiquity considered for Aboriginal people in Australia (see Miller et al. 1999). Consideration of fires without consideration of people in Australia is sometimes difficult, sometimes impossible, often unwise.

Fire regimes and their effects are wide ranging. Fires occur with a mean interval of 1 to 2 years in parts of the savannah in the tropical north and of the order of 300 or more years in the temperate rainforests of the southeast. Fires occur at all times of the year in some part of the continent. Intensities of surface fires probably reach a maximum of the order of 100 000 $kWm^{-1}$ (Gill and Moore 1990). Peat fires, which occur especially in Tasmania, can have long-term ecological significance, but are not widespread on a continental scale.

Australia has a large and diverse flora and fauna, much of it unique to the continent. This diversity, combined with the fact that there is a wide range of fire regimes and physical environments, means that there is an enormous range of potential fire regime effects. These effects include local extinction of flora and fauna, changes in water yield and quality, changes in pasture palatability, and woody plant encroachment.

**Major wildfire impacts on people and property during the 1980s and 1990s**

Most socio-economic damage from wildfires in Australia occurs in the southeastern part of Australia (see Cheney 1979 for 'fire-hazard areas'), but more generally where forests and woodlands abut cities and their suburbs. In the 1980s, there were extensive fires in South Australia and Victoria; 76 people died and there was massive property damage including the loss of 2 463 houses and 30 000 stock (see Ramsay et al. 1996). In the 1990s, there were fires in Sydney, New South Wales, where 206 houses were destroyed and four people died (see Ramsay et al. 1996). The impacts of such circumstances can last decades or more for the people involved.

Most human deaths in wildland fires in the last decade have been those of firefighters. At least 52 have died on active duty since 1980: in South Australia (10), Victoria (19), and in NSW (23) (Paix 1999). In early 2000, three more firefighters were killed in Sydney.

**Fire database: fire numbers, areas burned, and fire causes**

Various problems arise in the use of statistics for forest fires in Australia. The use of differing classifications of vegetation types creates difficulties. For example, 'forest' in the Food and Agriculture Organization (FAO) definition includes trees at least 5m tall having a cover of more than 10 percent, but the Australian National Forest Inventory, while using the same 5m height threshold, requires a "projected foliage cover of overstory strata about equal to or greater than 30 per cent" (Resource Assessment Commission [RAC] 1992). The definition of 'forest' used by forestry organisations, for fire-reporting purposes, has been the vegetation of the land under forestry jurisdiction.

Forest fire statistics usually apply to data collected by State Forest Authorities and may not include the forests in National Parks, Crown Lands, and private property. Some State forestry organisations have been amalgamated into agencies with larger jurisdictions and the way that statistics are published may reflect this.

The area base for the statistics is continually changing so care should be taken in the use of fire statistics. Changes occur due to tenure and land-use changes. The area of forest in Australia around 1790 has been estimated as 69 million ha while about 43 million ha survived to about 1990 (RAC 1992).

The following caveats apply generally but unevenly across the vegetation types and tenures of land in Australia:

- The methods used for the establishment of a database of areas burned varies (e.g. ground observation, aerial photography or satellite imagery) and thus the accuracy of the data varies.
- The diligence of reporting fires and the areas they burn may vary.
- Data may, or may not, include areas burned by prescription. For example, satellite sensing of areas burned will not discriminate between causes of fires. The major cause of burning in some major forest areas is due to prescription (see Gill and Moore 1997 for south-western Australian eucalypt forests).
- Data are often presented for short periods only.

Estimating the numbers of fires in Australia by any means is difficult even with a constant methodology. Data on High-Temperature Events (HTE) which represent vegetation fires depicted by satellite remote sensing gives a national coverage. Numbers of HTE's for the past two years (1998-1999 and 1999-2000) are 115 000 and 230 000 per year for Australia as a whole (Western Australian Department of Land Administration [DOLA] - data courtesy of Mr R. Craig). However, the number of HTE is inflated, on the one hand, by multiple counts of single fires and deflated, on the other, by the many fires that are missed by the evening pass of the satellite used for the daily detection of HTE.

The areas of burned surface estimated from satellite imagery by DOLA (viz. 'fire-affected areas' or FAA), for the two years were 312 000 and 712 000 $km^2$. This wide difference was apparently caused by large differences in the area of FAA in arid Western Australia (WA). These figures indicate an average proportion of the continent burned per year of 6.5 percent. This average contrasts with the extreme year of 1974-1975 when 15.2 percent of the continent was estimated to have been burned (Luke and McArthur 1978). In that same extreme year, a massive 33.5 percent of the entire Northern Territory was burned (Luke and McArthur 1978).

For 'forests' in the period 1956-1971 there was an average of 1945 fires per year with an average area of forest burned of 362 000 ha, or 1.8 percent of the total area (Luke and McArthur 1978). Forests in this case probably represent the vegetation managed by forestry agencies (see above). Taking the *average* area burned is a bit misleading, however, because the range in the area burned was from 53 000 to 1 061 000 ha (Luke and McArthur 1978). Estimates of areas of forest burned in more recent times are shown in Table 1. The Table is a summary of those produced by the National Greenhouse Gas Inventory for the period 1991-1996 (see Table 1 for the URL). The tables showed nominal, constant, figures for some years; where these extended for more than two years they were not included in Table 1.

It is suspected that the numbers in Table 1 were for 'forests' in the broad sense, whereas the data from the Forest Services quoted from Luke and McArthur (1978) were from forestry jurisdictions. Drawing comparisons between the two sets of figures would be unwise. For a detailed study of historical trends in areas burned and number of fires in southwestern Australian forests, see Gill and Moore (1997).

The Victorian Department of Natural Resources and Environment has posted the average figures for fire causes on public land over a 20-year period (http://www.nre.vic.gov.au/ ). Of the average 584 fires per year, 26 percent were caused by lightning, 25 percent were deliberately lit, and 26 percent were caused by agricultural sources and campfires combined. These fires did not burn areas proportionate to their numbers, however. Nearly half the area burned, on average, was due to lightning-caused fires; deliberate fires burned 14 percent, while agricultural sources and campfires, collectively, accounted for only 8 percent of the burned area.

Estimates of the areas burned by prescription are shown in Table 2. 'Areas burned' are usually the sum of the areas of burning blocks, not necessarily the actual area burned, which is less than that of the burning block (see Gill and Moore 1997).

**Table 1.** Estimated areas of forest land (ha) burned by wildfires in Australia. Source: National Greenhouse Gas Inventory 1991-1996 (<http://www.greenhouse.gov.au/index.html>). Abbreviations: NSW - New South Wales; WA - Western Australia; SA - South Australia; ACT - Australian Capital Territory.

| Year | NSW | Tasmania | WA | SA | Victoria | Queensland | ACT |
|---|---|---|---|---|---|---|---|
| **1983** | 326 000 | 62 385 | 12 000 | 20 000 | 21 000 | 197 000 | |
| **1984** | 8 000 | 20 283 | 9 000 | 100 | 486 000 | | |
| **1985** | 242 000 | 2 230 | 60 000 | 4 000 | 240 000 | 19 000 | |
| **1986** | 35 000 | 873 | 73 000 | 100 | 15 000 | 15 000 | |
| **1987** | 249 801 | 5 079 | 235 678 | 101 | 24 958 | 44 000 | |
| **1988** | 158 954 | 30 861 | 76 543 | 293 | 32 352 | 14 000 | |
| **1989** | 79 452 | 8 833 | 78 431 | 138 | 30 744 | 33 000 | |
| **1990** | 99 340 | 14 529 | 247 147 | 300 | 26 297 | 73 930 | |
| **1991** | 251 252 | 9 675 | 1 221 102 | 101 | 51 943 | 28 945 | |
| **1992** | 449 800 | 15 466 | 279 320 | 102 | 4 815 | 37 925 | |
| **1993** | 10 000 | 5 623 | 144 200 | 1 | 4 815 | 39 855 | 200 |
| **1994** | 123 604 | 12 735 | 199 200 | 21 | 16 000 | 14 464 | 200 |
| **1995** | 23 716 | 52 572 | 101 692 | 7 | 19 000 | 81 860 | 180 |
| **1996** | 32 764 | 2 822 | 10 101 | 7 | 25 612 | | 500 |

**Table 2.** Estimated areas of forest land (ha) burned by prescribed fires in Australia. Source: National Greenhouse Gas Inventory 1991-1996; http://www.greenhouse.gov.au/index.html ). Abbreviations: see Table 1.

| Year | NSW | Tasmania | WA | SA | Victoria | Queensland | ACT |
|---|---|---|---|---|---|---|---|
| **1983** | 65 000 | 16 722 | 273 000 | | 167 000 | 119 000 | |
| **1984** | 101 000 | 32 042 | 253 000 | | 62 000 | 96 000 | |
| **1985** | 72 000 | 26 183 | 282 000 | | 106 000 | 164 000 | |
| **1986** | | 41 811 | 269 000 | | 96 000 | 141 000 | |
| **1987** | 160 917 | 30 476 | 208 569 | | 211 000 | 165 000 | |
| **1988** | 133 574 | 22 423 | 227 281 | | 200 000 | 151 000 | |
| **1989** | 103 253 | 5 356 | 234 514 | | 34 171 | 28 000 | |
| **1990** | 158 675 | 22 239 | 277 364 | | 105 000 | | |
| **1991** | 171 077 | 19 442 | 365 164 | | 205 000 | | |
| **1992** | 61 777 | 5 101 | 309 350 | | 100 000 | | |
| **1993** | 93 971 | 11 317 | 270 680 | 12 | 100 000 | | 300 |
| **1994** | 205 469 | 6 532 | 248 330 | 140 | 180 000 | | 300 |
| **1995** | 131 629 | 6 700 | 278 887 | 142 | 141 000 | 101 039 | 20 |
| **1996** | 168 798 | 2 269 | 233 758 | | 131 000 | | 200 |

**Fire-suppression and fire-management organizations**

There are many agencies in Australia concerned with suppression of wildland fires. In Table 3, agencies listed as "Fire Suppression Agencies" are those State government agencies that have as their major role the immediate suppression of any wildfire. Assisting them in suppression are, often, the State fire-management organisations and, less often, the metropolitan fire brigades. "Fire-management organisations" are government land management agencies which, if large enough, have a dedicated branch concerned solely with fire management. No private suppression organization is known to us, but many farmers, graziers and forest-plantation owners have their own fire suppression equipment.

Wildland fires in Australia are fought largely by volunteers belonging to a local brigade. Luke and McArthur (1978) estimated that there were 300 000 volunteer fire-brigade members in Australia. Volunteers are coordinated, equipped and trained by paid employees of the suppression agencies. State governments are the primary source of funding for the suppression agencies, but local government and communities are often heavily involved as well.

Among the State Government agencies which have significant capability for firefighting, but are primarily land-management agencies, are those in Western Australia (Department of Conservation and Land Management), Victoria (Department of Environment and Natural Resources) and New South Wales (State Forests of New South Wales). For further information, see the web page of the Australasian Fire Authorities Council (http://www.ausfire.com).

Both fire-suppression agencies and land-management agencies may be involved in the production of educational and training literature for firefighters and the public. They advise householders and rural people about preparedness for fire.

**Table 3.** Australian agencies that have as their primary role the suppression of landscape fires. Abbreviations: see Table 1.

| Fire Suppression Agencies | | |
|---|---|---|
| **State** | **Authority** | **Internet Contact** |
| ACT | ACT Bushfire Service | http://www.esb.act.gov.au/bs/bs.htm |
| NSW | NSW Rural Fire Service | http://www.bushfire.nsw.gov.au/ |
| Victoria | Country Fire Authority | http://www.cfa.vic.gov.au/ |
| Queensland | Queensland Fire & Rescue Authority | http://www.fire.qld.gov.au/ |
| Tasmania | Tasmania Fire Service | http://www.fire.tas.gov.au/ |
| WA | Fire and Emergency Services Authority of Western Australia | http://www.fire.wa.gov.au/ |
| SA | South Australian Country Fire Service | http://www.cfs.org.au/splash.shtml |
| Northern Territory | Northern Territory Fire Service | http://www.nt.gov.au/bfc/ |

**Use of prescribed fire to achieve management objectives**

Prescribed burning is used widely in Australia. In forestry it is used primarily for crop protection, disposal of debris after silvicultural operations, and for the protection of human lives and property (e.g. see Williams and Gill 1995 for New South Wales, and Gill and Moore 1997 for southwestern Western Australia). In Western Australia, the extent of prescribed burning has been in gradual decline for many years (Gill and Moore 1997), possibly because of reactions by the public to smoke.

For land uses outside of forestry there are many reasons for prescribed burning. In the pastoral areas Leigh and Noble (1981) list, among other reasons, removal of top hamper (dead grass), extension of the growing season, control of woody weeds, assistance with the establishment of improved pasture species, fuel reduction, and nutrient release. In conservation areas, fires may be prescribed for the maintenance of natural values (Good 1981). In agricultural areas, fires may be used just before the harvest of sugar cane and just after the harvest of cereal crops (Johnson and Purdie 1981), although such practices have often been criticised in recent decades.

In most land uses where native vegetation is predominant there will often be some burning designated for the protection of human life and property.

**Systems employed to reduce wildfire hazards and wildfire risks**

Australian societies have many levels of interacting mechanisms pertaining to wildland fires. These differ widely from place to place but here we try to indicate a range of activities that, in various combinations, affect the responses of communities and governments to wildfires in Australia.

The infrastructure surrounding responses to fires in Australia includes:

- Fire-detection systems (which may involve dedicated observers using fire towers and aircraft, citizens using mobile phones, and analysts using satellite systems)
- Networks of safe outdoor cooking facilities for campers (e.g. gas barbecues)
- Firefighting equipment (4-wheel drive vehicles including tankers; graders; bulldozers; air tractors; helicopters)
- Networks of tracks, roads, fuel breaks, and buffer strips
- Supply systems for the use of water-enhancing agents such as foams
- Systems of regular fuel-condition assessment (models, ground observations, satellite data)
- Systems for the assessment of fire behaviour (models, ground observations, infra-red airborne systems)
- Systems of assessment of weather conditions (models, ground measurements, radar, satellite imagery; )
- Systems for data display and manipulation such as Geographic Information Systems
- Communication systems (control rooms, radio networks, computer networks, phones, vehicle-tracking devices)
- Training systems and ranking structures for firefighters (e.g. the Incident Command System [ICS])
- A system for the integration of emergency services in disaster situations (e.g. through police, paramedics, caterers, structural and rural firefighters)
- A system of recruitment, training, and record keeping for firefighters
- A system for the recording of mapped and other data for each fire to enable analysis, retrieval, and review
- A research program.

A suite of mechanisms exists in relation to the setting of policy and its implementation. Tools that assist in the education, communication, and establishment of responsibility for fire matters include Codes of Practice (see http://www.nre.vic.gov.au/), Fire-threat Analyses (e.g. Mueller 1993), Plans of Management, interagency fuel management plans, and published Annual Reports. Programs for the creation of public awareness of wildfires include Community Fireguard (see http://www.cfa.vic.gov.au ). There is a vast quantity of printed material available from firefighting and land-management agencies suited to community education (e.g. accessed through the home page of the Australasian Fire Authorities Council <http://www.ausfire.com/ >).

**Public policies**

There is a large and complicated set of legal documents affecting fire suppression and management in Australia. There are:

- International treaties and agreements
- Within Australia inter-government agreements
- Australian Standards
- State laws and regulations
- Local government regulations

There are Acts and Regulations pertaining to:

- Set-up and responsibilities of government agencies
- Protection of human life and property
- Land tenure
- Biodiversity conservation
- Greenhouse gas emissions
- Smoke pollution
- Building design
- Total fire bans; etc.

An 'Environmental Impact Statement' may be required for some activities. A source of detailed information on legislation and regulation may be found at <http://www.austlii.edu.au>.

Having an impact on land-use practices has been the widespread membership of the 'National Landcare Program', a government-based program through which funding is provided to the community (<http://www.landcare.gov.au>). Though not specifically addressing wildfires, the projects undertaken by community groups can involve fires. The farming community is heavily involved in this movement. Community-based 'Park Care' groups exist in the Australian Capital Territory; their involvement in the management of conservation areas includes fuel manipulation. There is a range of Community organisations that may affect policy such as various National Park Associations (State based) and Conservation Councils.

**Conclusion**

Responding to wildfires in various ways are, among others, pastoralists in Northern Territory savannahs, traditional (Aboriginal) owners in desert grasslands of northern South Australia, managers of eucalypt forests of southwestern Australia, National Park managers in the semi-arid mallee shrublands of NSW, pine-plantation foresters in southeastern Queensland, and urban-interface residents in Tasmania. In this variety of circumstance, there is no single, planned, integrated system. Rather, there has developed a set of responses varying from the very simple to multi-faceted, multi-level, multi-agency mechanisms that vary regionally in accord with the diverse environments, tenures, population densities, and resource supplies present in different parts of the nation.

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**Figure 1.** High-intensity fire in a eucalypt stand under investigation by the C.S.I.R.O. Bushfire Research Unit in the 1980s. The New South Wales wildfires of 2001-2002 (*Christmas Fires*) have called for strengthening national wildland fire research capabilities. Photo: Courtesy C.S.I.R.O.

# CHINA

## Fire Situation in China

### Fire Environment and Fire Regimes

China is a country that is by no means rich in forest resources. Its total forest cover is 158.9 million ha which cover 16.55 percent of the total land area. The potential timber supply is 11 267 million steres ($m^3$) and the average forest area *per capita* is 0.128 ha.

The occurrence of forest fires varies from year to year depending on inter-annual climate variability. Furthermore, the variations of fire occurrence, fire size, and fire severity are closely related to the accumulation of combustible material in the forest. The major portion of forest fire occurrence is concentrated in a small number of regions (*"High Fire Occurrence Regions"*). Statistics reveal that the highest number and largest sizes of forest fires occur in the five provinces: Heilongjiang, Inner Mongolia, Yunnan, Guangxi and Guizhou. In these provinces, the numbers of forest fires accounted for 42.5 percent of the whole country, and the damaged area accounted for 75 percent of the area affected by fire in the whole country during the period 1950-1998. Within the above mentioned provinces and in other forest zones the forest fire distribution is not even. Highest concentration is in more than 100 key counties (cities) of 16 key regions. This phenomenon results from the fact that these regions have a higher share of forest cover, are exposed to more climatic extremes, including extreme wind events, and are remote with limited access and fire management (prevention and control) facilities. In combination with the complexity of fire origins, the high combustibility of forests, and the difficulty to control wildfires, the probability of large forest fire occurrence in these regions is very high.

The number of forest fires is large in forests of the South while the damaged forest area is largest in the Northeast and Inner Mongolia. Because of the gentle topography, the broad trench and embankment, the linking (ecotones) between grassland and forest, and the influence of the monsoon in spring and autumn, forest fires in the Northeast and Inner Mongolia spread quickly and over large areas. Just because of the different characteristics of various forest regions, fire prevention methods and control measures are also different in the South and in the North.

The seasonality of high forest fire danger phases among the various forest regions is different. China lies in the northern hemisphere. Influenced by atmospheric circulation, climate, and monsoons patterns, the occurrence of forest fires in the Northeast, Inner Mongolia, the South, the Southwest (mainly in Xinjiang Uigur Autonomous Region), and the North-East have different fire-danger phases. This is due to such natural phenomena as drought, windiness, precipitation patterns, low temperature, and accumulated snow, all of which attribute to different fire-danger phases. These periods are synonymous with *Fire Prevention Phases*.

### Narrative summary of major wildfire impacts on people, property, and natural resources that occurred historically

Statistical evidence reveals that the number of forest fires and the area affected by fires is subject to high variability. During the second half of last century more than 15 000 forest fires occurred and affected more than 20 million ha of forest lands. The most prominent fire years were 1951, 1955, 1956, 1961, 1962, 1972, 1976, 1977, 1979 and 1987.

In 1987, a large fire situation occurred in the Greater Xingan Mountains, Heilongjiang province. During these fires, 213 persons were killed and the burned area reached l.33 million ha. Of this area, 890 000 ha were damaged, with a loss of 39.6 million cubic meters of wood volume. Thus, the forest cover rate of these regions has decreased by 14.5 percent from 76 percent to 61.5 percent. The fires caused high mortality to large areas of young, mature, and overmature forest stands. The extreme fire severity not only led to the destruction of forest and forest floor cover, but also affected forest structure, biodiversity, micro- and macroclimate, and water regimes. It resulted in the reduction of the protection function of the forests, e.g. the protection of watersheds, soil conservation, and climate. Research revealed that the denudation of land surface resulted in changes of micro-climatic patterns, destruction of organic layers, and loss of water retaining capability.

### Narrative summary of major wildfire impacts on people, property, and natural resources during the 1990's

During the 1990s (1990-1999) an average annual number of 5 324 fires affected forests with an average annual area burned of 122 036 ha (non-forest lands are not included in this figure). Although the number of forest fires in the Northeast accounts for just five per cent of all forest fires in China, these fires involve as much as 60 percent of national fire losses. The South and Southwestern regions account for 95 percent of fires, but just 40 percent of

total annual fire losses. Fire seasons peak in May and October in the Northeast, while in the Southwest the peak fire season is from January to April. Across China, humans cause more than 95 percent of forest fires. In the Northeastern forest regions, however, lightning accounts for up to 30 percent of fire occurrences in some years.

**Fire management organization**

As far as forest fires are concerned, the policy of "take prevention first and extinguish fire second" should be followed. A nation-wide system of forest fire prevention and suppression needs to be established. The work of the country's forest fire management program underwent a turn for the better after the very large forest fire in the Greater Xingan Mountains in 1987. In order to strengthen the leadership of forest fire management, Forest Fire Offices were set up successively in 30 provinces, autonomous regions, and municipalities. These offices are under the jurisdiction of the central government, and special working bodies were established accordingly.

**Rules and regulations on forest fires**

Clearly defined responsibilities of governments at different levels and of the different units in the forest regions are an important aspect of forest fire prevention. Through this system the fundamental and crucial problems in forest fire prevention have been tackled in the recent years, resulting in strengthening of forest fire prevention and a visible reduction of forest fire occurrence and damages. In the period 1960-1987, 16 000 forest fires damaged an area of 950 000 ha in the whole country, representing a forest damage rate of 8.5 percent. Compared with these figures, the number of forest fires, the damaged forest area, and the forest damage rate from 1988 to 1998 was cut down by 49 percent, 98 percent, and 95.4 percent, respectively.

Important steps were taken to revise and improve regulations on the use of fire in the agricultural and forestry sectors. Several important laws, decrees, regulations, and stipulations became effective after being passed by the local people's congress, and promulgated by the governments. Many villages have developed community regulations and agreements and have strengthened forest fire management at the local level with successful achievements.

**Special firefighting teams arranged**

In the forest region of the Northeast and Inner Mongolia, permanent professional firefighting teams were established in every forest industrial enterprise and in large state forest complexes. In the collectively owned forest regions of the south, seasonal special firefighting teams, mainly consisting of military personnel, were set up. These special teams are guided and provided with equipment by the forest department, trained by people's armed forces, and commanded by Forest Fire Prevention Headquarters.

**Aerial forest fire protection**

Aerial forest protection is an important part of forest fire prevention, detection, and suppression. The 14 aviation stations are subordinate to the Northwest Aerial Forest Protection Centre and the Southwest Aerial Forest Protection Station, respectively. They are responsible for patrol, protection, and aerial fire suppression, including the application of chemical retardants, in the Northeast, Inner Mongolia, Southwest, and other remote forest regions.

**The development of a fire management infrastructure**

The development of infrastructure is the way to improve forest fire prevention and suppression efforts. The conflagration of the Greater Xingan Mountains in 1987 educated people that the investment must be made, and organisational improvements should be made as quickly as possible. From 1988 on, the state has appropriated special fund every year, and provinces, prefectures, and counties take out their related necessary funds at a certain rate. These new developments since 1987 have played an important role in preventing and extinguishing forest fires.

**Table 1.** Wildland fire database (number of fires and area burned) in China: Total number of fires and area burned in China between 1990 and 1999 on forest, other wooded land, and other land. The management of the wildland fire database is computerized. There is no website to access the fire database.

| Year | Total No. of Fires on Forest, Other Wooded Land, & Other Land | Total Area Burned on Forest, Other Wooded Land, & Other Land ha | Area of Forest Burned ha | Area of Other Wooded Land Burned ha | Human Causes No. | Natural Causes No. | Unknown Causes No. |
|---|---|---|---|---|---|---|---|
| **1990** | 5 681 | 67 608 | 9 666 | 57 942 | | | |
| **1991** | 5 899 | 90 713 | 16 515 | 74 198 | | | |
| **1992** | 8 728 | 160 440 | 47 605 | 112 836 | | | |
| **1993** | 5 699 | 78 572 | 22 102 | 56 470 | | | |
| **1994** | 3 317 | 144 196 | 10 050 | 134 146 | | | |
| **1995** | 5 197 | 270 686 | 25 574 | 245 112 | | | |
| **1996** | 4 948 | 116 054 | 44 770 | 71 284 | | | |
| **1997** | 2 465 | 82 980 | 34 656 | 48 324 | | | |
| **1998** | 4 455 | 74 820 | 19 263 | 55 557 | | | |
| **1999** | 6 847 | 134 293 | 38 412 | 95 881 | | | |
| **Average** | **5 324** | **122 036** | **26 861** | **95 175** | | | |

**Use of prescribed fire to achieve resource management objectives**

Following the experiences in prescribed burning in other countries, a number of experiments were carried out in China. In the early 1980s it was concluded on the base of scientific research that prescribed burning not only prevents high-intensity forest fires, but also helps to improve the growing conditions of forest trees.

Prescribed burning is being used in the forest regions of the Northeast, Inner Mongolia, and Sichuan. The major goal of prescribed burning is to reduce the load of fuels (combustible materials) which, in conjunction with the meteorological factors, are determining the intensity and severity of a forest fire. Because of this, no large forest fires occurred in these regions recently.

In some provinces or regions, such as Jilin province, the reduction of large-scale burning of forests in the past ten years and more have led to an increasing accumulation of combustible materials inside the forest. This situation has led to a high hazard of very large and destructive forest fires. Thus, the use of prescribed fire to reduce forest fuels is of significant importance for preventing very large and destructive wildfires.

Prescribed burning operations observe meteorological factors (wind, temperature, humidity and relative humidity), moisture of fine fuels, and stability of the atmosphere. Downed woody materials and the litter layer are burned out under control. In the Northeast forest region, the most common method is to burn after frost, or immediately after snow melt. Forest sites with difficult topographical characteristics can be treated by prescribed fire efficiently.

There are also plans to use herbicides to clear the weeds in the young or mid-age forests in the southern broadleaf forests, or in the broadleaf/conifer forest ecotones. This method will reduce fire danger levels by accelerating the decomposition of flammable materials.

Besides the prescribed burning techniques, the establishment of green belts and firebreaks have proven to effectively prevent the spread of wildfires. Aerial patrols and increased use of watchtowers combined with satellite remote sensing monitoring and satellite communications have resulted in earlier fire detection and initiation of firefighting activities. In the Daxinganling forest region (Northeast China), a lightning detection and monitoring system has been established to identify and locate fires started by lightning.

**Construction of greenbelts (fuelbreaks)**

The construction of fuelbreaks is a long term effort that can reduce the impacts of future fires. Their benefits will accrue over a long period of time. Fuelbreaks on which fire-resistant trees, fruit trees, and other economic plants are grown are designed to slow down or halt the spread of a wildfire. These systems can produce economic benefits to the area, conserving the water and soil, and improving ecological conditions. The change of tree and other vegetation composition on fuelbreaks can prevent the spread of forest disease or insect pests. Economic,

socio-economic, and ecological benefits all can be achieved through a network of fuelbreaks. The total length of greenbelt fuelbreaks in China at the end of the year 2000 is 172,100 km.

**Public policies affecting wildfire impacts**

A nation-wide publicity and education campaign helps in raising awareness of the importance of fire management. Activities include billboards and slogans, and the use of radio and television to reach all communities. These fire prevention awareness measures are implemented in accordance with fire weather predictions.

During the fire season, fire prevention efforts are intensified. Planning and financial departments at all levels increase funding to expand and strengthen fire management infrastructure.

**Community involvement in fire management activities**

Much progress has been made over the last forty years in forest fire prevention in China. However, problems and differences do exist in this field among the different provinces or districts, reflected mainly in the form of unbalanced development, poor fundamental facilities, inefficient bottom-level organisational work, and incompleteness of networks. Compared with other countries, China has to catch up with prevention technologies. The current situation is characterized by insufficient capabilities to predict and control forest fires. As for administrative management, striking progress has been achieved. A framework of a forest fire prevention system has been established based on administrative leadership, regulations, information, firefighting units, socio-economic cooperation and fundamental firefighting facilities. Therefore, the frequency of destructive forest fires and area burned has dropped sharply.

Following increases in population, science and technology will be challenged in future years to improve capabilities in fire prevention, fire prediction, and fire control. Through sustained efforts, higher levels of fire prevention work will be achieved and the annual burned area could be less than 0.1 percent of the total forest cover of China.

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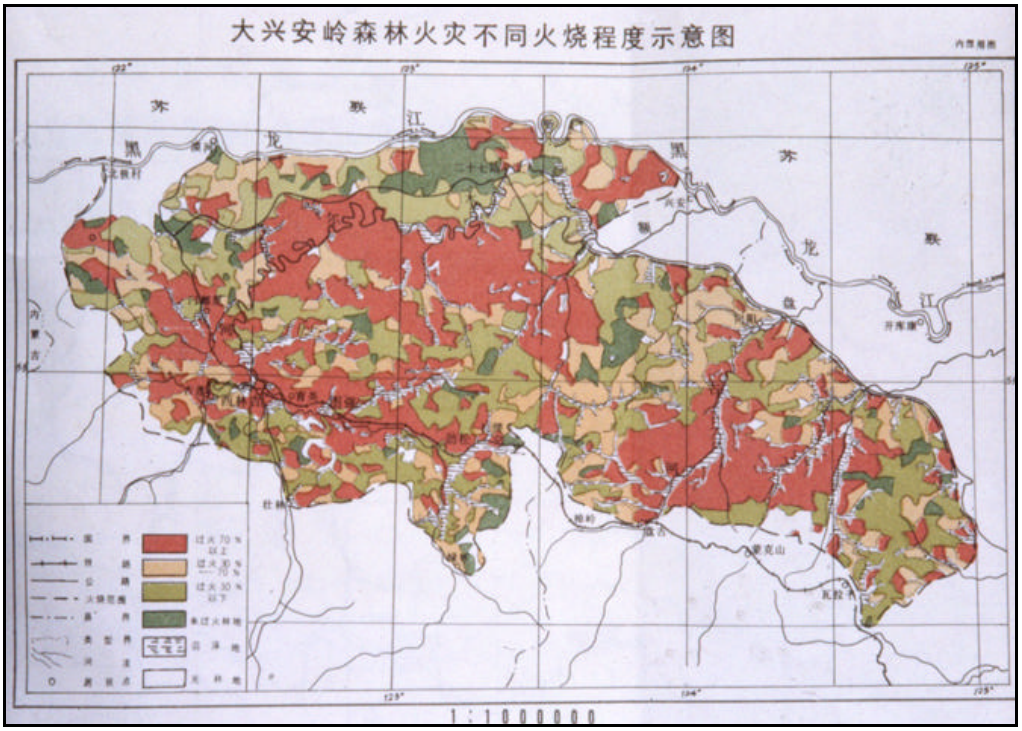


**Figure 1.** Map of the forest region of the Greater Xingan Mountains (Daxinganling), Heilongjiang Province, showing the area of 1.33 million ha. damaged by the 1997 fires. Source: GFMC archive.

**Figure 2.** Typical fire-influenced pattern of montane-boreal forests in the Greater Xingan Mountains (Daxinganling), Heilongjiang Province. The light-coloured trees represent pioneer species (birch, poplar, aspen) that colonize burned areas. Groups of old pines that have survived initial fires will also withstand future fires. Thus, re-current short-interval fires will maintain the fire-induced landscape mosaic. Photo: GFMC.

**Figure 3.** Typical greenbelt fuelbreaks in the Southwest of China. The total length of greenbelt fuelbreaks in China at the end of the year 2000 is 172,100 km. Photo: GFMC.

**Figure 4**. Typical interface between a greenbelt fuelbreak (right) and the wildland vegetation (left). The greenbelts are built and maintained to provide a shaded, moist micro-climate and little to none fuels in the litter and grass-herb layers. Photo: GFMC.

# FIJI

## Report on the Fire Situation in Fiji

### Introduction

Fiji, one of the larger clusters of islands in the tropical southwest Pacific, includes several large, hilly, islands of volcanic origin. Some of these, especially the two largest, Viti Levu and Vanua Levu, are divided climatically into dry leeward and wet windward regions. The context for this report is the leeward region, where wildfires are a common occurrence during the May-October dry season.

The leeward vegetation is various: from coastal mangroves, indigenous forest, exotic *Pinus* spp. (mainly *P. caribaea*) plantations, secondary swidden forest, sugar cane plantations, and large areas of grassland (with some ferns) made up of various species.

### Fire environment

The main threat to indigenous forest is logging but fire damage occurs along the margins. Destructive wildfires are a seasonal problem for the activities of Fiji Pine Limited which manages the large plantations of *Pinus* species (Were 1997). Secondary forest is managed as part of an increasing population of swidden and permanent agriculturalists, whose increasingly frequent cultivation cycles have lead to an increase in uncontrolled burning and complaints of soil erosion and declining fertility (King 2000). Sugar cane plantations exist mainly on the fertile lowlands where intentional burning during the harvest period has constituted an increasing problem (Davies 1998). Finally, large areas of grassland are fired annually (Whitehead 1952).

There are no comprehensive records of wildfire events in Fiji apart from Fiji Pine Limited records with some contributions from the Fiji Sugar Corporation.

Perhaps because the centre of power lies in the wet windward region there is a lack of interest by the Fiji government. Other factors, including historical circumstances, are relevant. Prior to independence in 1970 the British colonial government enforced (sometimes in a draconian manner) a conservationist ethic regarding fire prevention. There were various laws enacted to sustain conservation, including the cutting of firebreaks for intentional fires. Fire wardens were employed and village headmen had the authority to punish offenders. Upon independence, however, there was a general relaxation of control. Fire wardens were no longer employed and the ability of village headmen to enforce the fire prevention laws was undermined. As a result, local villagers now report that uncontrolled fires are more prevalent than before 1970. The older people in the villages complain of the indiscriminate firing and harvesting of the younger generation who, among other things, sell wild yams for cash in the towns (often without replanting the reproductive head of the yam). This is despite a decree originating in 1969 which prohibits the burning of vegetation over a large part of the leeward region in the dry season of any year (unless authorised by a government officer) (Government of Fiji 1985a). This law, and other fire prevention laws (Government of Fiji 1985b), are ignored and not enforced.

Part of the problem is that these laws take little account of the practicalities of managing land in order to make a livelihood in the region. For example, the temperatures during the late fire season in the central hills are often extreme and the effort of making four metres wide firebreaks on steep hillsides in these circumstances is very strenuous, and simply not practicable, especially for large areas. In addition, the local enforcement agency (the police) often sympathize with these farmers or are simply unreachable in many of the remote locations where fires are prevalent. In effect, the laws are alien to the local situation in that they do not allow for compromise approaches to fire prevention where livelihood circumstances are difficult. Research has shown that local people have many specific reasons to start fires which are part of making a livelihood in the region (King 2000). These reasons should be acknowledged and ways of controlling fires that are practical should be developed in order to prevent their spread. In the Navosa region of the central highlands, 71% of burned land was the result of escaped land-use fires. The percentage of land burned annually is difficult to estimate but certain large areas of grassland are burned every year, and much of the non-forested interior leeward landscape is probably burned at least every few years. The local people are well aware of the need to prevent fires, and complain of the lowering of fertility on hillslopes, the drying of the land, and the poor growth in native trees. However, various social structural, leadership, knowledge and policing issues need to be addressed in order to make improvements in this area. For example, traditional chiefs or village headmen (often lacking the power to police) sometimes urge their fellow villagers to minimize firing, but will admit privately later that `the people don't listen to us.'

The main reasons for fires are (a) clearing land for planting, (b) new grass for the animals (fodder in the season of scarcity), and (c) harvesting wild yams. Clearing land for planting in this dryland context is sometimes more appropriately termed ‘burn and slash’ rather than ‘slash-and-burn’ agriculture. Fires are often created to do the

initial clearing in low-growth secondary forest, and then the remaining vegetation is cleared and small trees are trimmed to provide supports or shade for crop plants. The shift to cassava as the main subsistence crop in historical times may have contributed to a more careless use of fire because it tolerates poorer soils and growing conditions. In contrast, burning was less, and mulching used more, where yams (*Dioscorea*), dalo (*Colocasia)*, plantain, dalo ni tana (*Xanthosoma)*, bele (*Hibiscus)* and yaqona (kava) were grown because of their higher fertility requirements.

During the dry season there is little fodder for domestic animals so areas of mission grass (*Pennisetum polystachyon*) with unpalatable mature leaves are burned. Young shoots quickly arise from the stumps and are palatable to the animals for a few weeks.

Wild yams often grow among dense stands of a tall grass (or reeds, *Miscanthus floridulus*) whose thickets are difficult to penetrate and where the emerging shoots of yams are hidden from view. Fijians burn the thickets over large areas so that the emerging shoots can be easily seen and the tubers dug up free of the hindrance of dense vegetation.

Fire also helps to control wild pig activities (either by keeping them away from the village and gardens, or by making it easier to hunt them).

This was especially important in those villages on forest margins where the wild pigs can devastate the gardens. Gardens are sometimes relocated in deference to the threat of pig damage.

There are many other reasons for starting fires, many of which were only important in specific communities. The destruction of pests and disease is one that was mentioned by a Fijian agricultural official but not volunteered by local people (who may have subsumed it under clearing land for planting).

Rangeland wildfire has been a perennial part of leeward-climate Fijian life. Early European visitors of the 19th century inevitably made comment on the prevalence of human-caused wildfires. This was understandable given that such visitors came from relatively cold and wet climates where wildfires were absent. The indigenous Fijian view is that human-caused wildfires are an inevitable, but sometimes excessive, occurrence that is a normal part of the Fijian calendar. Many Fijians 'like to burn', however, as yet unpublished thesis research done by the author shows that despite this cultural more, detailed evidence of opinions within farming villages shows that excessive burning is done only by certain households (King 2001).

**Forest wildfire data**

The only continuous fire data comes from the reports of Fiji Pine Limited (FPL) (Tab. 1,2) and to a small extent the Fiji Sugar Corporation (FSC) (Tab.3). Outside of these sources no records of wildfire have been kept despite the annual firing of the hilly savanna-like rangelands. Estimates of firing can be ascertained fairly readily from aerial photographs held in the Fiji Lands Department, but to my knowledge no person has quantified this data for Fiji as a whole. According to the estimates of the author of this report and the data he collected in Navosa province, about 70 percent of the land has been fired at least every few years.

In many years a portion of the pine plantations are written off due to fire damage. For example, 8,566 ha were written off over the 10 year period between 1987-1997 (Were 1997) out of the total of 43,201 ha managed in 1997 (Fiji Pine Limited 1997). In addition, many areas are burned but not written off. For example, in 1992 no plantations were written off but fire crews fought 156 plantation fires which burned 2,905 ha, responded to 56 wildfires near pine plantation boundaries, and undertook 952 control burns over 1,642 ha (Fiji Pine Limited 1992). There has been a reduction in the number of fires that occur inside plantation boundaries in recent years (Were 1997). The occurrence of the El Niño-Southern Oscillation (ENSO) event and government elections are associated with the worst years which were 1987, 1988 and 1994 (Were 1997). Records for the 1998 El Niño episode were not available. The causes of fire in FPL plantations between 1995 and October 1997 were: (a) arson (51%), (b) escaped agricultural burnings from adjacent farms (39%), (c) grazing (7%), (d) negligence by FPL employees (2%), and (e) lightning (1%).

The cause of the high arson rate involved conflict with landowner communities. Issues included low returns, loss of alternative means of income, employment prospects for community members, drying-up of community water supplies and other resource degradation, social equity issues, and party politics. In order to lower the rate of loss, prescribed burning for fuel reduction is being experimented with, and attempts are being made to increase benefits to landowners.

**Table 1.** Plantation areas affected by wildfires and written off in Fiji Pine Limited (FPL) forests between 1987 and 30 June 1997. Source: Were (1997).

| 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3274 | 3711 | 0 | 0 | 0 | 0 | 9 | 1111 | 254 | 92 | 49 | 8,566 ha |
| | | | | | | | | | | | |

**Table 2.** Causes of wildfires in plantations of Fiji Pine Limited (FPL) between 1995 and October 1997. Source: Were (1997).

| Fire Cause | Arson | Escaped Agricultural Fires | Negligence | Grazing | Lightning | Total |
|---|---|---|---|---|---|---|
| Total (%) | 51 | 39 | 2 | 7 | 1 | 100 |

**Table.3.** Burned sugar cane as a percentage (%) of Fiji's total cane harvest (by volume) 1969-1997. Source: Fiji Sugar Corporation (1998) Davies (1998)

| Year | Percentage (%)of Cane Burned | Year | Percentage (%)of Cane Burned |
|---|---|---|---|
| 1968 | 12.9 | 1983 | 14.9 |
| 1969 | 6.9 | 1984 | 25 |
| 1970 | 18.2 | 1985 | 19.2 |
| 1971 | 9.6 | 1986 | 25.6 |
| 1972 | 15.1 | 1987 | 23.6 |
| 1973 | 24.3 | 1988 | 15.5 |
| 1974 | 18.6 | 1989 | 22.8 |
| 1975 | 16.1 | 1990 | 39.8 |
| 1976 | 18.6 | 1991 | 49 |
| 1977 | 18.1 | 1992 | 31.5 |
| 1978 | 16.4 | 1993 | 33.4 |
| 1979 | 21.5 | 1994 | 40.2 |
| 1980 | 19 | 1995 | 47 |
| 1981 | 20.7 | 1996 | 43.4 |
| 1982 | 17.7 | 1997 | 62 |

**Sugar cane burning**

The rate of sugar cane burning has increased steadily from a rate of 19 percent in 1968 to an average of 62 percent in 1997 (Fiji Sugar Corporation 1998). Cane burning is discouraged and penalised under certain conditions but is practised by farmers to speed the task of harvesting, clear weeds and undergrowth, destroy insects, solve labour problems, minimize labour costs, increase crop weight, advance milling priority, and voice industrial or political disapproval. Over 95 percent of cane burning is deliberately started by the farmer. The residual 5 percent is attributed to lightning, carelessness or neighbourly sabotage (Davies 1998). Cane fires sometimes spread to grasslands, forest and pine plantations thus contributing to the increased prevalence of wildfires.

**Operational fire management**

Most of the indigenous forest is in the windward wet zone of Fiji where fire management is of minimal concern. The only fire management system is that of FPL which is a state-sponsored public company operating in the dry

leeward zone. Prescribed burning is being practised, and has been successful in reducing wildfires, but damage occurs to the lower trunks of *Pinus caribaea* if the heat of the fire is too intense. This damage manifests in reduced timber quality (see also below).

In FPL plantations fire detection systems are in place but there is a low rate of consistency in the time of response to wildfires even when the need for control is urgent (Were 1997). There are complaints about the level of preparedness, the lack of accountability of all parties, reductions in the number and quality of staff, and the efficiency of the fire-fighting system.

There have been complaints that the fire management system is inadequate for non-plantation fires, and could be much improved if a more efficient system of detection and communication with rapid-response tenders was put in place, especially in cane-growing areas. The government is challenged to become active here.

**Use of prescribed fire**

Prescribed burning as a forest management tool is only practised in FPL pine plantations as described before. However, in the savanna rangeland zone, burning is practised in a locally-prescribed way according to the livelihood and security needs of the subsistence-commercial communities of farmers in the region. It needs to be recognised that local farmers have their own needs that are prescriptive for their own purposes, and which are different from the needs of forest plantation managers. In Navosa province, local people prescribe fire to: (a) clear land for planting, (b) promote the growth of new grass, (c) to find and harvest wild yams, (d) help grow certain 'wild' green vegetables, (e) help with fuelwood harvest, (f) to keep wild pigs away from gardens, (g) to help hunt wild pigs, (h) clear tracks (of obstructions, and bristly or thorny vegetation) for both people and animals, (i) to help harvest 'wild' turmeric, (j) to clear land for pine planting, (k) to help control or find domestic animals (King 2000), (l) to temporarily improve fertility, (m) to help control insects (especially snails, slugs, and army worms) and disease (especially anthracnose and yam rot, mildew on cassava), and (n) to remove undesired vegetation from rangelands.

**Reduction of wildfire hazards**

There is little emphasis on techniques to reduce wildfire hazards apart from those used by FPL in plantation situations. In Navosa an average of 71 percent of land was needlessly burned because intentional fires were not controlled. Wildfire is commonly accepted a normal event and no attempt is made to alter the course of uncontrolled fires which in most cases burn uphill away from the villages which are mainly located in river valleys. Most open rangeland is burned relatively frequently: thus fuel loads are low and fires are of low intensity. As a result fires are rarely considered to be dangerous. However, if an uncontrolled fire destroys other peoples gardens or plantations, especially those containing valuable cash crops such as yaqona (kava), then there will be conflict and some form of locally-arranged restitution will occur (provided the person/s who initiated the fire can be identified).

The topography of much of the uplands is hilly and the maintenance of firebreaks is difficult and very costly. Variations in the type of vegetation will influence the buildup and the amount of the fuel load. Much of the regularly burned land is composed of grass species which will not increase their fuel load beyond a threshold for a number of years and cannot be considered under risk of having excessive fuel load. However, some shrub and tree species can regenerate quickly in the tropical environment and increase their fuel load to a point where they may pose a serious fire risk in certain locations if not burned regularly. Thus, the firing of this vegetation may be considered a form of sustainable land management that reduces wildfire hazards caused by a buildup of fuel load. It is worth commenting, however, that this reason was not proffered by the local people in the Navosa study, and my view is that this reason is applicable only in a relatively few contexts near villages.

**Public policies concerning fire**

There are few policies which address fire outside of the relevant legal provisions. There have been opportunities to address fire and sustainability through a recent environmental bill, but this document mainly concerns itself with urban concerns such as pollution rather than rural interests. In effect, responsibility has been devolved to FPL, which, however, does not have any mandate over rangeland fires.

The current legal provisions are contained in the legislation concerned with Land Conservation and Improvement (Government of Fiji 1985a, b). In brief: (a) the legislation covers the requirements for firebreaks of 4 metre width around any prospective fire, (b) notification for adjoining landowners, (c) responsibilities and duties for extinguishing wildfires (d) responsibilities of fire rangers (police), and (e) punishments. In addition another order prohibits fires to be lit in most of the leeward regions of Fiji during the dry season without permission (cane farmers excepted).

It is apparent that the livelihoods of many hill communities are suffering from increased erosion and a decline in soil fertility as a result of excessive burning. Pine forests and the quality of sugar cane are suffering. With an increasing population and an increased prevalence of fires in the region, there is a need for informed debate on the present role of fire in land management. In the author's view, changes need to be made in many areas, and appropriate education about the various impacts of fire and creative or constructive ways of preventing uncontrolled burns are a necessity. Fiji needs to develop new informed policies on the role of fire on its land.

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# Navosa Sustainability Study:
# Preliminary Results of the Survey on Burning: A Short Report For Participants

## Introduction

This report provides the results of a study of peoples livelihoods, agriculture and land degradation in the Navosa region of Fiji. The report has been written in a short version for the participants.

The study has been conducted between the months of October 1998 and January 1999 in the Navosa region of the upper Sigatoka valley in central Viti Levu. The survey involved the local people of 18 villages or settlements in a study of burning following a participatory model. Separate men and women groups contributed to the averages for each village. The names of the villages or settlements are given in Table 1.

**Table 1.** Names of the 18 villages in central Viti Levu that participated in the study

| | | |
|---|---|---|
| Nasauvakarua | Nakoro | Nasaunokonoko |
| Nanoko | Nubuyanitu | Namoli |
| Nubutautau | Navitilevu | Korolevu |
| Nasaucoko | Waibasaga | Nukulau |
| Draiba | Vatubalavu | Korovou |
| Keiyasi | Sawene | Nawairabe |

## Reasons for the land being burned

The first question was: *why is the land burned?* The results are illustrated in Figure 1. The three highest scoring reasons (*clearing land for teitei*, *new grass*, and *harvesting vitua*) were consistently mentioned by nearly all groups.

Other reasons were often more of local nature. For example: *clearing tracks* was mentioned in only 6 villages; *keeping away vore/vuaka* in only 7 villages, *clearing land for pines* in only 2 villages; *digging kari* in 4 villages, and *harvesting fuelwood (usually quwawa)* in 5 out of the 18 villages. *Nevertheless, these less-mentioned reasons were often important for the particular places concerned.*

In addition, there were numerous background or minor reasons suggested during separate interviews. These are not mentioned here, but are to be discussed within the author's thesis at a later date.

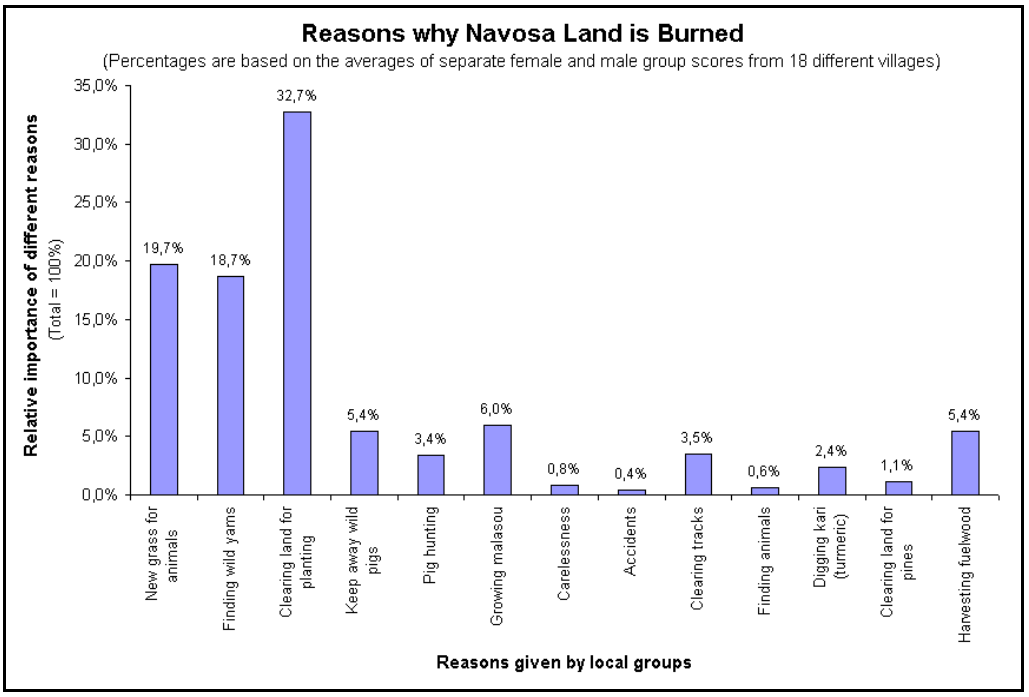


**Figure 1.** Reasons for burning Navosa lands

**Land burned because of carelessness or accident**

The second question was: *what part of the land that has been affected by fire was ignited by carelessness or accident?* The answers from separate men and women groups showed a strong level of consistency and reveal that on average *71 percent* of the land area affected by fire is due to negligence (Figure 2).

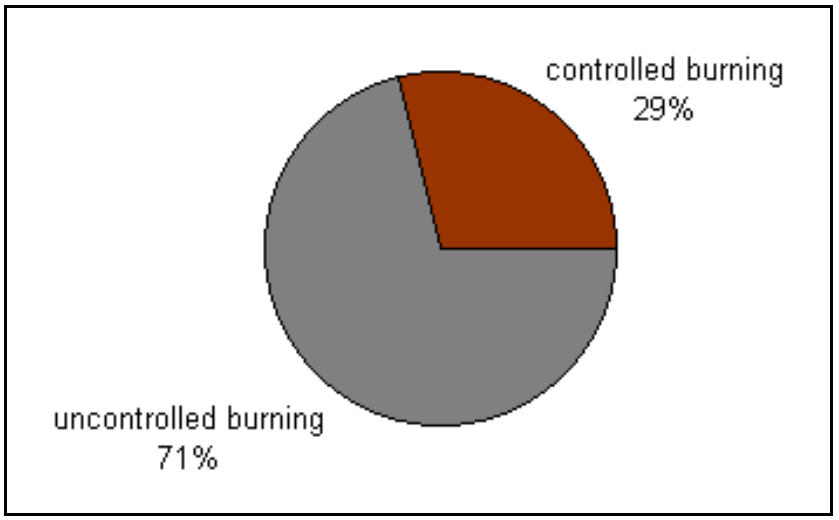


**Figure 2.** Results of the survey show that the majority (71%) of the land affected by fire is due to uncontrolled (accidental, negligent) fires.

**Land degradation and its prevention**

In addition, nearly all groups reported widespread *soil erosion* and an overall *decline in soil fertility* as the major problems that result when they were asked: *how does repeated burning effect the land?* The difficulty of growing (especially native) trees and the drying-up of the land were also mentioned frequently.

Respondents reported that land degradation could be prevented by stopping careless burning and planting pine and mahogany trees.

**Importance of wild subsistence resources**

Participant groups compared indigenous categories representing either wild or cultivated food or drink sources, and were asked: *which is the most important?* The relative importance of these categories for livelihoods are illustrated in Figure 3. Examples include *vitua* (wild yams) which are categorized as *Kakana ni veikau* and *malasou* (a wild green vegetable) which is *Gunu ni veikau*. The cultivated root crop doko (dalo) is classified as *Kakana*, and doko leaves (bote) are in the *Gunu* category.

**Social Ecology Values**

Lastly, six categories representing a range of social and ecological factors that relate to local peoples culture and livelihoods were selected. These categories were chosen by the researcher following dialogue with local people. The groups were then asked: *what is the most important for you in [own village]?* The importance of *safeguarding natural resources for future generations* was recognized by the local groups, but scored lower than some other value categories associated with daily life as illustrated in Figure 4.

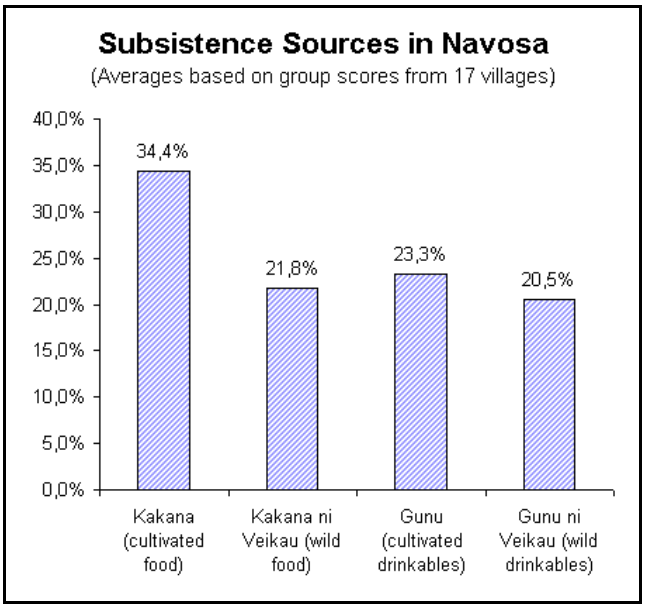


**Figure 3.** The relative importance of categories for livelihoods

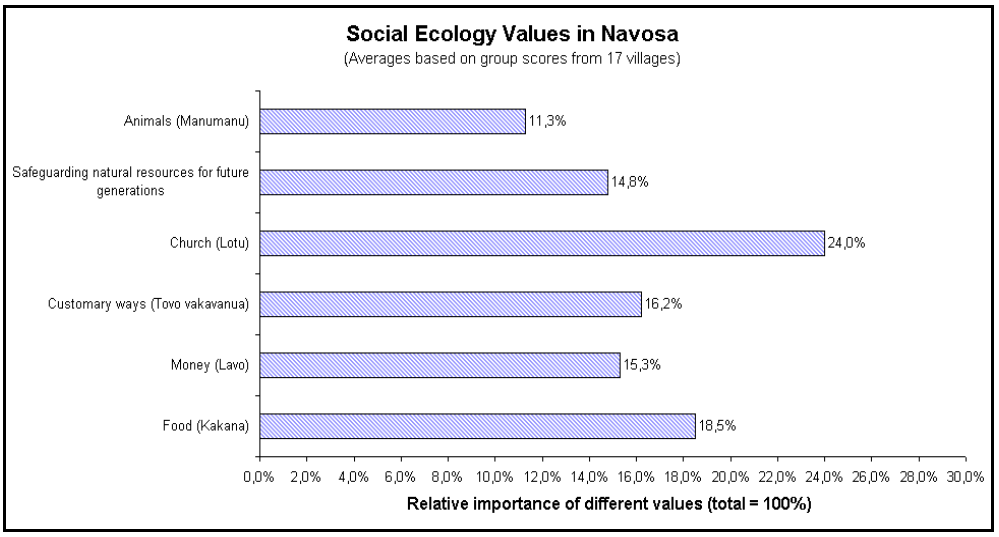


**Figure 4.** Social ecology values in Navosa

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# INDIA

## Fire Situation in India

### Introduction

India, with a forest cover of 76.4 million hectares, contains a variety of climate zones, including the tropical south, northwestern deserts, Himalayan mountains, and the wet north-east. Forests are widely distributed in the country. India's forests are endowed with a variety of biomes and biological communities. The forest vegetation in the country varies from tropical evergreen forests in the West Coast and in the Northeast to alpine forests in the Himalayas in the North. In between the two extremes, there are semi-evergreen forests, deciduous forests, sub-tropical broad-leaved hill forests, sub-tropical pine forests, and sub-tropical montane temperate forests.

With increasing population pressure, the forest cover of the country is deteriorating at an alarming rate. Along with various factors, forest fires are a major cause of degradation of Indian forests. According to a Forest Survey of India Report, about 50 percent of forest areas in the country are fire prone (ranging from 50 percent in some states to 90 percent in the others). About 6 percent of the forests are prone to severe fire damage.

### Ecological, economic and social impacts of the forest fire

The ecological and socio-economic consequences of wildland fires in India include:

- Loss of timber, loss of bio-diversity, loss of wildlife habitat, global warming, soil erosion, loss of fuelwood and fodder, damage to water and other natural resources, loss of natural regeneration. Estimated average tangible annual loss due to forest fires in country is Rs.440 crore (US$ 100 millions approximately).
- The vulnerability of the Indian forests to fire varies from place to place depending upon the type of vegetation and the climate. The coniferous forest in the Himalayan region comprising of fir (*Abies* spp.), spruce (*Picea smithiana*), *Cedrus deodara*, *Pinus roxburgii* and *Pinus wallichiana* etc. is very prone to fire. Every year there are one or two major incidences of forest fire in this region. The other parts of the country dominated by deciduous forests are also damaged by fire (see Table 1).

**Table 1.** Susceptibility and vulnerability of Indian forests to wildfire

| | Type of Forests | Fire frequent (%) | Fire Occasional (%) |
|---|---|---|---|
| 1 | Coniferous | 8 | 40 |
| 2 | Moist Deciduous | 15 | 60 |
| 3 | Dry Deciduous | 5 | 35 |
| 4 | Wet/Semi-Evergreen | 9 | 40 |
| 5 | Northeastern Region | 50 | 45 |

Various regions of the country have different normal and peak fire seasons, which normally vary from January to June. In the plains of northern and central India, most of the forest fires occur between February and June. In the hills of northern India fire season starts later and most of the fires are reported between April and June. In the southern part of the country, fire season extends from January to May. In the Himalayan region, fires are common in May and June.

### Summary of major wild fire impacts on people, property, and natural resources during the 1990s

During the 1990s, several forest fires occurred in the hills of Uttar Pradesh and Himachal Pradesh. From 1995 to 1999, fire hazards in these two states assumed dangerous dimensions. An area of 677 700 hectares was affected by these fires. The estimated timber loss from these hazards was US $ 43 million. Other losses due to these fires included loss of soil fertility, soil erosion, loss of employment, drying up of water resources, and loss of bio-diversity. These fires brought a major change in the microclimate of the region in the form of soil moisture balance and increased evaporation. The dense smoke from the fires affected visibility up to 14 000 feet.

Beside these major forest fires, the losses from the other fires reported from 13 states for the period 1994-1996 came to US $ 20 million. One other major fire, reported from the state of Tamil Nadu, for the year 1996-1997 in sandal wood forest caused a loss of approximately US $ 43 million.

Losses in productivity of the land, impacts on regeneration of species, and deleterious impacts on water shed also resulted from the forest fires.

**Figure 1.** Regularly occurring surface fires and the impacts of browsing and trampling by cattle lead to severe site degradation in the steep slopes of the Himalayan foothills in India. The photograph shows a typical situation in a *Pinus roxburghii* forest near Nainital, Uttar Pradesh. Photo: GFMC.

**Wildfire statistics**

In India there are no comprehensive data to indicate the loss to forests in terms of area burned, values, and volume and regeneration damaged by fire. The available forest fire statistics are not reliable because they under estimate fire numbers and area burned. The reason behind this is attributed to the fear of accountability. However, Forest Survey of India in a country-wide study in 1995 estimated that about 1.45 million hectares of forest are affected by fire annually. According to an assessment of the Forest Protection Division of the Ministry of Environment and Forests, Government of India, 3.73 million hectares of forests are affected by fires, annually in India.

**Table 2.** Extent of fire incidence in forest areas of the country (based on the inventory conducted by the Forest Survey of India since its inception)

| State/ District | Forest Area (ha) | Sample Plots (No.) | Extent of fire incidents (ha) | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Very Heavy | Heavy | Frequent | Occasio-nal | No Fire | Unrec | |
| **Andhra Pradesh** | 14826.71 | 2037 | 60.58 | 5.75 | 521.99 | 3335.27 | 10016.34 | 886.78 | 14826.71 |
| **Assam** | 15427.88 | 2482 | 70.91 | 0 | 590.25 | 4551.13 | 10176.68 | 38.01 | 15427.88 |
| **Bihar** | 5317.01 | 296 | 57.718 | 0 | 452.6223 | 3330.7426 | 1505.927 | 0 | 5317.01 |
| **Himachal Pradesh** | 10269.40 | 4878 | 163.7 | 0 | 671.45 | 3811.38 | 5054.92 | 567.98 | 10269.40 |
| **Jammu & Kashmir** | 3331.75 | 428 | 7.5 | 0 | 60.98 | 1089.58 | 2088.05 | 85.64 | 3331.75 |
| **Haryana & Punjab** | 1180.72 | 45 | 0 | 0 | 41.54 | 332.48 | 807.7 | 0 | 1180.72 |
| **Karnataka** | 13223.30 | 1780 | 59.71 | 30.33 | 470.64 | 3342.94 | 9309.79 | 9.89 | 13223.30 |
| **Manipur** | 15154.00 | 1880 | 0 | 151.54 | 454.62 | 5758.52 | 8789.32 | 0 | 15154.00 |
| **Madhya Pradesh** | 1962591 | 1947 | 136.53 | 23.07 | 1838.83 | 10644.29 | 6983.19 | 0 | 19625.91 |
| **Maharashtra** | 8165.54 | 1355 | 0 | 0 | 186.83 | 4222.57 | 3756.94 | 0 | 8165.54 |
| **Meghalaya** | 9905.00 | 1659 | 26.75 | 0 | 269.12 | 3347.25 | 5230.91 | 1031.6 | 9905.66 |
| **Nagaland** | 14954.91 | 1128 | 0 | 0 | 1084.231 | 12038.703 | 1831.976 | 0 | 14954.91 |
| **Orissa** | 20143.38 | 2972 | 204.42 | 78.5 | 923.19 | 11345.345 | 5258.182 | 333.52 | 20143.38 |
| **Rajasthan** | 20178.79 | 2446 | 71.39 | 0 | 99.03 | 4348.12 | 14763.26 | 896.99 | 20178.79 |
| **Sikkim** | 1707.77 | 401 | 47.12 | 0 | 18.14 | 544.84 | 1097.67 | 0 | 1707.77 |
| **Tripura** | 6445.36 | 555 | 34.59 | 0 | 361.75 | 5293.65 | 755.37 | 0 | 6445.36 |
| **Uttar Pradesh** | 23164.09 | 2825 | 871.43 | 0 | 2092.51 | 11124.1 | 907605 | 0 | 23164.09 |
| **West Bengal** | 5764.81 | 1471 | 4.77397 | 0 | 656.4338 | 1356.5246 | 3444.318 | 302.76 | 5764.81 |
| **Dadra & Nagar** | 186.49 | 62 | 0 | 0 | 0 | 180.8953 | 5.5947 | 0 | 186.49 |
| **Grand Total** | **208973.5** | **307.47** | **1817.122** | **289.19** | **10794.16** | **89998.3305** | **101952.188** | **4154.07** | **208973.5** |
| **Percentage** | | | **0.87** | **0.14** | **5.16** | **43.06** | **48.79** | **1.99** | **100.00** |

In India there are very few cases of fire due to natural causes. The majority of the forest fires (99 percent) in the country are human caused. It is widely acknowledged that most of these fires are caused by the people deliberately and have a close relationship to their socio-economic conditions. Grazing, shifting cultivation, and collection of minor forest products by villagers are major causes of fires in India. Carelessness of the picnickers, travellers, and campers are also responsible for forest fires.

**Operational fire management systems and organizations**

According to the Constitution of India, the central and state governments in the country are enabled to legislate on forestry issues. The implementation part of the forest policy/programmes lies with the state government. Thus, fire prevention, detection, and suppression activities are the responsibility of the state governments' forestry departments. The policy, planning, and financing are the primary responsibility of the Central Government. There is generally no separate department for carrying out forest fire management in the states. The regular staff of the forest departments in the states carries out various activities of forest fire management. During forest fire seasons

in some of the divisions, fire watchers are recruited by the state governments as a special provision. At the central level, the Ministry of Environment and Forests is the ministry responsible for forest conservation and protection. Forest fire management is administered by the "Forest Protection Division" of the Ministry, which is headed by a Deputy Inspector General of Forests. The Ministry is implementing a plan called "Modern Forest Fire Control Methods" in India under which state governments are provided financial assistance for fire prevention and control. This assistance is being used by the state governments for procuring hand tools, fire resistant clothes, firefighting tools, radios, fire watch towers, fire finders, creation of fire lines, research, training, and publicity on firefighting. This project is carried out in fourteen states and covers more than 70 percent of the forest area of the country.

**Community involvement**

In India, Joint Forest Management (JFM) Committees have been established at the village level to involve people in forest protection and conservation. At present there are 36 165 JFM committees throughout the country, covering an area of more than 10.24 million hectares. These JFM committees also have been given responsibilities to protect the forests from fires. For this purpose, the Modern Forest Fire Control plan is being revised and JFM is being made an integral component of the forest fire prevention strategy. Use of aircraft and helicopters has not been very cost effective in the fire management program and the Air Operation Wing is being closed down. For emergency purposes, however, a provision for hiring aircraft for transportation of crews and water is being maintained. The Government of India has issued national forest fire prevention and control guidelines. Salient features of the guidelines include identification of vulnerable areas on maps, creation of a data bank on forest fires, evolving fire dangers, fire forecasting system, provisions for a crisis management group, involvement of JFM committees, and efficient enforcement of legal provisions.

**Research Issues**

In India, there is an urgent need to initiate research in the fields of fire detection, suppression, and fire ecology for better management of forest fires. The research and technology developed in western countries always suitable for the Indian environment. Thus, it is essential that original research specific for Indian conditions be conducted. The Government is considering setting up a National Institute of Forest Fire Management with satellite centres in different parts of the country to bring the latest forest fire fighting technologies to India through proper research, training of personnel, and technology transfer on a long term basis.

**Public policies concerning fire**

India's National Forest Policy (1988) presents a visionary strategy for forest conservation and management and emphasizes protection of forests against encroachment, fire, and grazing. It states that "The incidence of forest fires in the country is high. Standing trees and fodder are destroyed on a large scale and natural regeneration annihilated by such fires. Special precautions should be taken during the fire season. Improved and modern management practices should be adopted to deal with forest fire". This policy provides a positive step towards protection of forests from fire. The legal and policy framework exists in support of fire protection in the country.

**The needs of the fire management**

The incidence of forest fires in the country is on the increase and more area is burned each year. The major cause of this failure is the piecemeal approach to the problem. Both the national focus and the technical resources required for sustaining a systematic forest fire management programme are lacking in the country. Important forest fire management elements like strategic fire centres, coordination among Ministries, funding, human resource development, fire research, fire management, and extension programmes are missing.

Taking into consideration the serious nature of the problem, it is necessary to make some major improvements in the forest fire management strategy for the country. The Ministry of Environment and Forests, Government of India, has prepared a National Master Plan for Forest Fire Control. This plan proposes to introduce a well-coordinated and integrated fire-management programme that includes the following components:

- Prevention of human-caused fires through education and environmental modification. It will include silvicultural activities, engineering works, people participation, and education and enforcement. It is proposed that more emphasis be given to people participation through Joint Forest Fire Management for fire prevention.
- Prompt detection of fires through a well coordinated network of observation points, efficient ground patrolling, and communication networks. Remote sensing technology is to be given due importance in fire detection. For successful fire management and administration, a National Fire Danger Rating System (NFDRS) and Fire Forecasting System are to be developed in the country.
- Fast initial attack measures.

- Vigorous follow up action.
- Introducing a forest fuel modification system at strategic points.
- Firefighting resources.

Each of the above components plays an important role in the success of the entire system of fire management. Special emphasis is to be given to research, training, and development.

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# Community involvement in forest fire prevention and control: Lessons from Joint Forest Management (JFM)

## Introduction

Fire is a common feature in the Indian forests every year, causing incalculable damage to the forest wealth and ecosystem. High proportions of these fires are attributed to man-made reasons either deliberately or accidentally. Also the components of fires are very localised and the people who live in the locality know the local conditions best. Therefore, efforts to involve communities in fire prevention and control offer viable alternative to minimise the damage due to fire losses. This necessitates better understanding of the conditions under which community would participate in fire prevention and control.

The purpose of this article is to outline the lessons learnt from community-based approaches like Joint Forest Management (JFM) in fire prevention and control. It also argues that effective policy for fire management cannot rely on technological solutions only separate from the societal context. It suggests that fire management require a more balanced approach involving suitable technical practices that are simple, compatible as well as adaptable to local conditions and social arrangements and awareness campaigns.

## Forest fires in India

In India forest fires are significant and one of the increasing contributory factors in the degradation of existing forest resources (Saigal 1999). Its is estimated that proportion of forest areas, prone to forest fires annually ranges from 33% in some of the states to over 90% in other (MOEF 1987). Although the data on forest fire loss is very sketchy and fragmented according to one estimate the total reported loss from the states of the union is around Rs 35 crores (US $ 7.3 million) annually (Bahuguna 1999).

Majorities of forest fires in India are mad-made and main causes of fire being:

- Deforestation activities: conversion of forestland to agriculture, pasture development etc.
- Traditional slash and burn/shifting agriculture
- Grazing land management: Setting of fires in forests by villagers for getting fresh blade of grass, fodder etc.
- Collection and use of NWFPs: e.g. fires set for the purpose of collection of honey, Sal (*Shorea robusta*) seeds, flowers of Mahua (*Madhuca indica*) etc.
- Forest/human habitation interface: e.g. uncontrolled fire set to burn leaves and other biomass from agriculture fields and spreading to fringe forest areas, also fire set to scare the wildlife etc.
- Conflicts over the land right claims and last but not the least
- Fire caused by negligence

The situation is further exacerbated by other contributory factors such as

- Poverty, social conflicts, and lack of incentives for communities to participate in forest fires prevention and control
- Weakness in policies and legislation and their implementation: for instance the Section 79 (1) of Indian Forest Act, 1927 makes provision for any person who exercises rights in forests to assist authorities in prevention and control but the reality is that it seldom happens
- Absence of any well defined forest fire management policy and
- Institutional inability to learn from past experiences

Forest fires in the country are mostly experienced during summer months from April to June, though the extent and type varies from state to state, type of forest as well climatic conditions like prolonged spell of dry conditions or delay in arrival of monsoon etc.

## Involving local communities in fire prevention and control

Over the years, there has been a significant decline in the prioritisation of fire management in the forest management objectives. With various social sectors competing for funds, the funding for the fire prevention and control has also gone down or has been diverted to schemes like 'employment generation' or even the establishment expenses of the forest department. In fact at present most of the states do not have any regular schemes/funds for prevention and control of forest fires (Singh 1997). With meagre human resource at its disposal (e.g. as per one of the estimates on an average 500 ha of forests have to be patrolled by one forest guard), the forest departments in most of the states are poorly equipped to prevent or control the spread of forest

fires. This situation and the fact that forests are under tremendous pressure, due to increasing population pressure and hence commensurate demand of land, forest products etc necessitates exploration of alternatives to arrest this phenomenon. Attempts to elicit peoples' participation in fire control offers hope of minimising the damage caused by fires. In this context Joint Forest Management (JFM) assumes an important role in fire prevention and control. JFM has been a significant development in the context of institutional arrangements pertaining to forest management in India. The effective involvement of local communities in evolving sustainable forest management systems was looked upon as an important approach to address the long-standing problems of deforestation and land degradation in India.

The National Forest Policy (1988) and Joint Forest Management (JFM) Guidelines (1990) of the Government of India acknowledged and endorsed this system of management, which supports the involvement of village communities and non-governmental organisations (NGOs) in the regeneration, management and protection of degraded forests. The conducive environment created by these enabling legal and administrative measures is manifested in the fact that as many as 22 State Governments have issued directions to the respective State Forest Departments for adoption of JFM. At present about 36,130 forest protection committees are protecting about 10.25 million ha of forest area in the country (MOEF 1999). These committees operational in various states are assisting the forest department in forest protection (including fire prevention and control) and management, though the extent of participation and contribution to efforts varies.

A very definitive lesson and pre-requisite for community based approach to fire management, which emerges out of the JFM experience in forest protection, is that the for communities with stake in forests would be sufficiently motivated to prevent and control forest fires if their livelihood and subsistence needs are met. The JFM program is an example of a participatory approach in which people co-operate with forest department in forest protection in return for economic benefits.

**Figure 1.** Meeting of a Village Forest Committee (VFC) for fire prevention and control. Photo: C.Kumar

**Lessons learnt from JFM**

The JFM program in various states of the country has served to increase the stake of forest dependent communities in the surrounding forest areas. The lessons learnt from the experience of community involvement in fire prevention can be summarised as following:

***Participatory approach in fire prevention and control***

The community based fire management has to rely extremely on the positive relationship between the people in the rural space and their forest. Mutual confidence and public support has to be created by participatory

approaches e.g. incentives, income generation activities, involvement in production enterprises etc. for involvement of communities in fire prevention and control (Goldammer 2000).

The study of fire in the JFM and non-JFM areas clearly reveal that despite similar kind of dependence on the forest people's response to forest fire differed. This was discerned particularly in the response of JFM villages where people felt duty bound to put out the fire in the forest because they have a stake in it. Remarks like *'the forest now belongs to us and we feel obliged to protect it*' were common in JFM villages, whereas the non-JFM villages were non-enthusiastic about such voluntary efforts. Their efforts were mainly confined to check spread of forest fires to their agricultural fields.

***Creating awareness among the community of loss due forest fires***

People's view on the occurrence of forest fires is of vital importance in assessing the impact of community efforts at fire control. It is not surprising that socio-economic and cultural surveys on fire causes often reveal that most important reason for failure of prevention of forest fires is related to the fact that communities do not realise the economic and ecological losses due to forest fires. Therefore, an efficient motivation strategy for fire prevention requires an initial understanding of the cultural, socio-economic and psychological background of community perception of fire losses.

Within the village forest protection committees (VFCs) in JFM villages, interestingly it was observed that the assurance of economic incentives in the form of fuelwood, fodder or non timber forest produce etc. need not be the sole factor which motivated the communities to protect the forests from fire. What was more important was the level of community awareness of the potential losses that could result from forest fires. For instance basket making community in Haryana, whose livelihood is greatly dependent on availability of bamboo, have not only been active in preventing and controlling fire in their area, but also of the adjoining area to prevent its spread to their forests.

***Equity in benefit sharing***

This experience is related to aspect of causes of forest fires. It necessitates that the study of causes of fires should involve besides other causative factors, motives and behaviour of communities. Detailed information about the causes and through understanding of the motivation behind the forest fires provides the necessary background for prevention work. The job is then to reach and influence people to do or not to do something.

Equity in benefit sharing has been another factor, which was found to affect the community efforts to control forest fires. In the absence of an equitable distribution system of incentives, there were cases of the aggrieved group deliberately setting forest fires.

***Complexity of legal provisions and lack of enforcement***

Though the subject of law and its enforcement in relation to forest fires is a wide and complex subject and opinions may differ as to the part of it should play in prevention and control of forest fires in a democratic set-up. Generally speaking an adequate legal enactment accompanied by enforcement is an indispensable ingredient of forest fire prevention.

The experience of under reporting due to provision of lodging a First Incidence Report (FIR) with the local police by the Forest Guard on spotting a fire in his area and subsequent litigation reflects on the issue of re-consideration of reporting provisions. Also lack of voluntary participation despite provisions in the Indian Forest Act brings forth the issue of lack of enforcement mechanisms.

***Clarity of rights and responsibilities of the communities***

Clear specification of future benefits (in the form benefit sharing statement) that will accrue to the community at the time of the final harvest could bolster community efforts at fire protection.

It was found that some of the village forest committees (VFCs) besides putting out the fires in the forest areas where they have their rights also voluntarily put out fires in the Reserve Forest areas where they do not have any major rights. In the various meetings with these VFCs the issue of availing benefits from these forest also came up. Also apprehension of future benefits from timber sharing at the time of final harvest of forest crop protected by them was found to cause the decreased enthusiasm of village communities in fire protection and prevention.

***Techniques of fire prevention***

Formal training in fire prevention and control is invaluable for preparing a nucleus of people for leading fire prevention and control programs. This is because with untrained people the control of fire becomes difficult.

The usual method of fire fighting that is followed by using earth, by beating and by counter fighting. Usually all mild fires are extinguished by beating them out with broom made of cut branches and twigs. Counter firing is also adopted if the fire is so fierce that fire-fighting crew can not stand near the head to beat it out. However it is was observed that most of the villagers and even some forest staff were not adequately aware of employing these techniques.

**Conclusion**

The JFM experience across the states has clearly brought out that the community involvement can play an important role in minimising the damage caused by forest fires. The adage 'prevention is better than cure' is most apt to emphasise the role of village communities in fire prevention. However it needs to be emphasised that community participation in fire prevention is not an end in itself. Proper planning is imperative for fire prevention. This calls for the three general approaches to work in tandem i.e. Education, Engineering and Enforcement (Nair 1992). Motivation of community to participate in fire prevention and control should follow education to underscore its importance. An important strategy in fire prevention is to educate the villagers in the forest area and along its fringe regarding the care required to keep fires well under control if lit for legitimate purposes like for example, subjecting agricultural plots to a light burn as a pre-monsoon preparation. An education strategy must appreciate that a series of edicts will not work unless the villagers are convinced about the harmful effects of fire in context of their dependence on the forest resource. Also villagers believe most in what they see than what they hear. Taking groups of villagers to burnt areas and explaining the fire effects will be useful.

Hazard reduction or limiting the exposure of forests to fire risks constitutes mainly the engineering aspect (Brown and Davis 1973). This also included clearing along paths, early and control burning of vulnerable areas, fire lines etc.

Ensuring that the public abides by the rules and regulation set out for prevention of fires calls for effective enforcement of regulations.

Finally, while community participation is important, it needs to be further augmented with appropriate (a) pre-fire planning and fire prevention strategy like developing fire plans, fire maps, capacity building through training, pilot demonstration, (b) fire suppression mechanism, and (c) and if necessary post-fire rehabilitation and management.

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## Forest Fire and Biotic Interferences -A Great Threat to Nilgiri Biosphere

**Introduction**

India constitutes one of the mega biodiversity countries of the world, which is abundant with unique and diversified floral and faunal wealth. Western Ghats of peninsular India, a green lung between bay of Bengal and Arabian sea plays a vital role regarding biodiversity in southern India. The prevailing tropical climate coupled with physical and biotic factors have unitedly made an impact on resources of many ecosystems, which are highly complex and fragile in nature. The land ecosystem is facing mounting problems in the hands of man. Biotic pressure due to increasing populations periodically covers larger areas in the tropical forests of southern India destroying timber and other properties.

Nilgiri Biosphere Reserve (NBR) in western ghats is a major floristic region of southern India. Biotic influence in this area is very heavy. The natural vegetation of the higher elevation of the Nilgiri plateau comprises of patches of *sholas* (montane broad leaved evergreen forest) and grassland (scrub-savannah). The montane forests are generally confined to the sheltered sites such as valleys, hollows and depressions where moisture is higher. The grassland comprises of grasses, herbs and shrubs in varying proportions. Since population explosion, heavy biotic pressure existing continuous in these forests and grassland. Present paper deals with land use change and other human interference in these forests.

**Nilgiri Biosphere Reserve**

The NBR is most important floristic region embraces the sanctuary complex of Wayanad, Nagerhole, Bandipur and Mudumalai. It has a total area of 5520 $km^2$ with core area of 1240 $km^2$ and buffer zone of 4280 $km^2$. This area is lies in Western Ghats of peninsular India. It was declared the first biosphere reserve of India on 1 September 1986. It has a unique bio-geographic region with many endemic floral and faunal species covering three states i.e. Tamil Nadu, Kerala and Karanataka. Entire area is having countless micro flora, fauna and the germplasm bank of various rare, threatened and endemic species and are facing continuous pressure by one way or the other. The average annual rainfall of this reserve ranges from 500 to 7000 mm.

**Table 1.** Percentage of protected area, reserve forests and core area of the NBR in the three states

| State | Protected Area | | Reserve Forests | | Core Area | |
|---|---|---|---|---|---|---|
| | Sq. Km | % | Sq. Km | % | Sq. Km | % |
| Karnataka | 1513.56 | 64.48 | 462.70 | 14.49 | 701.80 | 56.58 |
| Kerala | 433.92 | 18.49 | 858.80 | 26.90 | 264.50 | 21.32 |
| Tamil Nadu | 399.56 | 17.03 | 1870.66 | 58.60 | 274.00 | 22.09 |

Belonging to the Indo-Malayan realm, its biodiversity ranges from tropical dry deciduous forests to tropical rain forests. The NBR has more area uner reserve forests (59%) than protected area in Tamil Nadu (Table1). Although these forests are being subjected to severe biotic pressures, it has good population of Elephant (*Elephas maximus*), Gaur (*Bos gaurus*), Sambhar (*Cervus univolor*), Nilgiri Langur, Nilgiri Tahr, Four Horned Antelope, Blackbuck, hyena (*Hyaena hyaena*), Tiger, Leopard and Wild Dogs. The main reason for large-scale biodiversity is due to the fact that it is having conducive climatic conditions. The average high annual rainfall and the variation in temperature also reflects in a vast range in different types of forests from dry deciduous to montane evergreen forests. However, the most distinct feature is the development of the tropical wet evergreen forests, more prominent along the windward side of the humid tropical belt of the southern region. These forests are characterized by multistoried structure with emergent species raising their crowns above the general canopy layer, and as a result imparting undulating look to the canopy surface. The tallest emergent trees may grow up to 60m with slender and clear boles and often buttressed at base. The light coloured bark in a number of tree species is less than 3 mm thick. The copious growth of feeder roots in the soil surface occupying the interface of the decaying litter layer and mineral matrix of the soil is yet another characteristic of these forests. The biodiversity spread over wide ranges of hills of Nilgiris, Neelambur and Siruvani hills from where numerous rivers rolls down to the below viz. Bhawani, Siruwani, Cauvery and Shailkudri etc.

A characteristic feature of this biosphere is the occurrence of shoals (montane forests) above 1500 m. They are found in patches in hollows and sheltered folds surrounded by rolling downs in the Anamalais, Nilgiri and Palni hills and the high ranges of Kerala and Karnataka. Montane evergreen forests have thick undergrowth; the trees are short boled and attain a low height of 15-20m. That the shoal forest community had wider distribution in the past has been established through pollen analytical investigations. The rich soil exposed after the clearance of forest, erodes rapidly under the prevalent climatic conditions and the operating biotic factors and the absence of suitable edaphic conditions prevent the regeneration of these forests. This non-regenerating, and fast receding shoal forest is a dying community; more appropriately called a ‘living fossil community’ (Vishnu-Mittre and Gupta

1968). Meher-Homji (1965) opines that two adverse factors, viz. frost during the cold season, and fire during the drier months, prevent the spread of the shoals.

**Cattle Pressure**

The loss of grasslands has another severe impact on the existing forests. Traditionally the Todas used the grasslands to graze their buffaloes and probably the first cattle in this area did the same. But with the increasing cattle number and decreasing grasslands the only place left where the cattle could be fed was the shoals and they were made full pressure on sholas. Moreover, the grasses dry out in the winter and is unpalatable, so this is another reason for the use of shoals by the cattle and especially in this period the sholas seem to be totally relied upon. People prefer to be surrounded with cultivated plants and farms along with more and more number of animals, which resulted heavy damages to sholas and grassland (Chitrapu 1986).

Over-grazing has been identified as a factor responsible for the degradation of the forests ad the resultant increase in the number of weeds. The spread of such weeds has taken away much of the fodder resources as such obnoxious weeds cannot be grazed upon. Measures to contain such factors, albeit minor, have been suggested by Gadgil (1984).

**Fire Hazards**

The greatest pressure on forest is by way of forest fire. The man for his own greed is putting fire every year in one or the other part of Nilgiri biosphere causing more than 1000 ha annually heavily intentional fire which is not only retarding the growth of existing standing vegetation but also not allowing new recruits to emerge out on the forest floor (Srivastava 1997). In the process of which many endemic species are disappearing from their native place. The exotics which were introduced long back such as wattle, *Eucalyptus*, *Eupatorium*, *Cestrum*, *Eulex* species in the Nilgiri plateau having strong germination percentage and invading very fast in fire burnt areas. The ill effects of this are too well known and too numerous to be enumerated. Spread of alien weeds can be destructive to native species. More importantly, species like *Lantana camara* var *aculeata* and recently *Eupatorium odaratum, Mikania cordata, Parthenium hysterophorus, Eulex europeaus, Cestrum nigrum. Cassia tora* etc have invaded the NBR and tend to smother the natural vegetation. The wattle, introduced long back, has now become a weed.

Intentional setting fire to the seasonally dry forests has disastrous effect so much so that such forests may not resume the original shape at all. In addition to slash-and-burn cultivation practiced almost throughout the NBR also causing ill effects to the vegetation.

Ascending growth of human and cattle population accelerate the forest fires which play a predominant role in the process of devastation of large areas. The local cattle grazers often set ablaze grazing areas in the hope of getting new shoots. The head loaders destroy vegetation to create pathway through the forests. The encroachers set fire to forest in order to clear the land for agricultural purpose. The careless tourists throwing away lighted matches and cigarette butts start fire, which not only reduce the trees and herbs to ashes but also damage of wildlife.

Forest fires and indiscriminate grazing are the most important factors that affect the natural regeneration in the forest and cause its degradation. These results further reveal that moist deciduous forest have more incidences of fire while dry deciduous and thorny forests are more subjected to grazing. After going through the records and observation made, it is found that major cause for the depletion and loss of bio-diversity in the Nilgiris is man made fire. The recurrent fire set by grazers during summer (in southern India the summer starts from January onwards), has dealt a severe blow to the floristic composition. Forest fires either natural or man-made play a significant role in ecosystem dynamics. In the Nilgiris up to an extent Todas have played the role to convert the sholas into grassland. On the other hand in the North Coimbatore plateau for instance where the forest is burnt regularly and the incidence of grazing for heavier than that of Toda grazing on the Nilgiris. Moreover, the average rainfall is considerably less, the forest has become undoubtedly degraded and open, but shows no signs of disappearing. Grassland occur at similar elevation on the Palnis and the Anamalais where no Todas live (Ranganathan 1941). Here it has to be reiterated that the grasslands are an integral part of the natural vegetation of the Nilgirs. Paleo-ecological studies of the vegetation show the presence of extensive grassland at least 20000 years ago (Sukumar 1993), showing that they are also a climatic climax of the area. Recurrent fire decreases the green cover through prevention of regeneration and leads to the slow death of the forest. It also increases erosion and alters the physical and chemical properties of the soil, converting organic ground cover to soluble ash and modifying the microclimate through the removal of overhead foliage. The soluble ash is washed away in the next rain. Fires can also make trees more susceptible to insect attack. Simultaneously much woody vegetation present in the grasslands disappears. The upper most layer of soil, which is in the process of formation of humus, gets very badly affected and microbial organisms that play a very vital role in the system get destroyed. Severe burns such as those caused by wildfire can result in nearly complete destruction of organic matter and bring about changes in the physical, chemical and biological properties of the upper layers of mineral soil.

Forest fires ceases their effects on climate change vigorously. In the past decade researcher have realized the important contribution of biomass burning and it is recognized as a significant global source of emission contributing as much as 40% of gross Carbon dioxide and 30% of tropospheric ozone (Andreae 1991). Heavy smoke during forest fires also damage the forest ecosystem. In a study in Garhwal Himalaya forested area under smoke plumes has been estimated as 130.96 $km^2$ or 2.96% of total forests area (Roy 2000).

**Changing Landscape**

The biodiversity of NBR started getting deteriorated from 1832 onwards with the impact of human population and entry of exotics. There was maximum 92.3 % decrease in area under shola forest was recorded in the catchment area of Ooty from 1949 to 1992 and during the same period maximum 100 % decrease in the area under grassland was recorded in catchment areas Deva shola, Parson`s Valley and Ooty, respectively (Table 2). Not only the original habitat has sunk but also faces continuous pressure in one way or the other with the increase in population, which started with a few in 1840 to the tune of lakhs at present. Most of the human population visits this habitat for their basic needs and survival. Some of them visit this area primarily for fuel wood collection, some of them for grazing livestock and few for collecting Minor Forest Produce. The fuel wood is mostly collected from the hill slopes.

It is also worth mentioning that there is an overlap in the habitat use by man and wildlife. Elephant, Spotted deer and Sambar prefer many of the plant species, which are collected by the villagers as fuel wood. Similarly human interference has caused poor density in respect of *Emblica officinalis* in the process of collection of *Emblica* fruits. Continuous lopping of trees results in loss of population of *Emblica*. Indirectly it deprives herbivores i.e. Spotted deer/Sambar of their food. Thus a very strong destructive factor which has vital role in degrading forest in these ghats is man, who has been continuously interfering with natural vegetation, clearing and burning it, grazing his innumerable cattle removing forest produce at will, killing wildlife and carrying on shifting cultivation and raising various plantations. These activities have resulted in serious erosion, drying up of rivers and recurring droughts and fragmenting forested areas. Head loaders, cattle grazers, MFP collector's etc, in general people are unaware of the bio-diversity concept sensing the shortage of fuel wood, the foresight of the forester had led to planting of Eucalyptus and Wattle in order to protect these living fossil forests. But increasing demand from the public and industries did not spare the shoals by late $20^{th}$ century. Cattle population has also increased manifold in the upper hills, trampling the indigenous flora and disturbing the eco system. Apart from this poaching of endangered species has also led to shrinkage of wildlife. Hundred years back the anthropogenic pressure was not much on the Nilgiri hills and the forest green cover was much more compared to what it is now. Ultimately the original landscape of both these beautiful hills has changed.

The Nilgiri plateau has undergone vast changes through the past century. The scene in the past was strikingly different from what it is today. Ouchterlony's map served as an important document to show us the scenario of a century and a half ago and also proved useful for a comparative study of the land use patters. (Saravana 1993). There has been a noticeable decrease in the natural vegetation cover over this period. It refers to both the shoals and the grasslands because most people prefer to call the shoals as forested lands while they consider the grasslands as wastelands. The shoals have reduced by half (from almost 8600 ha to about 4225 ha), the grasslands have come down by factor of six (from 29875 ha in 1849 to about 4700 ha) (Table 3). With increase in population and influx of settlers especially when the various hydel projects were under construction, there was an increased need for more land, housing and cultivation purposes. Also the Nilgiris had a climate well suited for tea cultivation. In a long span of time of 143 years almost 26000 ha of grasslands have been replaced by cultivation (12,400 ha), tea (11,500 ha), wattle (9775 ha) and Eucalyptus plantations (5150 ha).

**Table 2.** Past and present area of the shoals and grasslands in different catchments (Kumar 1993)

| Catchment | Area under shoal in ha | | | Area under grassland in ha | | |
|---|---|---|---|---|---|---|
| | 1849 | 1992 | Decrease % | 1849 | 1992 | Decrease % |
| Emarald | 550 | 450 | 13.9 | 2025 | 375 | 80.3 |
| Avalanche | 300 | 850 | - | 1450 | 625 | - |
| Upper Bhavani | - | 275 | - | - | 1300 | - |
| Sillahalla | 725 | 150 | 78.3 | 3075 | 25 | - |
| Kundah | 725 | 625 | 16.5 | 1200 | 150 | 87.9 |
| Deva shola | 900 | 125 | 0 | 3800 | 0 | 100 |
| Kothibenu | 775 | 150 | 100 | 2425 | 75 | 92.7 |
| Keti-Kateri | 100 | 0 | 69.9 | 1450 | 100 | 95.3 |
| Porthimund | 200 | 175 | 16.6 | 625 | 300 | 53.8 |
| Mukurthi | 1050 | 125 | 87.8 | 1250 | 600 | 57.5 |
| Pykara | 1000 | 350 | 60.9 | 3550 | 125 | 96.1 |
| Kamarajasagar | 375 | 100 | 72.9 | 2800 | 75 | 97.3 |
| Parson's Valley | 375 | 170 | 53.5 | 950 | 0 | 100 |
| Ooty | 325 | 25 | 92.3 | 675 | 0 | 100 |
| Naduvattam | 750 | 125 | 81.4 | 1175 | 375 | 64.4 |
| Pykara River | 300 | 75 | 77.4 | 900 | 100 | 89.9 |
| Glenmorgan | - | - | - | - | - | - |
| Sholur Kokul | 200 | 150 | 24.8 | 775 | 50 | 94 |
| Sandynala | 750 | 125 | 83.4 | 2950 | 550 | 81 |
| Anikorai | 400 | 50 | 87.5 | 1925 | 25 | 98.8 |

**Table 3.** Changing landscape pattern of Nilgiri Biosphere Reserve (Kumar 1993)

| Total Area | Ouchterlony's Map (1849) | Current Map (1992) |
|---|---|---|
| Sholas | 8,600 ha | 4,225 ha |
| Grasslands | 29,875 ha | 4,700 ha |
| Cultivation | 10,875 ha | 12,400 ha |
| Tea | 0 ha | 11,475 ha |
| Wattle | 0 ha | 9,775 ha |
| Eucalyptus | 0 ha | 5,150 ha |

These figures are only for those area covered on the map while there is some additional area left on the eastern edge. The only region that seems to have been spared is a few pockets within the Mukurthi National Park. This too was not really left alone but plateau with wattle, which failed to survive and the grasslands seem to be coming up again.

**Conclusions**

The Nilgiri biosphere, which is having countless micro flora, fauna and the germplasm bank of various rare, threatened and endemic species are facing continuous pressure by one way or the other. The greatest pressure on forest is by way of forest fire. The man for his own greed is putting fire every year in one or the other part of Nilgiri biosphere causing more than 1000 ha annually under fire which is not only retarding the growth of existing standing vegetation but also not allowing new recruits to emerge out on the forest floor. In the process of which many endemic species are disappearing from their native place and giving mosaic pattern to the landscape. If the process is not being checked many of the endemic flora and fauna will disappear from the biosphere reserve even before its documentation is completed. The exotic which were introduced long back such as *Acacia meansii,, Eucalyptus* spp, *Eupatorium grandilosum, Cestrum nigrum, Eulex europiaus* etc. in the Nilgiri plateau if not checked will slowly take over the place of native. Monoculture plantation of tea, coffee and other forestry species have already change the landscape. It is the right time for the foresters, naturalists and environmentalists to concentrate and solve this problem by way of utilizing some of these exotics as a fire wood for the neighbouring rural masses and regular women head loaders. It also reminds us to protect the beautiful creature from the indiscriminate destruction. Forest fire is one of the major detrimental factors in depletion of biodiversity of Nilgiri

biosphere. If not checked at this juncture it will not only lead to reduction in forest covers but also pave way to unfriendly species to ecosystem by wiping out the sensitive endemic species forever. The people along the reserve forests are not very clear about the biodiversity conservation concept. The role of each organism in an Eco system is largely unnoticed. At this juncture the awareness alone can bring down the incidences of destruction. It is the foremost duty of every human being to come forward for repairing the loss already done to our nature treasure.

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# INDONESIA

## Fire Situation in Indonesia

### The situation between 1982 and 1997

#### *Preface*

The wildland fire and smoke-haze episodes in Indonesia during the 1980s and 1990s have been largely influenced by the occurrence of droughts triggered by the El Niño-Southern Oscillation (ENSO) (Figure 1.) and the associated increase in wildland fire danger (Figure 2).

#### *The fires of 1982-1983*

The first documented large fire and smoke episode in the second half of the twentieth century in Indonesia occurred during the ENSO event of 1982-1983. The fire scene in the Indonesian and Malaysian provinces of Borneo was set by extreme drought and by extensive slash-and-burn land-clearing activity that resulted in a large number of escaped fires. In East Kalimantan alone, ca. 3.5 million ha were affected by drought and fire. Of the total area, 0.8 million ha was primary rain forest, 1.4 million ha logged-over forest, 0.75 million ha secondary forest (mainly in the vicinity of settlement areas), and 0.55 million ha peat swamp biome (Lennertz and Panzer 1984). It has been assumed that the overall land area of Borneo affected by fires exceeded 5 million ha (Goldammer and Seibert 1990).

One of the first aerial and ground surveys of the fire damage was carried out in a burned area in Kutai National Park, to the west of heavily logged and farmed areas (Leighton 1984). It was found that fire damage was higher in secondary forest than in primary forest, although the degree of damage varied greatly. The fires had twice swept through the ITO timber concession southwest of Kutai National Park, the first causing defoliation of many trees and lianas; the second completely burning this accumulated litter. No surviving trees were observed in areas that had burned twice.

In his 1983 ground survey of the northern part of the National Park, Leighton (1984) found that the primary forest had been badly damaged. He was unable to report any unburned primary forest on hills, ridges, or slopes that could have served as a control plot to distinguish damage by drought or fire. Narrow belts (width 5 to 20 m) of unburned primary forest flanking streams were also observed, but these accounted for only 5-10 percent of the total area. In the burned areas, 99 percent of the trees below 4 cm DBH had died, although about 10 percent were resprouting. Mortality was 50 percent for trees 20-25 cm DBH and 20-35 percent for trees larger than 25 cm DBH.

A series of studies on regeneration of the fire-affected rain forest were conducted in the mid-1980's and reviewed by Goldammer and Seibert (1990). Another review is currently prepared by Dennis et al. (2001). In 1988-1989, a comprehensive research project was carried out on the cause and effects of forest fires of the 1982-1983 fire season in East Kalimantan. Goldammer et al. (1996) provided a summary of the findings. The study area was the Mahakam basin, which was most seriously affected by drought and forest fires. The research area, mapped by satellite remote sensing and aerial videotaping, has a total size of 4.7 million ha and stretches from the east coast of Borneo to the mountainous areas in the centre and the north. A line from Balikpapan to Long Iram forms the southern boundary.

Within the study area the actual area affected by fire was ca. 3.2 million ha, of which 2.7 million ha were tropical rainforests. Forests on sites with low water retention capacity were most seriously affected by fire, especially peat swamp forests, heath forests (*kerangas*), forests on limestone hills and rocks and all other forests on shallow soils. Logged-over forests were also particularly affected by fire, especially those growing on drought-sensitive sites. There is a close correlation between the year of logging and fire intensity. Those forests that had been logged shortly before the fire event were very seriously damaged. Finally, the fire particularly affected forests in the vicinity of settlements and along rivers and roads.

#### *Wildfires and land use fires after 1982-1983*

During and after the ENSO and fire episodes of 1987, 1991, 1994 and 1997, only limited research has been accomplished on the extent and damage caused by fire and atmospheric pollution. In 1996 the Environmental Impact Management Agency (BAPEDAL) released fire statistics for the period 1984-1994 that were published in International Forest Fire News (Makarim and Deddy 1997). They revealed that in most years wildfires affect between 15 000 and 25 000 ha. Extreme years were 1991 (199 000 ha) and 1994 (406 000 ha). The figures on fire occurrence released by the Indonesian Ministry of Forestry for 1994 included burning activities other than

wildfires for the first time. According to the Ministry a total land area of ca. 5.1 million ha was affected by fire in 1994in the categories listed in Table 1.

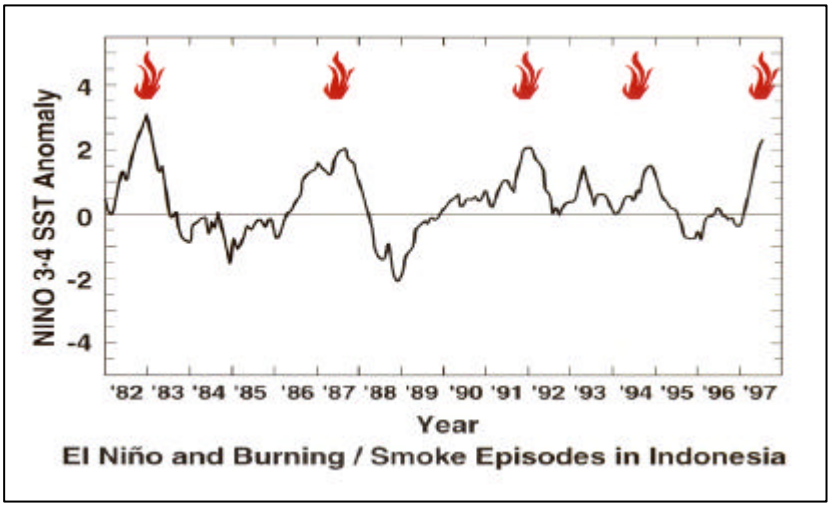


**Figure 1.** Sea-surface temperature (SST) anomalies in the NINO 3-4 region coincide with the occurrence of ENSO events and droughts associated with increased burning activities in Southeast Asia. Source: Global Fire Monitoring Center (GFMC).

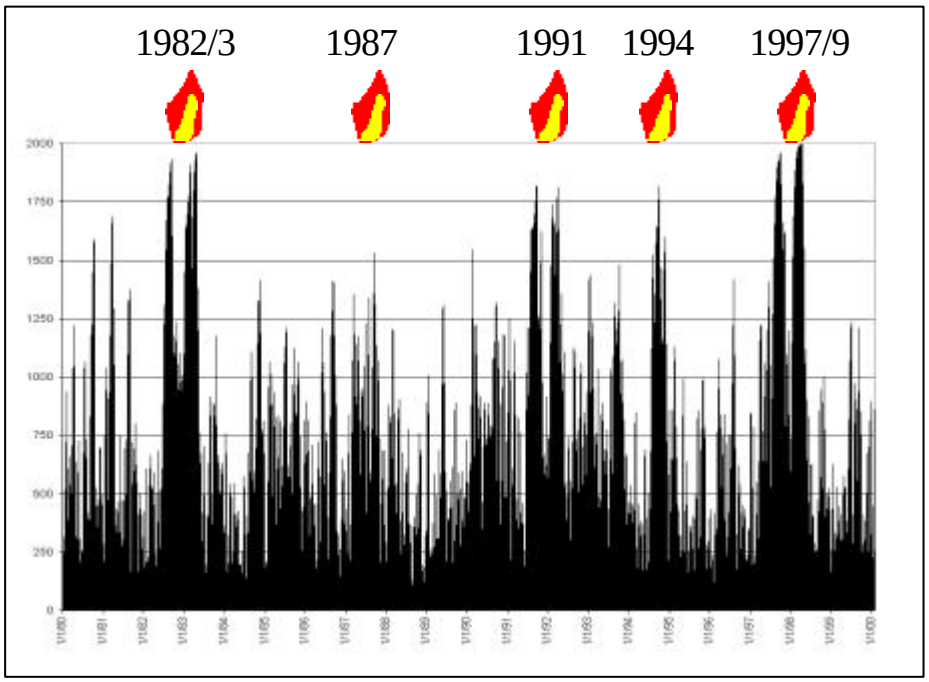


**Figure 2.** The Keetch/Byram Dryness Index (KBDI) for East Kalimantan, 1980-2000. The KBDI is a metric fire danger index based on rainfall and temperature data and expresses the moisture deficiency according to the maximum possible moisture content of the soil. It indicates the dryness condition of the vegetation and therefore the level of fire danger. The Indonesian-German Integrated Forest Fire Management project (IFFM) has been working with this Fire Danger Rating system in East-Kalimantan since 1995 and has established a historical analysis dating back to 1979. Source: Fire Information System of the Integrated Forest Fire Management (IFFM) project, Samarinda, East Kalimantan, Indonesia (IFFM 2000).

**Table 1**. Categories of fires and area affected in Indonesia in 1994.

| Categories of fire use and wildfires | Area affected (ha) |
|---|---|
| Traditional dryland farming | 2.800.000 |
| Shifting cultivation | 1.500.000 |
| Transmigrant farming | 260.000 |
| Plantations | 221.000 |
| Transmigrant settlements | 39500 |
| Reforestation areas | 20.500 |
| Timber estates | 17.000 |
| Natural forests | 8.000 |

***National Indonesian fire management and related projects before 1997***

As a consequence of the smog episode of 1991 in Southeast Asia, which was mainly caused by fires burning on the Indonesian archipelago, the Government of Indonesia called for international cooperation to support national fire management capability. In June 1992 an international conference on "Long-Term Integrated Forest Fire Management" was held in Bandung. Participants included national agencies involved in fire management and the international community, represented by national and international development organizations and potential donors. The objective of the conference was to develop the framework for a concerted international action plan on "Long-Term Integrated Forest Fire Management" for Indonesia. In this programme all partners involved share expertise and fire management resources (BAPPENAS 1992).

The implementation of the "Bandung Strategy" is underway. In 1994 a bilateral Indonesian-German project "Integrated Forest Fire Management" (IFFM) became operational. The project will build up fire management capability in the Province of East Kalimantan (project duration: 1994-2002). The IFFM system includes community-based fire management approaches. IFFM aims to serve as a model for other Indonesian provinces.

After 1994 several additional foreign assisted projects were established:

- Fire management projects supported by the Japan International Cooperation Agency (JICA) in Sumatera (Jambi) and West Kalimantan;
- The European Union "Forest Fire Prevention and Control Project" (FFPCP) in Sumatera (Palembang);
- The UK Overseas Development Administration (ODA) "Tropical Forest Management Project" with a fire management support component in Central Kalimantan;
- The Food and Agricultural Organization of the United Nations (FAO) at the national level (Ministry of Forestry; since terminated); and
- The fire management training courses conducted by the United States Department of Agriculture (USDA) and USAID (inter-project).

In 1995, legal provision was made to establish a "National Coordination Team on Forest and Land and Fire Management" under the Ministry for Environment (executed by BAPEDAL) for coordinating fire and atmosphere pollution management measures at the national level in case of a large fire and smog disaster. This coordination body was also active in 1996 in public awareness campaigns (Makarim and Deddy 1997). Also in 1995, the Ministry of Forestry was designated to establish national and provincial fire coordination committees.

The International Tropical Timber Organization (ITTO) and the Common Fund for Commodities (CFC) sponsored the development of "National Guidelines on Protection of Forests Against Fire". The guidelines were finalized in 1999 (ITTO 1999). This project followed the framework provided by the international "ITTO Guidelines on Fire Management in Tropical Forests" (ITTO 1997).

All the ambitious projects initiated in the first half of the 1990's had only a limited impact on the overall fire and smog situation during the 1997-1998 episode. In the province of East Kalimantan the institutional approach of the GTZ-assisted IFFM Project obviously had a strong impact on the provincial government in the first phase of the 1997-1998 ENSO event. The integration of IFFM into the structures of the Ministry of Forestry (Kanwil) and the Provincial Forest Service (Dinas) provided direct access to the governor and the provincial Pusdal Committee through which all agencies concerned with fire and smoke issues make joint decisions.

The operational use of the Early Warning System (Fire Danger Rating System) was proven to give a realistic and meaningful assessment of the build-up of fire danger during 1997-1998. The provincial governments were alerted

in early August and immediately took the necessary steps to reduce burning by concessionaires and villagers. It was very important that the foreign-assisted project had begun to create line organisation structures in the Provincial Forest Service, Dinas (top-down development of lines of responsibility and command). On the other hand, the IFFM project – like the EU- and JICA-assisted projects in Sumatra – has a distinct grassroots-level (community-based, participatory) approach by involving the villagers in the fire prevention program. Furthermore, IFFM assists the fire users by providing extension service. In 1998, however, East Kalimantan was extremely affected by the illegal use of fire and escalating wildfires (see part II).

The government of Indonesia took the first measures in 1995 to discourage the use of fire in land clearing activities by issuing a decree to the forest plantation industry *(Hutan Tanaman Industri* - HTI) that banned the use of fire in converting forests. In December 1997 the government imposed another ban on the use of fire in forest conversion and slash-and-burn agriculture. However, this fire ban was not enforced and was largely ignored by both smallholders and large forestry enterprises.

The search for alternatives to burning for forest conversion and traditional slash-and-burn agriculture must receive high priority. Until 1997 only a few cases are known in which HTI enterprises used conversion methods not involving fire. Pt. Adindo Hutani developed an interesting alternative system for its conversion program in East Kalimantan (Tarakan). This non-fire conversion procedure involves a three-step mechanical treatment of non-commercial wood/plant biomass, the extraction of commercial timber and mechanical site preparation. Research projects are underway within the international program "Alternatives to Slash-and-Burn" supported by the Center for International Forestry Research (CIFOR). Little research and development has been devoted to the utilization of woody biomass for chip or briquette production and to the exploration of potential markets.

***Projects initiated during and after the fire/smoke episode of 1997***

In response to the fires of 1997-1998, a large number of bi- and multilaterally-supported projects were initiated and implemented in Indonesia. Detailed information is available at the Global Fire Monitoring Center (GFMC 2000) and in a survey prepared by CIFOR (Dennis 1998). Major new activities include the *East Asia and Pacific Environmental Initiative* (EAPEI), supported by the U.S. Agency for International Development (USAID 2000), and a project supported by IUCN-WWF, *FireFight South East Asia* (IUCN 2000).

In November 1997, the Government of Indonesia convened an "International Conference on Science and Technology for the Assessment of Global Environmental Change and its Impacts on the Indonesian Maritime Continent" in Jakarta. The conference resulted in recommendations for a national action plan in research and technology development, increasing international research cooperation and the establishment of a multinational research centre to serve the countries within the region in the areas of climate prediction, crop estimation and disaster mitigation. This centre is still in the process of being established as the "Indonesian Research Institute for Climate, Environment and Society" (INRICES) under the founding initiative of the Indonesian Ministry for Research and Technology (BPPT).

Following discussions with senior government officials in Jakarta and Manila regarding the fire and smoke situation in Indonesia, assistance was requested from the Asian Development Bank (ADB). An Advisory Technical Assistance, "Planning for Fire Prevention and Drought Management and Mitigation of their Impacts", was prepared by the ADB. Under the coordination of BAPPENAS (the executing agency) the program was to be implemented through the Environmental Impact Management Agency (BAPEDAL) in 1998.

The initiative of the Consultative Group on Indonesian Forestry (CGIF), under the GTZ-supported program "Strengthening the Management Capabilities of the Indonesian Ministry of Forestry", restored the lost momentum of cooperation between the national agencies and foreign-assisted projects in fire management.

**The fire episode of 1997-98**

In 1997-1998 Indonesia experienced a fire episode that exceeded the size and impact of the 1982-1983 fires (Goldammer et al. 1999; Hoffmann et al. 1999a; Siegert and Hoffmann 2000). A prolonged and severe fire season occurred during the ENSO of 1997-1998. Six months of drought occurred in 1997. Following a short period of rainfall in December 1997, the drought continued through May 1998. During the 1997 ENSO event large fires occurred in Sumatra, West and Central Kalimantan and Irian Jaya/Papua. In 1998 the greatest fire activity occurred in East Kalimantan. These widespread fires resulted in dense haze across Southeast Asia, causing respiratory health problems as well as transportation delays and accidents on land, air and sea. Economic costs were estimated at over US$9.3 billion (ADB 1999) and the smoke-haze resulting from the fires led to disagreements with neighbouring countries (i.e. Malaysia, Brunei, and Singapore).

All the fires of 1997-1998 were human-caused. The majority of the fires were due to land speculation and large-scale forest conversion as a result of inadequate and unenforced land use policies. In addition, fires in

settlement/transmigration areas were caused by land use conflicts, carelessness or hunting. However, the lack of inter-agency coordination to respond and suppress the fires played an important role in the severity and extent of the fire situation. Although strong winds and prolonged drought contributed to the rapid spread of wildfires, Indonesia's inadequate initial attack and large-fire suppression capacities were not sufficient to deal with the situation. These conditions continue to exist. The Indonesian province of East Kalimantan was the area most severely affected by the fires. Burned area is estimated at 5.2 million ha for 1997-1998, about 25 percent of the entire province (Hoffmann et al. 1999b). As a result of the 1997-1998 fires, East Kalimantan's forests are now more susceptible to fire during normal dry seasons due to the degraded forest condition and the accumulation and alteration of native fuel complexes.

In 1999, fires occurred in Sumatra, West Kalimantan and Central Kalimantan. In Kalimantan over 400 fire events were detected in a single day in August using NOAA-AVHRR imagery. Although the 1999 fires did not reach the extent of those in 1997-1998, the risk of severe fires remains if another ENSO event occurs as predicted in 2001-2002.

***Fire damage assessment:***

Several approaches using optical and microwave sensors were undertaken to determine the extent of the 1997-1998 forest fires in Indonesia. Studies by several agencies, projects, organizations and institutes, both in Indonesia and overseas, were based on the visual interpretation of multi-temporal SPOT quicklook mosaics, the evaluation of NOAA (National Oceanic and Atmospheric Administration) AVHRR (Advanced Very High Resolution Radiometer) imagery and the combined use of ERS-2 SAR (European Radar Satellite-2-Synthetic Aperture Radar) coherence data and ATSR (Along Tracking Scanning Radiometer) data. Liew et al. (1998), using SPOT quicklook mosaics, estimated the total burn scars in Sumatra at 1.5 million ha and 3.06 million ha in Kalimantan for the period January-December 1997. Fuller and Fulk (1998) estimated 2.3 million ha by using NOAA-AVHRR data within the IFFM GTZ NOAA\AVHRR processing window, which did not completely cover Sabah and West Kalimantan.

Through the combined use of ERS-SAR and ATSR, Antikidis et al. (1998) produced a first estimation of the forest area burned in Central Kalimatan in 1997. Out of an area of 21.76 million ha analysed, 588 000 ha of forest was classified as burned at that time. This number was later corrected to 1.8 million ha (Antikidis et al., pers. comm.). For the province of East Kalimantan, Hoffmann et al. (1999), using ERS-2 SAR and NOAA-AVHRR data, estimated that in 1997-1998 some 5.2 million ha, about 25 percent of the entire province, was affected by fire. A number of assessments and estimates by several Indonesian agencies and international organizations, based either on satellite assessments, aerial surveillance or ground assessments were compiled by the Asian Development Bank Project (ADB 1999) into a general estimate of 9.7 million ha, as shown in Table 2.

**Table 2.** Estimated extent of fire-affected forests and other lands in Indonesia, 1997-1998. Source: BAPPENAS (1999).

| Land use/ land cover / Island | Lowland Forest | Peat and Swamp Forest | Dry Scrub and grass | Timber Plantations | Agriculture | Estate Crops | Total (ha) |
|---|---|---|---|---|---|---|---|
| **Kalimantan** | 2 375 000 | 750 000 | 375 000 | 116 000 | 2 829 000 | 55 000 | 6 500 000 |
| **Sumatra** | 383 000 | 308 000 | 263 000 | 72 000 | 669 000 | 60 000 | 1 755 000 |
| **Java** | 25 000 | | 25 000 | | 50 000 | | 100 000 |
| **Sulawesi** | 200 000 | | | | 199 000 | 1 000 | 400 000 |
| **Irian Jaya** | 300 000 | 400 000 | 100 000 | | 97 000 | 3 000 | 900 000 |
| **Total (ha)** | **3 283 000** | **1 458 000** | **763 000** | **188 000** | **3 844 000** | **119 000** | **9 655 000** |

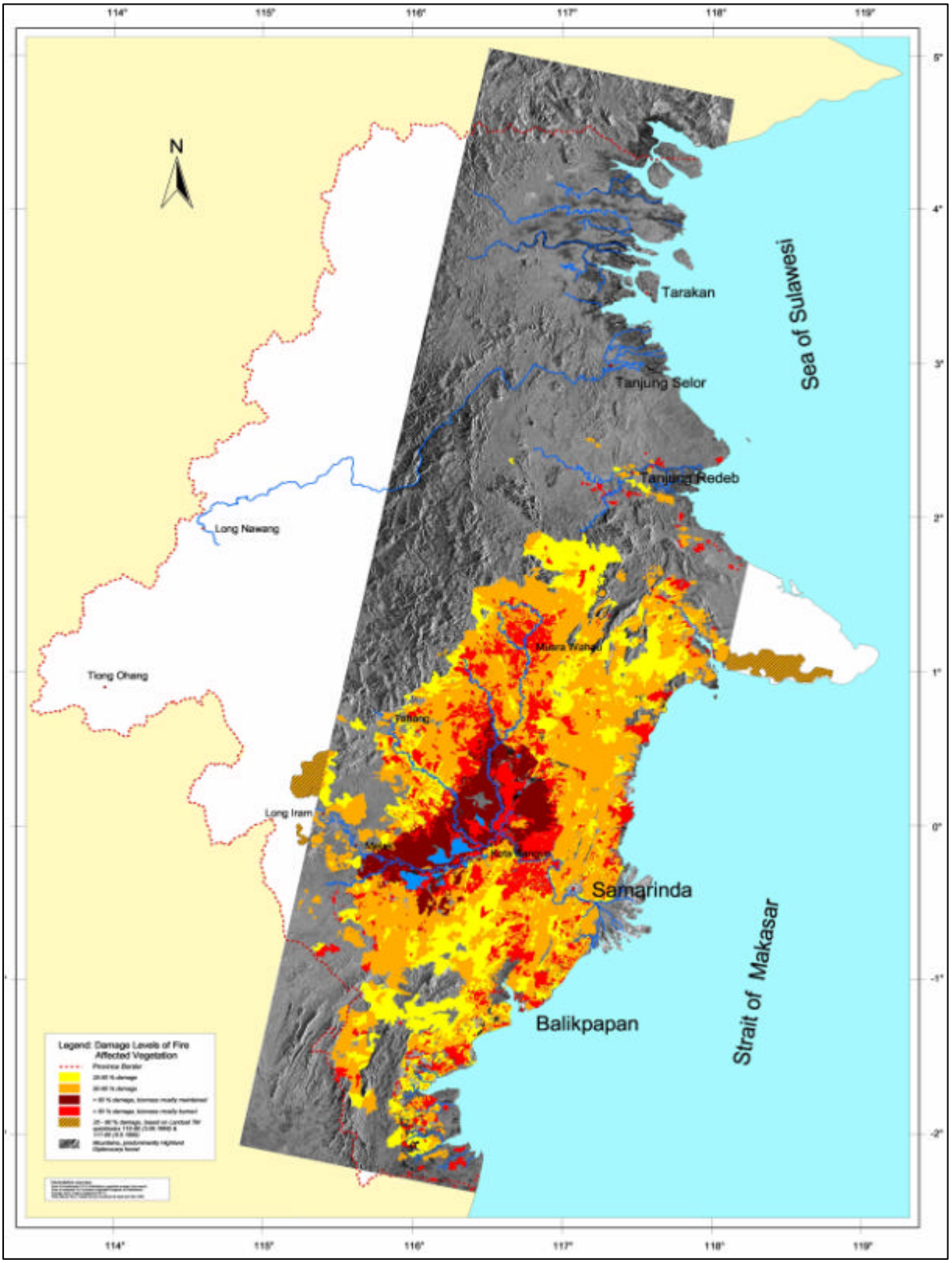


**Figure 3.** Fire damage classification of the 1997-1998 fires in East Kalimantan, Indonesia, based on ERS-SAR images. Source: Hoffmann et al. (2000).

***Fire management organization***

The economic and ecological loss due to the 1997-1998 wildfires exceeded several billion dollars (US) (ADB 1999). However, not all losses are accounted for, i.e. decreased biodiversity, increased soil erosion and the resulting loss of productive agriculture land. In the forest concessions of East Kalimantan, the estimated loss of 23 million cubic meters of harvestable timber due to the 1997-98 fires was estimated to be worth approximately two billion dollars (US) (Hinrichs 2000). This does not include reduction of biodiversity or loss of non-wood forest products, regeneration and small-diameter trees. Rehabilitation costs in the fire-affected concessions of East Kalimantan are estimated to be in the range of US$330-385 million.

The reasons for uncontrolled fires in Indonesia are manifold and complex. However, one factor is the lack of a functioning fire management organization. Considering the huge financial losses caused by past wildfires, a fire management organization is needed with the organizational capability to deal with the underlying technical, logistical, operational and social obstacles involved in managing human-caused fires.

At the national level, a new Directorate of Forest and Estate Fire Operations was established in early 2000 under the Directorate of Nature Protection and Conservation, Ministry of Forestry and Estate Crops (recently renamed the Ministry of Forestry). The new Directorate consists of four Sub Directorates (Figure 4) that are committed to dealing with the fire problem at a national planning level. However, past experience has shown that national planning efforts have little impact at the provincial and district levels. Although the root causes of wildfire problems in Indonesia are inadequate and conflicting land use planning policies and a lack of enforcement, a practical, "on-the-ground" approach is needed to deal with wildfires. Development of institutions and organizational structures at the provincial and district levels are needed to focus on environmental and fire prevention education in addition to fire suppression operations.

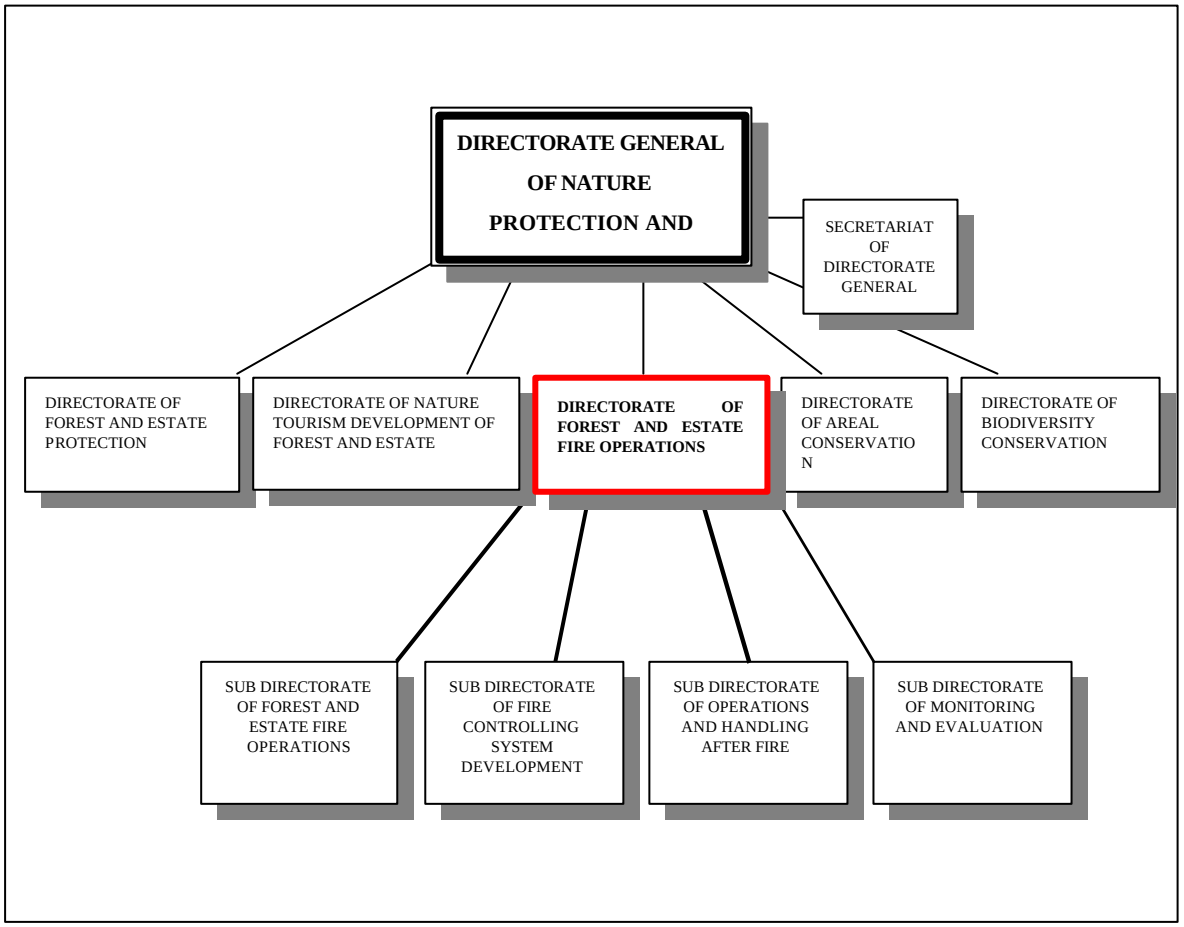


**Figure 4.** Organizational structure of the Directorate of Forest and Estate Fire Operations at national level

In the Province of East Kalimantan, no single organization is currently responsible for overall fire management, prevention or suppression activities. Instead, fire management responsibilities are distributed among several provincial agencies with no clear lines of communication, responsibility or coordination. Additionally, fire management responsibilities are also unclear at the district level. This has resulted in a confusing and dysfunctional situation, causing conflicts and inefficiency.

**The model of an integrated forest fire management system**

Since 1994, the Integrated Forest Fire Management (IFFM) project, a cooperative development project under bilateral agreement between Indonesia and Germany, is attempting to establish a fire management system for the Province of East Kalimantan (IFFM, 2000). IFFM is under the responsibility of the Ministry of Forestry (Directorate General of Forest Protection and Conservation, Sub-Directorate of Forest and Estate Fire Operation). The IFFM project is implemented by the two provincial forestry agencies, KANWIL and DINAS Kehutanan. The IFFM concept consists of three major modules that include fire prevention, fire operations and fire information.

To institutionalise the IFFM concept and its long-term application in a legal and sustainable framework, KANWIL, DINAS and IFFM are proposing an integrated fire management organization at both the provincial and district levels

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# Community Based Fire Management: The South Kalimantan Experience

**Summary**

The European Union funded 'South and Central Kalimantan Production Forest Project' (SCKPFP) is assisting the government of Indonesia to develop an integrated, sustainable management system for production forests, in areas operated by private companies. Of fundamental importance, is the role of the community in fire management, as is fire management a part of sustainable forest management.

Community-based fire management is the key to over-coming the recurring problems of forest fires in Indonesia. This paper contains recommendations on community fire management, based on a field-level, 'hands-on' approach to the problem, through working with local communities, private sector companies and government agencies of South Kalimantan.

Local communities must establish fire management systems at village, sub-district and district levels. Such management systems aim to reduce the frequency of uncontrolled fires, encompassing both prevention and control methods. Communities need to be strongly supported by private companies and government agencies. With co-operative agreements, it is essential that neighbouring partners co-operate and co-ordinate to protect their areas from fire.

A prime need is to bring together villagers, companies and government agencies at the local level to prepare the ground for joint development of fire protection initiatives. District level fire crews are the foundation of any future system and must be formed, trained and equipped. Fire prevention is preferable to later fire control, thus fire prevention and pre-suppression procedures are considered paramount. Crew safety and the necessity for protective clothing and first-aid must be stressed. Training is continuing in the choice and use of equipment to suppress vegetation fires, and in basic fighting tactics. Field experience has shown the necessity to keep equipment simple, compatible and adaptable.

In the longer term there is a need to support local institutions to organise fire management mechanisms including incident command structures at province, district and local levels. Modern methods to anticipate and manage risk, allocate resources, and deal with crises are needed if periodic smoke and haze events are to be avoided. Such an organisation will need continued and substantial donor support. For now, well-trained, simply-equipped, district level teams from community are an effective and realistic beginning.

**Introduction**

The main focus of the European Union funded 'South and Central Kalimantan Production Forest Project' (SCKPFP), working with the Ministry and Forestry, is to develop an integrated, sustainable management system for production forests in areas operated by private companies. SCKPFP is a 7-years technical assistance project organized in two phases of about 3,5 years each. The on-going activities are forest management, social and agriculture development, rehabilitation and reforestation of degenerated areas, remote sensing, GIS and mapping, industry and economics, environmental assessment. The fire management activities, started in April 2000, can be summarized as follows:

***Fire Management Planning***

Priority is given to the companies *Aya Yayang Indonesia* (South Kalimantan) and *Dwima Jaya Utama* (Central Kalimantan) but advices are also given to other logging concessions, plantation forests and risky areas of South and Central Kalimantan.

The concession holder is required to write and implement fire management plans for the land and to participate in general vegetation fire prevention and suppression programmes in neighbouring areas (e.g., access roads and firebreaks, water supplies and lookout towers, pre-attack planning and standard operating procedures). Holder companies must also establish a task force of forest firefighters that must be trained and equipped. Fire protection plans are integrated into the sustainable forest management models.

***Training in Prevention, Firefighting and Rescue***

At basic and manager level for the companies, governmental institutions, NGOs and local communities.

The fire crews are the foundation of any system to prevent and control fire. Without them, all the provided high technology is useless. Firefighting depends on well-trained crews kept in practice with regular theoretical and practical courses. Managerial staff need more advanced training in forest fire management, firefighting and

rescue. 'Tactical reasoning', strategic pyramidal organization and tactical chain of command are concepts which are developed. SCKPFP has prepared and distributed four pocket books in Bahasa Indonesia: *Pemadaman dengan peralatan manual, Pemadaman dengan pompa air, Pertolongan pertama pada kecelakaan* and *Perawatan pada korban luka bakar*.

***Research and Development***

Fire behaviour, fire prevention and suppression techniques, firefighting equipment, in collaboration with the Reforestation Technology Institute of Kalimantan.

Field experience has shown the necessity to keep firefighting equipment simple, compatible and adaptable. For their safety, the firefighters need proper protective gear. Standardization will avoid money being wasted on the purchase of equipment that is too complex or slow during use, that is incompatible with other equipment, and that is sometimes hazardous to firefighters.

Research and development activities contribute also to determine and define appropriate standards for fire management techniques (e.g., fire breaks, fuel breaks, wetting agents).

***Public Awareness and Community Based Fire Management***

Through the University of South Kalimantan, Faculty of Forestry (Sylva Borneo Research Group and Mapala Sylva students' NGO) in order to spread the knowledge to local communities.

It is recognized that fire prevention is preferable to later fire control and SCKPFP runs public awareness programmes. With the collaboration of the Faculty of Forestry, it is a major step forward if the concessions and plantations integrate key-communities into the protection management of the forests aiming at reducing the frequency of uncontrolled fires. All parties benefit if timber concessions encourage local communities to participate in fire management.

SCKPFP's fire management component works closely with the Reforestation Technology Institute of Kalimantan (Ministry of Forestry) that has a long experience of forest fires in South and Central Kalimantan provinces. For each of the activities, the role of the community is of fundamental importance.

**Support to be given to the community**

Local communities must establish fire management systems at village, sub-district and district levels. Such management systems aim to reduce the frequency of uncontrolled fires, encompassing both prevention and control methods.

South Kalimantan remains poorly prepared to deal with vegetation fires on the scale experienced during the drought of 1997 and 1998. A similar picture exists in the other provinces of Kalimantan and in Sumatra: few fire crews with poor command and communications structures, and insufficient firefighting equipment. Moreover, problems caused by the large size of Indonesia and the lack of access (few roads, and by rivers in the wetland) are not easy to overcome. Over the past decade numerous recommendations have been produced by donors organisations, NGOs and research centres. Forest fire-related projects funded by the European Union and the German and Japanese governments have already made valuable contributions to understanding fires and developing forest fire prevention and control in Indonesia.

The success of community involvement schemes depends on mutual trust, a commodity that has been singularly absent in the past and which will thus take time and patience to develop in the future. Figure 1 below shows that the prime need is to bring together villagers, companies and government agencies at the local level to prepare the ground for joint development of fire protection initiatives.

***Support from Companies***

Field experience in Indonesia shows that usually the only working model is of privates companies with valuable assists to protect, and permanent teams of well-trained, well-equipped, well-paid men to do the job. The concession holder is required by Indonesian regulations to write and implement fire management plans for the land and to participate in general vegetation fire prevention and suppression programmes in neighbouring areas. Companies must also establish a task force of forest firefighters that must be trained and equipped. With co-operative agreements, co-ordination with neighbouring concessions is needed. Most fires start outside concessions and enter as wildfires.

As noted earlier, it is essential that local communities be involved in that mechanism. Neighbouring concessions need to discuss:

- Communications to co-ordinate fire management operations

- Early warning and fire danger issues
- Plans to establish and safeguard fuelbreaks (patrolling) along the borders
- of the concessions
- Approaches to and co-operation with local communities
- Training and awareness campaigns
- Sharing of equipment and personnel in the case of fire


**Figure 1.** Example of co-operation with assistance from NGO and SCKPFP.

Co-ordination with the District Forestry Head Offices is also necessary. Districts are the keys to the formation of a competent institutional system of fire management within each Province. Fire management planners from the logging concessions and plantation forests need to establish strong links with the District forestry officers. At times of medium or high fire danger, companies put their fire management organization on red alert and coordinate fire prevention activities with the District forestry head office, the village fire crews and the neighbouring companies.

***Support from Government Agencies***

Officially in charge of forest and land fire protection, government institutions must support the communities. District level staff of the Ministry of Forestry have to form the backbone of an upgraded firefighting system although people from many other agencies must also be included. Volunteer firefighters from the communities have a part to play: not least because villagers have an extensive knowledge of fire as used in traditional land clearing. But all have to be commanded by official and well trained fire bosses.

By Decree No. 35/1995 dated 14 August 1995, the Regional Government of South Kalimantan established a provincial centre for forest fire suppression (*Pusat pengendalian kebakaran hutan dan lahan*). But the weakness of the existing radio communication network limits the efficiency of the Incident Command System that still needs to be improved.

In some Districts, the same year, operational teams have been officially constituted with civil servants from the Forestry and Soil Conservation Service *(Dinas Perhutanan dan Konservasi Tanah)*. At community level, some village heads decided to create a team of volunteer firefighters in order to protect forest land and farming fields from fire. But the villagers teams still need firefighting equipment, protective gears and appropriate training.

***Support from South and Central Kalimantan Production Forest Project***

Donor organisations like European Union do their best to give support to the Indonesian fire management organization that is still weak. SCKPFP gives support to the concession PT. Aya Yayang Indonesia in South Kalimantan for fire management plans and training in firefighting. Collaboration with PT. Dwimajaya in Central Kalimantan (second SCKPFP's pilot area) will start beginning of year 2001. In collaboration with the Reforestation Technology Institute of Kalimantan, SCKPFP gives also support to government agencies with training in firefighting at basic and manager levels. For each of the training sessions, some villagers are part of the trainees.

***Support from NGOs***

In order to develop specific training for communities at a large scale, SCKPFP and the Reforestation Technology Institute of Kalimantan have started a strong collaboration with two NGOs from the University of South Kalimantan. Based in the Faculty of Forestry, *Sylva Borneo Research Group* is a teachers' NGO and *Mapala Sylva* is the students' organization. In November 2000, more than 100 students and 10 teachers have been trained in forest fire prevention and control. Next step will be to spray the knowledge to communities in priority forestry sectors of South and Central Kalimantan before the next dry season.

**Field-level approach of the community**

***Communities' Experience with Fire***

The main asset of the communities is that they have a good knowledge of forest and land fires. Small farmers are already wise to the practical use and risks of fire. In areas of established farmlands, much of the tree-crops, usually rubber, damaged by wildfires in drought years is not a serious problem. Farmers recognise land that might pose a fire risk to established crops – areas of *Alang-alang*, *semak belukar* and various untended parcels of land within the mosaic of productive land. These are burnt over by the local adjacent land-users early in the dry season to preclude the development of wildfires later in the season when control would be more difficult.

***Land Clearance with Fire***

Zero-burning methods of land clearance are imposed to the companies. But for rural communities, fire is the favoured means of converting forest and land to agricultural use quickly and cheaply. Nevertheless, the use of fire for land clearance must be strictly controlled. High risk appears with illegal land clearance by fire that occurs more and more within the concessions. It is reported that illegal logging and illegal land clearance are often done at the same place and time. Indonesian authorities are inefficient to stop these actions, thus fire risk is high at the end of the dry season. In September 2000, around 1200 ha. of forest, beside the main access road, have been illegally destroyed and burnt to make farming lands within the concession PT Aya Yayang Indonesia (South Kalimantan). One month before, following a request from that company, the fire management section of SCKPFP and the Reforestation Technology Institute of Kalimantan advised the managerial staff from PT Aya Yayang Indonesia to control – since not possible to stop – the 'forecasted illegal burnings'. Names and permanent addresses of these people were registered. In the frame of a Controlled Burning Plan, they were asked to provide a burning schedule and to prepare firebreaks for each block of 2 to 5 ha. Finally, fire crews from the company have supervised these operations without difficulties owing to the early beginning of the rainy season.

**Responsibility and co-ordination**

Volunteer forest firefighters from villages might take the main active role in the Provincial Mobilisation Plan. Community fire crews are placed under the operational authority of District level responsibles from the Ministry of Forestry in charge of the Incident Command System (Fig.2). Co-ordination with the other partners present at field level is paramount.


**Figure 2.** From the Provincial Mobilisation Plan to the Local Fire Management.

The communities need to be identified and included in the fire protection mechanisms. The route to success is to compensate local communities to prevent fires, as well as paying them to form volunteers fire crews. Volunteer firefighters from community need a social protection system with accident insurance. This is an absolute necessity because fighting the fire is dangerous, thus the private companies might pay for that social security cover. As a further incentive to community involvement, properly trained and equipped village fire crews can be paid to patrol close to the village and to maintain the fuel breaks on the concession boundaries.

**Fire prevention**

It is however recognized that fire prevention is preferable to later fire control and SCKPFP runs extensive prevention programmes. For fire prevention and pre-suppression, subjects covered include the access roads, firebreaks and fuelbreaks, water supplies and lookout towers, pre-attack planning and fire management standard operating procedures (SOPs).

***Fuelbreaks***

A major aid to fire prevention is the engineering of fuelbreaks prior to the dry season. They are readily defensible zones around an area to be protected. The breaks will not in themselves stop a fire from entering a protection area but they do provide a site from which to more easily stop an advancing fire. Fuelbreaks can be planted with merchantable timber if the species are fast growing and form a dense canopy under which grasses and other flammable species are quickly shaded out. They require regular cleaning prior to and during the dry season.

***Access Roads***

A reasonable network of access roads exists within the forest, built to deserve villages or to allow commercial exploitation. Roads are absent within the coastal wetlands of Indonesia but access rivers are numerous and there is an extensive system of canals dug for failed drainage schemes. Logging concessions use also light railway systems with moveable tracks that lead into the areas being logged. Access roads, canals and railways are an important part of the fire prevention plan. Easy access is essential to allow patrolling, early detection and, to arrive as quickly as possible at a fire.

***Firebreaks***

Are a bulldozer-made discontinuity in a bed of fuel and are used to segregate, stop and control the spread of fire; or to provide a control line from which to suppress a fire. Firebreaks differ from fuelbreaks in that they have a complete lack of combustibles down to mineral soil. Firebreaks are best constructed in strategic locations while not under pressure during the wet season rather than as a hasty necessity as a fire approaches.

***Water Supplies***

Water has a high capacity to absorb heat and is therefore a very efficient agent to extinguish forest fires. Ready supplies from rivers, lakes or dams are needed to fill tanks, trucks and sources for pumps as well as for use in camp. Quantity and the accessibility are points to consider. The installation of man made sources and access are a part of fire management planning where natural sources of water are limited.

***Lookout Towers***

Lookout towers are a way of providing early warning of fire occurrence. They are permanently manned during times of high fire risk. Towers are useful in conservation forest and plantations where the area to be protected remains unchanged from year to year. They are less useful in logging concessions - the newly logged areas that most require protection change from year to year, often over considerable distances. Towers should be built on hill top sites to increase the area of view. But planners must bear in mind that lookouts are rendered pointless when smoke levels rise; new fires cannot be seen.

***Pre-Attack Planning:***

Pre-attack fire plans address a number of points:

- the location of fire lines, base camps, water sources
- transport availability, probable travel time to a fire for all types of attack units
- and, constraints to travel
- the need to construct additional fire lines, the probable rate of this construction
- and topographic constraints to construction.

In addition, forest type, fuel type, fuel amount and fuel arrangement are analysed to assess the fire risk faced by the concession. This first assessment is then modified according to:

- topography
- number of access roads
- access to natural and man-made water sources
- water availability during dry spells
- villages within or near the concession
- risky land clearance practices near the concession (e.g. timber, pulp or oil palm plantations)

The end result is a schedule of activities geared to the approach of the fire season and which covers routine staff preparation, fire prevention, equipment maintenance, etc.

**Fire Management Standard Operating Procedures:**
Fire management Standard Operating Procedures (SOPs) for prevention and suppression depend on the current and expected short-term fire danger rating, as well as on long-term predictions for El Niño occurrence and severity. The intent is that drought, a rising fire danger and weather forecast when taken together, trigger pre-planned fire prevention, pre-suppression, and/or suppression activities. The method tells managers exactly what they need to do given a particular set of weather and fire danger rating parameters. This takes the guesswork out of preparing for a period of high fire risk.

**Training of forest firefighters**

A shortage of competent fire staff at all levels severely limits fire prevention and control efforts throughout Indonesia. Priority is given to the teaching of the basics. These can be summarized as the training of (i) fire crews of 5 – 20 people organized as a unit, (ii) crew bosses – the men-in-charge of the fire crews, and (iii) the fire bosses those responsible for all suppression and service activities at a fire.

The current thinking and priorities on firefighter training are from countries with a long history of combating forest fires and tailors these to Indonesian conditions. The adaptations are based firmly on the long-term field-based experience in Kalimantan. They have been tested and shown to be appropriate.

The theoretical and practical training of firefighters is best carried out by local instructors (Tab.1). The first step is thus to train-the-trainers. The second is to spread the knowledge within to ensure the establishment of the modern, well-adapted organization that is urgently needed.

**Table 1.** Example of basic training programme used in South Kalimantan province.

| |
|---|
| **Days 1 and 2: Theory** |
| Fire Terminology and Legislation |
| Fire Behaviour, Weather and Topography |
| Fire Danger Index and Global Positioning System |
| Fire Prevention, Patrolling and Detection |
| Fire Suppression Techniques |
| Command, Communication and Discipline |
| First aid and Safety |
| Fire Reporting |
| |
| **Days 3 and 4: Practice** |
| Tool Use and Safety |
| Crew Organization |
| First Aid |
| Fireline Construction Techniques |
| Direct and Indirect Attack |
| Water use |
| Mop Up Techniques |

**Practice Fire**

The minimum theoretical knowledge and practical experience that is required to train the forest firefighters includes the terminology and theory of firefighting, the chain of command, the need to anticipate and the importance of communications. Practical components covered in the training course are intended to acquaint trainees with the essentials of fire behaviour and fire suppression techniques. Hands-on experience in the use of equipment under controlled conditions is seen as an essential pre-requisite before new recruits face a wildfire. Firefighting is dangerous and physically demanding. Safety is stressed and a module on first aid included.

**Firefighting equipment**

Field experience has shown the necessity to keep equipment simple, compatible and adaptable. Overly complex equipment is never used or is quickly broken. Equipment should not be distributed without training in its use. Firefighters need proper protective clothing to minimize personal risk.

Research and development activities by SCKPFP and the Reforestation Technology Institute of Kalimantan contribute to determine and define appropriate standards for fire prevention and firefighting equipment (e.g. individual protective equipment, effective hand tools, backpack pumps and collapsible tanks).

A secondary aim of equipment standardization is to help Indonesia to develop local fire equipment manufactures where none exist today. Backpack pumps and fire rakes were specially produced in South Kalimantan to a design by the Reforestation Technology Institute.

Table 2 below lists the contents of equipment sets for a 15 member village fire team. Fire managers should construct similar lists applicable to their own crew requirements.

**Table 2.** Example of an equipment set for a village fire crew (volunteer firefighters) of 15 men.

| Type of Equipment | Number |
|---|---|
| Fire rake | 3 |
| Fire shovel | 3 |
| Fire swatter | 3 |
| Machete | 15 |
| Chain saw | 1 |
| Backpack pump | 3 |
| 800 l collapsible tank | 1 |
| Protective clothing and water canteen | 15 |
| First aid kit | 2 |
| Handie-talkie radio | 1 |
| Crew transport truck (or boat) with mobile radio | 1 |

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# JAPAN

## Forest Fire Situation in Japan

### Introduction

Forests are deeply embedded in Japanese culture. This is not only represented by abundant traditional wooden buildings. Many tree reserves around temples and shrines indicate the high value of trees and forests. With 25 million ha of forests, corresponding to a forest cover rate of 67 percent, Japan is one of the most densely forested countries in the world (Japan FAO Association 1997).

The territory of Japan extends from 20° N to 46° N with climatic features ranging from subtropical to boreal conditions. The overall climatic conditions are characterized by high precipitation and a generally mild climate. During the winter, the continental high-pressure weather system is dominant, replaced in summer by the Pacific high-pressure system. The onset of monsoons in June-July and at the end of September coincide with this change of high-pressure areas. Annual rainfall is between 1 000 and 4 000 mm (Forestry Agency Japan 1990).

Stretching over 3 000 km, the archipelago of Japan consists of four major islands, Hokkaido, Honshu, Shikoku and Kyushu. Mountainous and hilly areas cover about 75 percent of the land area. Mountain slopes are generally very steep and dissected by short rivers of all sizes. Forestry is concentrated in mountainous regions with steep terrain, which makes forest firefighting countermeasures difficult and complex. Because of the scarcity of flat land, these areas are suitable for farming and settlement (Forestry Agency Japan 1990, Japan FAO Association 1997, Ota 1993; The National Land Afforestation Promotion Organization 1991).

The climax vegetation is forest, reflecting the warm monsoon climate with high precipitation. However, the species composition and the distribution of forest types differ from region to region because of marked climatic differences in Japan's long, narrow land area and also because of complex differences in topography, geology and soil. These forests are classified into four types or zones: (1) sub-frigid (including sub-alpine), (2) cool temperate, (3) warm temperate, and (4) subtropical (Japan FAO Association 1997).

The sub-frigid forest zone (also called sub-alpine forest where its occurrence is governed by height above sea level) is located in the mountains of central Honshu and in central Hokkaido. In northeastern Hokkaido it occurs even close to sea level. The dominant tree species are white fir (*Abies mariana*), yezo spruce (*Picea jezoensis*), Glehn's spruce (*Picea glehnii)* and, in Honshu, Veitch fir (*Abies veitchii*), northern Japanese hemlock (*Tsuga diversifolia),* and hondo spruce (*Picea jezoensis* var. *hondoensis).*

The cool temperate forest zone is characterized by the beech belt (*Fagus crenata*; in Japanese, *buna*). This type of forest occurs at elevations higher than 1 000 m above sea level in Kyushu, at 600 m around the Kanto district (greater Tokyo and Yokohama) and at sea level from the central part of Honshu north to western Hokkaido. Other tree species are Japanese lime tree (*Tilia japonica),* Japanese horse chestnut (*Aesculus turbinala),* katsura tree *(Cercidiphyllum japonicum),* and Japanese walnut (*Juglans ailanthifolia).*

The warm temperate forest zone itself is characterized by laurel *(Machilus thunbergii),* live oak (Quercus *phylliraeoides),* and camphor tree *(Cinnamomum camphora*).

In addition to these three main zones, a subtropical forest zone is found in Okinawa and in the southwestern part of Kyushu Island.

### The forest fire situation in Japan

Influenced by its climatic and topographic conditions, it is a widely accepted perception that natural disasters such as floods and landslides are common in Japan (Forestry Agency Japan 1994). Despite the humid climate, the annual number of forest fires often exceeds 4 000, affecting an average area of more than 4 000 ha in the 1980s and 2 300 ha in the 1990s (Tab.1 and 2).

**Table 1.** Number of fires and area burned in forests and other vegetation in Japan, 1980-1989.

| Year | Total No. of Fires on Forest, Other Wooded Land, & Other Land No. | Total Area Burned on Forest, Other Wooded Land, & Other Land ha | Area of Forest Burned ha | Area of Other Wooded Land and Other Land Burned ha | Human Causes* No. | Natural Causes No. | Unknown Causes No. |
|---|---|---|---|---|---|---|---|
| **1980** | 4 120 | 5 307 | | | 2 850 | | |
| **1981** | 3 709 | 1 969 | | | 2 471 | | |
| **1982** | 4 579 | 3 136 | | | 3 198 | | |
| **1983** | 3 918 | 7 666 | | | 2 624 | | |
| **1984** | 4 786 | 3 727 | | | 3 261 | | |
| **1985** | 4 155 | 4 924 | | | 2 743 | | |
| **1986** | 4 838 | 4 893 | | | 3 137 | | |
| **1987** | 4 120 | 4 890 | | | 2 702 | | |
| **1988** | 3 589 | 3 176 | | | 2 388 | | |
| **1989** | 2 894 | 2 117 | | | 2 894 | | |
| **Average** | **4 071** | **4 181** | | | **2 827** | | |

Source: Forestry Agency Japan (2000).

**Table 2.** Number of fires and area burned in forests and other vegetation in Japan, 1990-1999.

| Year | Total No. of Fires on Forest, Other Wooded Land, & Other Land No. | Total Area Burned on Forest, Other Wooded Land, & Other Land ha | Area of Forest Burned ha | Area of Other Wooded Land and Other Land Burned ha | Human Causes* No. | Natural Causes No. | Unknown Causes No. |
|---|---|---|---|---|---|---|---|
| **1990** | 2 858 | 1 333 | | | 1 990 | | |
| **1991** | 2 535 | 2 739 | | | 1 853 | | |
| **1992** | 2 262 | 2 323 | | | 1 652 | | |
| **1993** | 3 191 | 3 260 | | | 2 313 | | |
| **1994** | 4 534 | 2 776 | | | 3 150 | | |
| **1995** | 4 072 | 2 016 | | | 2 914 | | |
| **1996** | 4 339 | 2 420 | | | 3 038 | | |
| **1997** | 3 766 | 3 124 | | | 2 606 | | |
| **1998** | 1 913 | 808 | | | 1 346 | | |
| **1999** | | | | | - | | |
| **Average** | **3 274** | **2 311** | | | **2 318** | | |

Source: Forestry Agency Japan (2000).

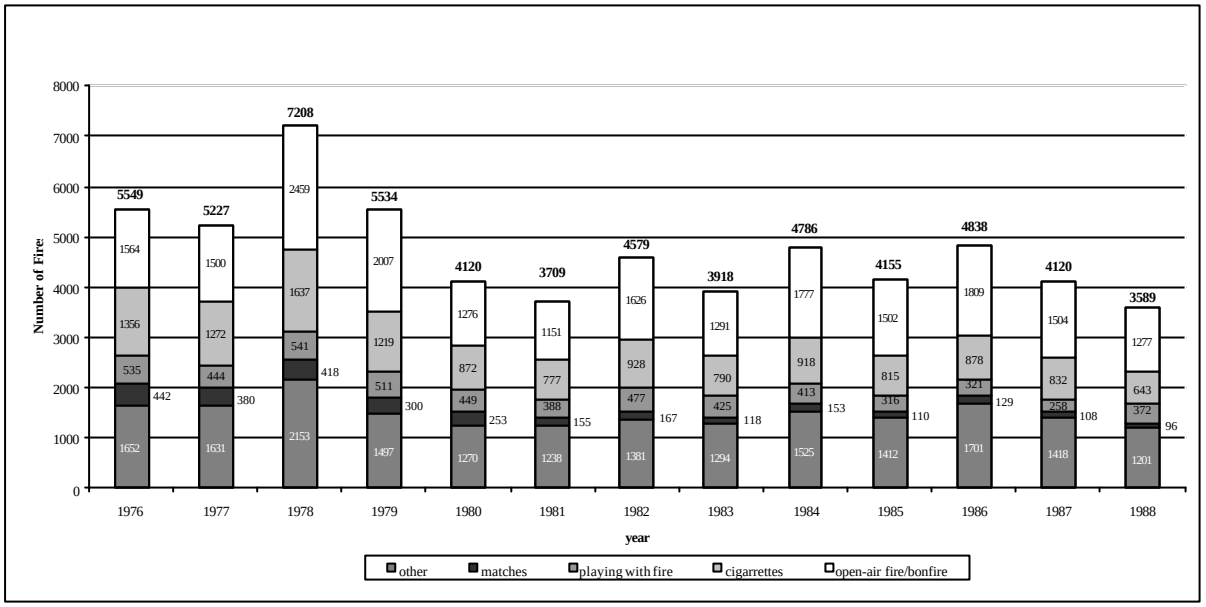


**Figure 2.** Number of forest fires by causes in Japan in the period 1976 to 1988. Source: Forestry Agency (2000)

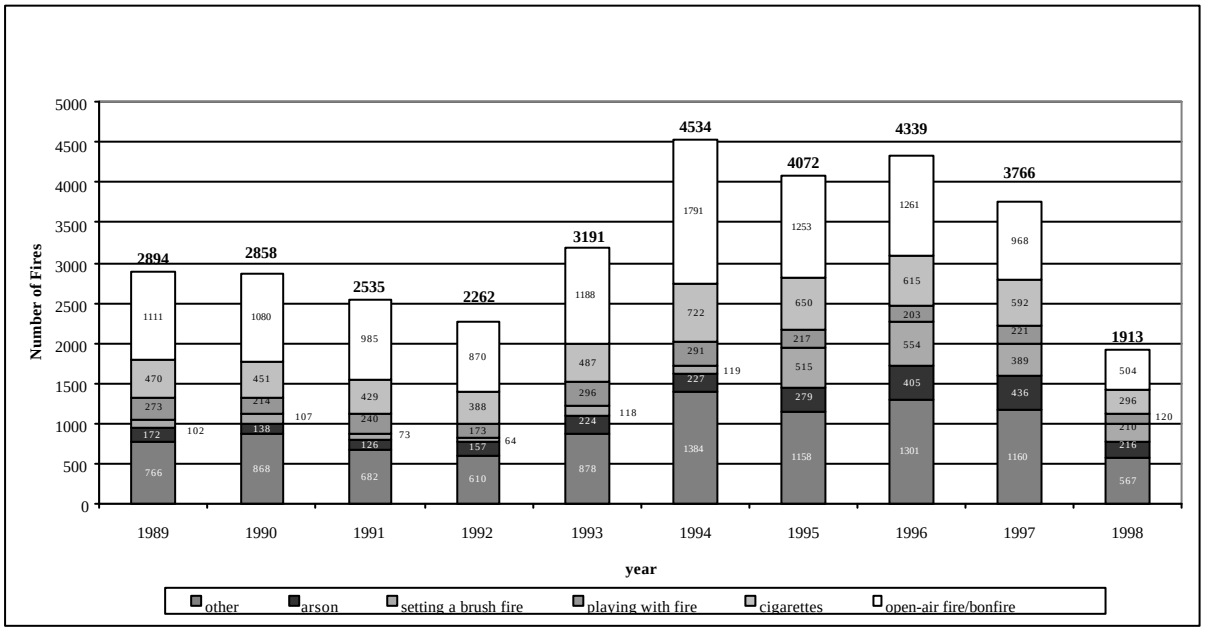


**Figure 3.** Number of forest fires by causes in the period 1989 to 1998 in Japan. Source: Forestry Agency Japan (2000).

Figure 1 shows that 99 percent of the wildland fires are human-caused (Nakagoshi et al. 1987), such as from the misuse of fire during afforestation and cultivation, bonfires, campfires, playing with fire, burning of rubbish, cigarettes, matches and fire works.

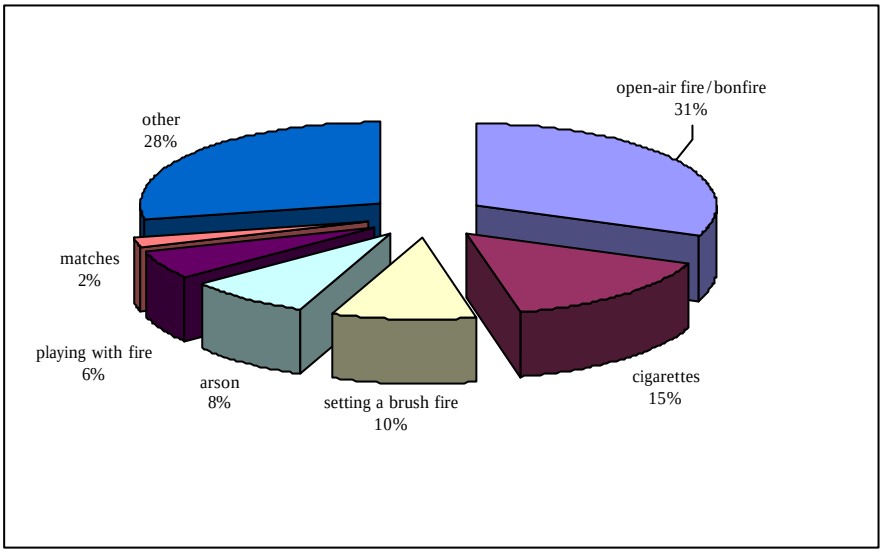


**Figure 1.** Causes of forest fires in Japan related to the number of fire incidents.

Explanation: "Setting a brush fire" (Japanese: *hiire*) may include setting a prescribed fire (NTT 1999). Open-air fires include fires set at the occasion of *Obon* (Festival of the Dead), a Buddhist ritual that is celebrated annually in July (Western Julian calendar) or August (Chinese lunar calendar), depending on the location. For several consecutive evenings, in the cemetery next to the temple, family members hang lit paper lanterns or deposit lighted candles. Wind and animals (often crows) are some of the reasons for the spread of fire into the open landscape.

In the early spring season (due to the longitudinal range of the chain of the islands the spring season stretches over two and a half to three months, from February in Kyushu to May in Hokkaido), a lot of dry litter is accumulated on the forest floor and the forest floor itself is also dry. Since rainfall or downpours usually accompany thunderstorms, lightning is rarely a fire cause in Japan. The occurrence of fires is highly correlated to human activities in this densely populated country. Propagation of forest fire is highly influenced by weather, human activity and forest conditions. As Figure 4 shows, the frequency, the distribution over the year and the number of forest fires is high during the season with the lowest precipitation and relative humidity and during the months when outdoor activities are high.

Most of the broadleaved forests do not burn easily. Because of the generally cool and wet weather conditions, only a few forest fires occur in the sub-alpine conifer forests. Forest fires are more common in western Japan, where secondary forests of *Pinus densiflora* are widely distributed. Pine forests *(P. densiflora, P. thunbergii* and *P. lutchuensis*) tend to burn easily.

**Fire control organization**

In Japan, the fire services of cities, towns and villages are responsible for wildland fire suppression. For large fire situations support systems are available (Tab. 3 and 4), such as dispatch of the fire services of neighbouring cities, towns and villages and the Japan Self-Defence Forces.

**Table 3.** Fire services of cities, towns and villages in 1998.

| Municipal Agencies | Number |
|---|---|
| Fire prevention headquarters | 920 |
| Fire departments | 1 662 |
| Fire houses | 3 232 |
| Fire brigades | 3 643 |
| Fire squads | 25 393 |

Source: White Book on Fire Service in Japan (1998).

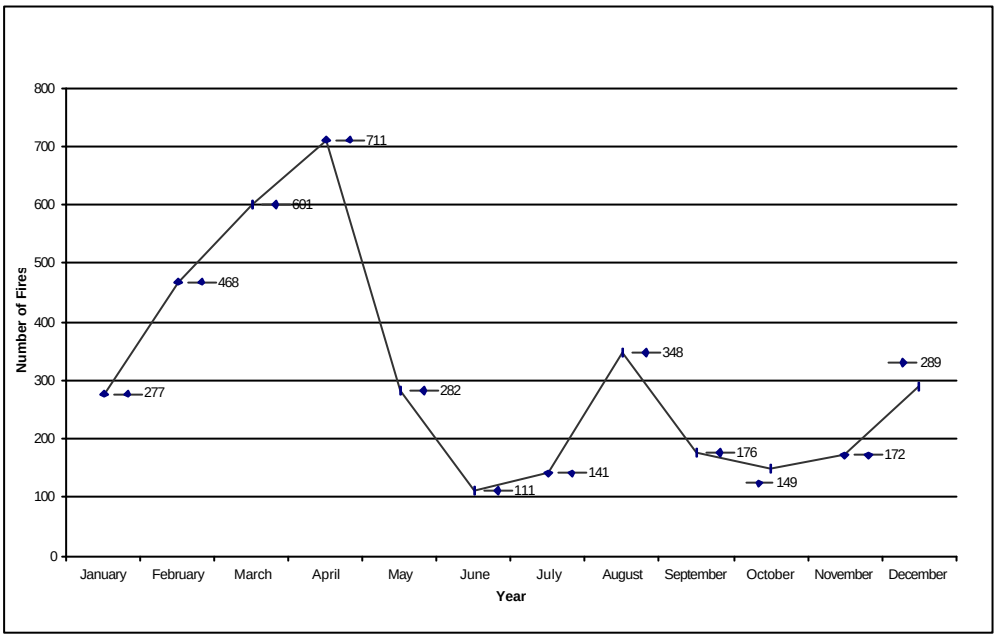


**Figure 4.** Distribution of the number of fire incidents over the year (5-year average between 1994-1998). Source: NTT (1999).

**Table 4.** Forest fire protection facilities subsidized by the Government of Japan

| Classification | | Quantity |
|---|---|---|
| Water tanks | | 3 694 |
| Natural water supply facilities | | 21 |
| Aerial fire–fighting supply bases | | 12 |
| Forest fire-fighting equipment | Fire defence radios | 1 743 |
| | Receivers | 1 340 |
| | Chainsaws | 290 |
| | Portable sprayers | 24 150 |
| | Portable water dischargers | 297 |
| | Light portable pumps | 96 |
| Utility vehicles | | 118 |
| Water trucks with small water pumps | | 23 |
| Brush Cutters | | 1 |

To ensure that adequate fire-fighting capability can be deployed to forest fires, the Agency has developed fire defence support systems for large areas, is promoting the use of helicopters for information collection and aerial

fire-fighting and provides guidance to prefectures and municipalities on timely requests for wide-area assistance. Helicopters are increasingly used for detection and communication in addition to being used in aerial fire suppression, including the use of fire retardants (White Book on Fire Service in Japan 1998).

**Fire defence program for special forest fire regions**

Since 1970 the Fire and Disaster Management Agency has been promoting a special forest fire defence programme in high risk areas in cooperation with the Forestry Agency. In municipalities bordering large areas of forest where there is a high risk of fire, the fire defence program includes the following measures:

- Forest fire prevention through public education, patrols and monitoring;
- Forest management with regard to fire prevention, such as the establishment and maintenance of firebreak belts;
- Establishment of communication systems;
- Development and improvement of fire fighting facilities;
- Restriction of fire use during the fire season; and
- Fire fighting training.

By 1997, this programme had been implemented successfully in 226 areas involving 940 municipalities in 38 prefectures (White Book on Fire Service in Japan 1998).

The early deployment of helicopters for reconnaissance and fire-fighting is an important concept in Japan. Further use of this strategy, in which helicopters work in close cooperation with ground firefighting operations, will require the development of additional bases for helicopter operations. In addition, water tanks and other water supplies are required for use during forest fires, especially in regions where residential areas are adjacent to forests and homes are at risk. There is a need to establish and continually update forest fire defence plans covering essential items about forest fire characteristics and firefighting operations. These plans allow firefighters to accurately grasp the state of a forest fire, determine firefighting tactics, deploy firefighting resources effectively and ensure reliable communications and a sufficient supply of water in the affected area. The effective use of simulation systems based on these forest fire defence plans has to be ensured.


**Figure 5.** Example for an educational forest fire prevention campaign

**Forest fire prevention campaign**

A joint initiative by Fire and Disaster Management Agency and the Forest Agency, the national forest fire prevention campaign is held in conjunction with the spring national fire prevention campaign to raise public

awareness and increase the effectiveness of fire prevention. This yearly educational campaign focuses on spreading the forest fire prevention message through educational activities aimed primarily at hikers, local residents and primary and junior high school students; banners and posters placed in stations, municipal offices and at the entrances to mountain routes; advertisements in the various media services, fire prevention training and study meetings.

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# KOREA

## Fire Situation in Republic of Korea

### Introduction

This report covers forest fires in South Korea only because limited information is available on North Korea.

### Fire environment, fire regimes, ecological role of fire

Korea is located between 33°06' to 43°01'N and 124°11' to 131°53' E, a peninsular country in the eastern part of the Continent of Asia and in the western part of the Pacific Ocean. The peninsula has a continental climate, except for the month of August when its climate characteristics are oceanic. The summer is characterized by a wet monsoon climate and is hot and humid with frequent rain showers; and it is cold and dry in winter. Seasonal changes are gradual but distinctive, and spring and autumn are relatively shorter seasons than those of summer and winter. Forest fires in Korea occur frequently in spring and autumn because those seasons are drier than summer and winter; summer has considerable rainfall and winter has appreciable snow. Forest fire prevention periods of South Korea are from 15 February to 15 May in spring and 1 November to 15 December in late autumn to early winter.

**Table 1.** Forest fire occurrence by season during the period 1995-1999

| | Mean of 5-years period | | Year | | | | |
|---|---|---|---|---|---|---|---|
| | Number of fires | Portion (%) | 1995 | 1996 | 1997 | 1998 | 1999 |
| **Spring** | 284 | 63 | 414 | 326 | 310 | 171 | 197 |
| **Summer** | 4 | 1 | 2 | 3 | 7 | 1 | 5 |
| **Autumn** | 29 | 6 | 27 | 12 | 79 | 14 | 14 |
| **Winter** | 136 | 30 | 187 | 186 | 128 | 79 | 99 |
| **Total** | **452** | **100** | **630** | **527** | **524** | **265** | **315** |

South Korea is classified into 16 eco-regions by cluster analysis of such variables as latitude, longitude, seasonal mean temperature, and seasonal precipitation measured at 28 Weather Forecast Offices and 40 Weather Observation Stations for 30 years from 1961 to 1990. Among the 16 eco-regions, the forests of three regions, Kangwon coastal, Woolyong coastal, and Hyung-Taewha coastal (eastern coastal region of Korea), are vulnerable to fire because they have very low rainfall in the spring; and foehn and quasi-foehn winds abruptly interchange many times in a day. Under these meteorological conditions, wildfires spread rapidly and over large areas. Moreover, vegetation is mainly composed of *Pinus densiflora* that is inclined to ignite easily. In April 1996, a large forest fire burned 3762 ha in Kosung, Kangwon coastal eco-region.

It must be noted that forest fires in Che-ju Province are the consequence of intentionally set fires in bushlands to control insects (ticks) that are harmful to humans.

### Major wildfire impacts on people, property, and natural resources during the 1990s

Forest fires are commonly ignited in the lower part of a mountainous area and spread to the top of the mountain. Thus, fires generally did not affect people or dwellings. However, the 1996 Kosung forest fire impacted natural resources and people. According to the investigation, it burned 3762 ha of forest, 16,215 kg of pine-mushrooms (*Tricholoma matsutake*), and many tombs. Damage cases totalled 66; and the amount of damages awarded reached 15.268 million. In addition, it damaged many residences and structures.

### Wildfire statistics

Statistical data on forest fires during the period 1990 to 1999 are given in Table 2. There is no typical tendency, but in the 1990s a few large forest fires occurred due to the failure of initial attack. For comparison with the 1980s, Table 3 shows the wildland fire database for the period 1980-1989.

Between 1990 and 1999 an average of 336 fires occurred annually and affected an average area of 1399 ha. Between 1980 and 1989 only 238 fires occurred, affecting 1102 ha.

Table 4 shows the details of fire causes for the period 1995-1999. The category “other causes“ of fires have been incorporated in Table 2 under the column “unknown causes”.

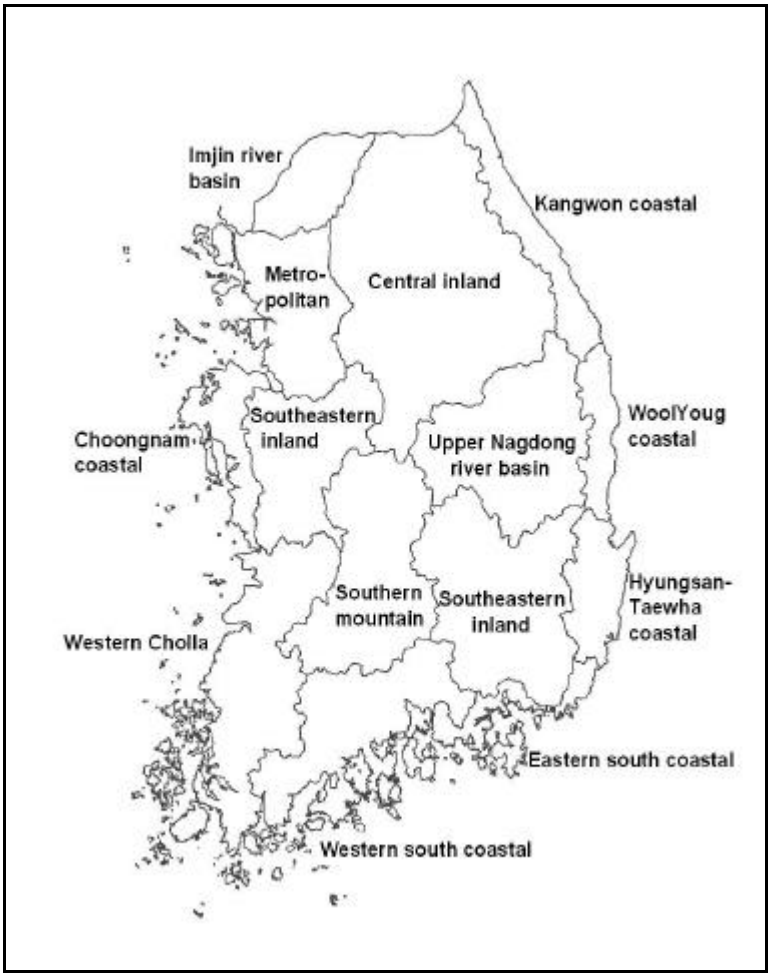


**Figure 1.** Eco-regions of South Korea.

**Fire management organization**

Forest fire management in Korea is under the responsibility of the Korea Forest Service, Department of Forest Fire Prevention, and the Aerial Forest Control Offices. Their tasks include:

- Wildfire prevention
- Establishment and operating the headquarters for wildfire prevention
- Supervision of wildfire prevention
- Administration of Forest Service personnel
- Operation and managing of forest protection equipment
- Education for wildfire prevention
- Improvement of wildfire management
- Forest preservation

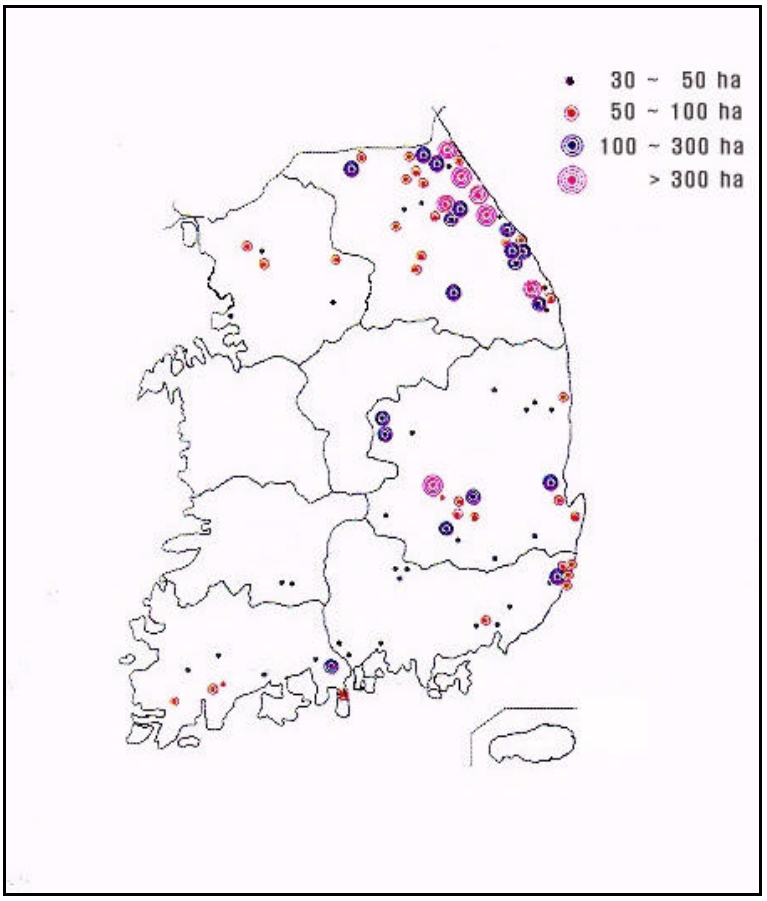


**Figure 2.** Large-scale forest fires during the period1980-1999.

**Table 2.** Wildfire database for the period 1990-199.

| Year | Total No. of Fires on Forest, Other Wooded Land, & Other Land No. | Total Area Burned on Forest, Other Wooded Land, & Other Land ha | Area of Forest Burned ha | Area of Other Wooded Land and Other Land Burned ha | Human Causes No. | Natural Causes No. | Unknown Causes No. |
|---|---|---|---|---|---|---|---|
| **1990** | 71 | | 175 | | | | |
| **1991** | 139 | | 429 | | | | |
| **1992** | 180 | | 640 | | | | |
| **1993** | 278 | | 1 752 | | | | |
| **1994** | 433 | | 781 | | | | |
| **1995** | 630 | | 1 031 | | 502 | | 128 |
| **1996** | 527 | | 5 368 | | 389 | | 138 |
| **1997** | 524 | | 2 330 | | 393 | | 131 |
| **1998** | 265 | | 1 014 | | 233 | | 32 |
| **1999** | 315 | | 473 | | 318 | | 38 |
| **Average** | **336.2** | | **1 399.3** | | **367** | | **93** |

**Table 3.** Wildfire database for the period 1980-1989

| Year | Total No. of Fires on Forest, Other Wooded Land, & Other Land No. | Total Area Burned on Forest, Other Wooded Land, & Other Land ha | Area of Forest Burned ha | Area of Other Wooded Land and Other Land Burned ha | Human Causes No. | Natural Causes No. | Unknown Causes No. |
|---|---|---|---|---|---|---|---|
| **1980** | 403 | | 1 218 | | | | |
| **1981** | 252 | | 814 | | | | |
| **1982** | 136 | | 509 | | | | |
| **1983** | 135 | | 919 | | | | |
| **1984** | 359 | | 1 164 | | | | |
| **1985** | 165 | | 363 | | | | |
| **1986** | 275 | | 3 417 | | | | |
| **1987** | 87 | | 91 | | | | |
| **1988** | 270 | | 878 | | | | |
| **1989** | 294 | | 1 652 | | | | |
| **Average** | **237.6** | | **1 102.5** | | | | |

**Table 4.** Details on wildfire causes during the period 1995-1999

| | 5-years mean | | Year | | | | |
|---|---|---|---|---|---|---|---|
| | Number of fires | Portion (%) | 1995 | 1996 | 1997 | 1998 | 1999 |
| **Mountain visitor's accidental fire** | 222 | 47 | 312 | 248 | 247 | 104 | 197 |
| **Levee fires** | 87 | 19 | 138 | 73 | 103 | 65 | 57 |
| **Cigarettes** | 14 | 3 | - | - | - | 37 | 34 |
| **Tomb visitor's accidental fires** | 28 | 6 | 34 | 38 | 33 | 16 | 20 |
| **Children's accidental fires** | 16 | 4 | 18 | 30 | 10 | 11 | 10 |
| **Others** | 93 | 21 | 128 | 138 | 131 | 32 | 38 |
| **Total** | **460** | **100** | **630** | **527** | **524** | **265** | **356** |

Tasks in wildfire suppression include:

- Pre-suppression planning
- Coordination of wildfire suppression
- Supervision of the forest aerial control offices
- Planning and command of aerial operations
- Operation and management of the communication system
- Personnel management for air/ground wildfire suppression, including training
- Damage assessment and rehabilitation

These latter tasks are implemented by the autonomous forest departments at provincial and municipal/local levels.

Using data of the Meteorological Service and fuel moisture data, the Korea Forest Research Institute assesses forest fire danger (forest fire danger map) and reports it to the Korea Forest Service. The Korea Forest Service notifies provincial, municipal, and local autonomous entities on fire danger. The public is informed by mass media, if fire danger is extreme.

When large-scale forest fires occur, the Forest Service establishes a Central Headquarters for fire emergency response coordinated by the director of the Forest Service. The directors of provincial, municipal, and local autonomous entities establish and coordinate local headquarters for comprehensive countermeasures. The heads of all headquarters have authority to mobilize civil defence forces for fighting forest fires.

**Forest fire research**

Forest fire research in South Korea currently is focusing on:

- Development of forest fire danger rating models
- GIS-based forest fire danger index forecasting
- Ecology and fuels research
- Fire effects and rehabilitation

**Use of prescribed fire**

Before the 1950s, prescribed fire was used in Korea for site preparation. However, this method is not used for planting today. In Che-ju Island (Province), prescribed fire is often used in bushlands to control insects and ticks. At Mt. Whawang in Kyungsangnam-Do province fire is prescribed to maintain mountain grasslands composed of *Miscanthus* spp. In early spring prescribed fire is also used for preparing the farming of paddy fields. Generally speaking, the forest fire policy of Korea is hardly interested in "let burn" or prescribed burning, but concentrates on fire suppression.

**Sustainable land-use practices employed to reduce wildfire hazards and wildfire risks**

Several decades ago, firebreaks were constructed on the ridges of mountains. These are still visible in some areas, but this practice has been abandoned today.

However, planning to set up a systematic firebreak system is under consideration in the east side of the Tae-back Mountains, Kangwon coastal eco-region and Woolyong coastal eco-region, where forest fires occur frequently.

**Public policies concerning fire**

The public perception of forest fire is rather negative in Korea. Therefore, the forest fire policy of Korea is focussing on reduction of fire incidents, area burned, and other damages. For example, the statute provides that any use of fire must be practiced under the direct supervision of county officials.

Recently, Korea experienced several large fires that burned more than 100 ha and involved major losses. It is now planning to create laws and regulations on forest fires that would provide compensation to those who have suffered losses from forest fires.

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# MALAYSIA

## Forest Fire Situation in Malaysia

**Abstract**

Forest fires and the resultant smoke-haze are relatively new experiences to Malaysia. However, the problems seem to be increasing in intensity and recurring periodically. Last year, the haze and forest fires caused a serious environmental problems in Malaysia, Singapore, Brunei and Indonesia. Most of the forest fires reported in Malaysia occurred in degraded or logged-over peat swamp forests, both in the east and west coasts of Peninsular Malaysia and the coasts of Sabah and Sarawak. The extent of peatland destroyed by fires is not known precisely, but a prolonged extremely dry period early in 1998 had exacerbated the resurgence of peat fires over a wide area in Malaysia.

Although peat forest fires in Peninsular Malaysia were not of the same magnitude as in neighbouring Indonesia, they have caused significant damage to property, vegetation, wildlife, environment and public health. Fire has been identified as one of the major threats causing the loss of peat swamp forests in several states in Malaysia. Serious occurrences of forest fires during recent years are due to improper peatland management, slash and burn activities and poor water management, rather than climatic factors such as a long dry spell. The condition is made worse because mitigating measures were not in place and the understanding and technical knowledge in forest firefighting was lacking.

The fires mainly involved peat and beris (heath) forest and bush areas. The fires burned in a slow and patchy manner, but were widespread. The fires spread slowly through the thick peat layers, making it extremely difficult to detect and extinguish them. In such areas, although the surface fires are extinguished, the peat underground will continue to burn unless a large amount of water is used to completely drench the peat layers. Consequently, those involved in extinguishing the fires had a difficult time, because they lacked the necessary tools and experience and they were not trained to handle forest fires. In addition, the remoteness and ruggedness of the terrain exacerbated the problem even further. In many of the affected areas, there were also logistical problems.

The forest fire and haze problems also resulted in government agencies such as the Fire and Rescue Department, Forestry Department and the Department of Environment in Malaysia to seriously re-examine their capacity to deal with wildfires. Relevant measures are being undertaken by these agencies to address the issue. In the long-term, an awareness campaign on the importance of peat swamp forests and forest fire hazards needs to be initiated at all levels by the relevant government agencies. An integrated approach of managing peatlands (agriculture, forestry, aquaculture etc.) is the best solution to avoid serious forest fires from recurring.

### Introduction

Various issues related to the conservation of natural resources and the environment have been given much attention lately at the local and international levels. The problems caused by the haze throughout Malaysia and her neighbours, mainly resulting from the rampant fires in various parts of Indonesia since the 1990's, has received much negative publicity. On the other hand, these effects have also improved the awareness of the transboundary nature of the impacts of forest fires, the need for better management of our resources and the need to enhance forestry cooperation within the region.

Forest fires and the resultant haze are still generally considered new problems facing Malaysia. However, their intensity and recurrence have been increasing. In 1997/98, one of the worst episodes of haze struck this region, engulfing Malaysia, Indonesia, Singapore and Brunei. The main source of the haze was attributed to the forest/bush fires that occurred in various parts of Sumatra and Kalimantan coupled with the *El Niño* phenomenon, although there were also forest and bush fires reported in Malaysia. At the height of the fire episode about 1000 new fires were recorded by satellite sensors in Indonesia within a two-week period. The Malaysian Air Pollutant Index (API)[1] exceeded the hazardous level of 500 in Sarawak, forcing the government to close schools and offices. The haze caused the Malaysian public much discomfort and resulted in disruption to air travel, increased respiratory and related health problems and a significant decrease in tourists visiting the country. Had the haze conditions persisted a little longer, it would have embarrassed the nation and disrupted the prestigious Commonwealth Games that the nation proudly hosted in September 1998.

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[1] Malaysian Standard of Air Pollutant Index (API) is measured in $\mu g/m^3$ of air sampled. The scales of the index are categorised as follows: 0-50 = Good; 51-100 = Moderate; 101-200 = Unhealthy; 201-300 = Very Unhealthy; 301-500 = Hazardous.

However, the haze cannot be totally attributed to the forest fires in Indonesia alone as there were also fires reported in various parts of Peninsular Malaysia, Sabah and Sarawak. Many of these fires occurred in degraded peat lands, logged-over forest reserves and secondary state forests. They have caused significant damage to property and loss of valuable timber as well as biological diversity. In this regard, however, there were no detailed studies on the extent and impact of the forest fires undertaken, making it difficult assess the actual situation.

**Extent of forest fires in Malaysia**

The worst forest fires experienced by Malaysia were in 1982/83 when almost one million hectares of natural forest burned in Sabah. This was at the same time when numerous fires affected Borneo and 3.2 million ha in Kalimantan. However, for Malaysia this was the only case where natural forest fires of this magnitude were ever recorded. Subsequently, forest fires continued to occur in Malaysia but the extent was less and mainly located in secondary conversion forests, forest plantations and degraded forests. Forest fires have been reported as early as the 1970s in the pine plantations and the 1980s in the *Acacia mangium* plantations. However, many of these fires were not recorded properly. Tables 1 and 2 show the occurrences of fires that were recorded in Malaysia beginning in 1992-1997 and 1998 respectively.

It is obvious from the above records that incidences of forest fires mainly occurred in forest plantations, degraded peat swamp forests and logged-over forests. The frequency of occurrences also increases appreciably during the El Niño-Southern Oscillation (ENSO) years where prolonged dry spells are experienced.

**Causes of forest fires**

Under normal conditions, the undisturbed tropical moist forests of Malaysia and Indonesia will not catch fire easily and even if they do burn, the fire will not be widespread. With an average annual rainfall of about 2 540 mm, humidity exceeding 75 percent and the rate of litter decomposition on the forest floor relatively fast, the climatic conditions are generally humid and fuel build-up on the forest floor is minimal. Unless these conditions are changed, there is very little chance of the forest catching fire. However, when the forest is disturbed and degraded with much debris available on the forest floor and canopy cover opened, the forest becomes more vulnerable to forest fires (especially after a prolonged dry spell). Particularly for the peat swamp forests, the soil is always moist. However, when water in these areas is drained during development projects, the peat becomes completely dry and is very prone to fire. Under these conditions the fire spreads underground and can stay burning for a long time.

The recent prolonged dry spell caused much of the lalang (*Imperata cylindrica*) and gelam (*Malaleuca cajuputi*) areas of the secondary beris (heath) forests and degraded peat swamp forests to dry up. Since the soil consists of mainly sand and humus in the beris areas and dried peat in the peatlands, small amounts of rain were not sufficient to retain adequate soil moisture. Most of the smaller rivers had also dried up. In such conditions, these areas are very vulnerable to fire. The sources of the fire are mostly human-cased. Some of the major reasons for the cause of fire are as follows:

- Land preparations in establishing agricultural plantations
- Land preparation by farmers
- Shifting cultivation by indigenous people
- Camping and picnicking
- Hunting
- Snapped electric cable
- Natural Causes – lightning, spontaneous combustion, etc.

**Table 1.** Forest fires in Malaysia 1992-1997

| Year | Location | Forest Type | Area burned (ha) | Probable Causes |
|---|---|---|---|---|
| **1992** | Terengganu | *Acacia mangium* plantation | 265 | Nearby land clearing and from picnickers at nearby recreational Forest |
| | Johor | *Acacia mangium* plantation | 3 | Unknown |
| | Selangor | *Acacia mangium* plantation | 10 | Power transmission undergoing maintenance |
| | | *Pinus caribaea* plantation | 16 | Adjacent land clearing by villagers |
| | Sabah | Natural forest | 2 500 | Cooking by hunters |
| | | Natural forest | 1 000 | Arson |
| | | Natural forest | 825 | Nearby land clearing, picnickers and cigarettes |
| | | Primary forest reserve | 65 | Adjacent land clearing by farmers |
| **1994** | Perak | *Acacia mangium* & *Tectona grandis* plantation | 333 | Adjacent land clearing by farmers |
| | Sarawak | *Acacia mangium* plantation | 15 | Unknown |
| | | Plantation (various species) | 50 | Adjacent land clearing by farmers |
| **1995** | Selangor | Degraded peat-swamp forest | 155 | Adjacent land clearing by villagers |
| **1996** | Perak | Secondary forest | 24 | Cigarettes |
| **1997** | Perak | Natural forest & FRIM research plots | 22 | Adjacent land clearing by farmers and hunting |
| | Pahang | Natural forest (state-owned) | 202 | Adjacent land clearing for oil palm plantation |
| | | Peat-swamp forest | 202 | Adjacent land clearing by villagers |
| **Total** | | | !Syntaxfehler, ) | |

**Table 2.** Forest fires in Peninsular Malaysia 1998. Source: Forest Department Peninsular Malaysia and FRIM statistics

| Location | Forest Type | Area burned (ha) | Probable Causes |
|---|---|---|---|
| **Kelantan** | Forest plantation | 15 | Snapped Electrical Transmission lines |
| | Secondary forest | 240 | Adjacent land clearing by farmers and private land owners |
| | Degraded heath forest | 310 | Adjacent land clearing by farmers and private land owners |
| | Degraded peat forest | 40 | Adjacent land clearing by farmers and private land owners |
| **Selangor** | Forest plantation | 5 | Cigarettes |
| | Peat-swamp forest | 250 | Burning of rubbish by adjacent villagers |
| **Perak** | Secondary forest | 60 | Unidentified |
| | Peat-swamp forest | 40 | Hunting |
| **Johor** | Peat-swamp forest | 41 | Unidentified |
| | Montane forest | 15 | Unextinguished carbide lamps by mountain climbers |
| **Kedah** | Secondary forest | 41 | Adjacent land clearing by farmers |
| **Trengganu** | Peat-swamp forest | 900 | Adjacent land clearing by farmers and private land owners |
| | Logged forest | 120 | Unidentified |
| | Heath forest | 250 | Unidentified |
| | Freshwater swamp forest | 15 | Fishing by nearby villagers |
| | Forest reserve | 30 | Adjacent land clearing by farmers and private land owners |
| **Pahang** | Peat-swamp forest | 360 | Land clearing by indigenous people and adjacent farmers |
| | Forest plantation | 6 | Unidentified |
| | Secondary forest | 61 | Unidentified |
| **Total** | | !Syntaxfehler ,) | |

In many cases fires get out of control during burning carried out during establishment of agricultural plantations. The same may also happen when smallholders and farmers undertake land clearing in preparation for the next planting. Improper burning techniques and strong winds may cause the fires to spread to nearby secondary forests. There were also cases where campfires made by campers and hunters were not extinguished properly, resulting in the occurrence of forest fires. Some areas were deliberately burned to facilitate hunting. The burned areas seem to attract game, making them easy targets for hunters.

In Selangor and Kelantan, part of the *Acacia mangium* plantations were burned because of a snapped high voltage electric transmission cable. In both cases, fortunately, the fire was quickly contained and damage was not extensive.

In Pahang, Sabah and especially in Sarawak, the practice of shifting cultivation by the indigenous people (*Orang Asli*) is also a major factor contributing to the occurrence of fires. It is estimated that approximately 65 000 ha. of forest in Sarawak are cut and burned by shifting cultivators. Not only do they degrade valuable prime forestland, their practice of clearing small patches of the forest by burning can sometimes cause widespread damage during the dry spells.

According to the Director of the Fire and Rescue Department (FRD), the awareness among the public, especially in rural areas, on the dangers of open burning during dry periods was clearly lacking. People are not aware that

taking the easy path of burning to facilitate land preparation for agriculture can be extremely dangerous. He advised that it would be appropriate that the FRD be consulted before any burning is undertaken, especially during the dry periods.

It was also found that the public is more concerned about the haze rather than the destruction of forests by fires. If forests were burned without causing too much haze in the populated centres, then the outcry would have been far smaller.

Irresponsible cigarette smokers are also a great concern. People who smoke cigarettes often simply throw the butts without ensuring that they have been properly extinguished. A large portion of fires that originated from the roadsides and then spread inwards to the forest reserves are suspected to be caused by smokers who throw unextinguished cigarettes while travelling along the roads.

**Impacts**

The fires caused extensive damage to vegetation, wildlife, environment and the health of people surrounding the affected areas. The haze and air pollution were at a dangerous level in most of these areas and at times reached unbearable and hazardous levels. Although there were increased respiratory and related ailments, the long term health implications of affected people in the vicinity of the forest fires is difficult to predict and are a cause for concern. Conditions in Peninsular Malaysia and Sarawak became so critical that the Malaysian Government decided to assist Indonesia in putting out the fires. A total of 1 262 firefighters (the largest ever recorded) from Malaysia were deployed to Sumatra and Kalimantan to combat the forest fires.

Areas affected by fire are rapidly colonised by resam and lalang. Consequently, as the fires occur every year, more and more highly rich and varied ecosystems will be replaced by weeds such as resam (*Glychenia* spp.) and lalang (*Imperata* spp.). There is a real danger that besides loss of biodiversity, the areas will never be regenerated by trees. The extensive *Imperata* grasslands in many parts of the Philippines and Papua New Guinea are clear examples. Forest fires have also been identified as a major cause for the loss of peat swamp forests in Malaysia.

Although direct financial estimates due to fires were not available, many hours were spent in fighting fires. This involved personnel from the FRD, State Forestry Department, Police, Drainage and Irrigation Department, Public Defence Department (JPA 3), Public Works Department, Local Town Councils and also members of the community. During the period, air travel was often disrupted, the tourism sector adversely affected and cost of medical treatment for haze related ailments increased.

**Other smoke/haze related losses**

The 1997 haze reached a critical level, both in terms of intensity and duration, causing much inconveniences and economic disruptions to the Malaysian economy. Other than health impacts, the haze has caused various other quantifiable losses including:

***Production losses***

The haze in 1997 reached a new urgency in Malaysia when the readings from the Air Pollution Index (API) reached 500. A state of emergency was declared for 10 days in Sarawak. The haze can result in various production losses of economic activities. These haze-related production losses included:

- A reduction in crop yields resulting from reduced sunlight. The appropriate method to adopt is a dose response function relating sunlight to yield. Data on sunlight would be needed.
- A reduction in fishing effort due to reduced visibility. The fishing days foregone would have to be multiplied by the expected profit per day. A more encompassing evaluation requires the computation of losses in consumer and producer surpluses.
- A reduction in industrial and commercial activity due to delays in transportation inputs and outputs; and an increase in cleaning and maintenance of equipment due to dust and corrosion. During production shutdown, profits foregone would have to be estimated.

In principle, as for all damages, estimates should be for profits foregone, not gross value. As a proxy, it is suggested to use days of work lost due to shutdowns at a minimum or average wage.

***Tourism losses***

Losses incurred by the tourism industry can be estimated by the reduced tourist arrivals from non-ASEAN sources. This is done in order to control for the effect of the 1997 ASEAN economic crisis which in itself is expected to effect incoming ASEAN tourists. Like the case in fishing effort, the losses occurring in August-

October 1997 were compared to the "normal" August-October period of 1996. In this way any change in impacts caused by other factors are controlled.

***Airline and airport losses***

To obtain the losses incurred from airport closures due to poor visibility, estimates of the number of cancelled flights and forgone sales were obtained and multiplied by the airline's average profit rate. Any profits foregone from operation of the airports themselves are then added to the above.

***Averting Expenditures***

Apart from the loss arising from the haze, the Malaysian Government and firms have incurred averting expenditures to contain the impacts of the haze and to help control the source, i.e. in forest firefighting and cloud seeding operations.

Although the cost of the health impacts is small, the overall impacts from other sectors were quite large. According to the Economy and Environment Program for Southeast Asia (EEPSEA) study, the estimated incremental cost of the haze damage to Malaysia during the months of August to October in 1997 was RM816 million (Tab.3). The largest component is the productivity losses during the declaration of a 10-day state of emergency in Sarawak. The health impacts contributed only 4.4 percent.

**Table 3.** Aggregate incremental costs of the damage caused by smoke haze.

| Type of Damages [1] | RM Million | Percentage |
|---|---|---|
| Adjusted cost of illness | 36.16 | 4.43 |
| Productivity loss during the emergency | 393.51 | 48.19 |
| Tourist arrival decline | 318.55 | 39.02 |
| Flight cancellations | 0.45 | 0.06 |
| Fish landing decline [2] | 40.72 | 4.99 |
| Cost of fire fighting | 25.00 | 3.06 |
| Cloud seeding | 2.08 | 0.25 |
| **Total** | **816.47** | **100.00** |

[1] Cost to Malaysian MNCs of RM2.5 million is not included as this amount might have been used by the Government to pay for various avertive expenditures.

[2] Only declining consumer surplus is taken into account as the gain in producer surplus is not a cost.

Source: Mohd Shahwahid and Jamal (1999).

**Issues in combating forest fires**

In Malaysia, the Fire and Rescue Department is the agency responsible for combating all kinds of fire including forest fires. However, during the combating of forest fires the agency is assisted by other relevant agencies such as the Forestry Department, Public Defence Department, Drainage and Irrigation Department, the police and the local town councils.

The fires that occur in the peat and heath forest/bush areas are relatively slow and patchy but widespread. The fires spread through the forest floor. Thus, even if whole trees were not felled, the root systems could be completely damaged and often the trees would fall and die. In peat lands, the fires spread slowly through the thick peat layers making it extremely difficult to detect and extinguish fires. In such areas, although the surface fires are extinguished, the peat underground will continue to burn unless a large amount of water is used to completely drench the peat layers. Consequently, in peat lands, the most effective way of containing the fires will be by flooding the area.

In Kelantan and Terengganu, the areas that were burned had relatively shallow peat layers. As such, a single heavy rainfall would be sufficient to ensure that the fires are extinguished. Much of the fire that finally came under control in Terengganu was due to some heavy showers that occurred in early May. However, this was not the case for Pahang and Selangor where peat layers were found to be relatively deep. In such conditions, to fully extinguish the surface as well as the subterranean fire, the area would need a continuous heavy rainfall or an artificial flooding with water from nearby sources. The latter method was implemented effectively in Selangor by pumping water from adjacent tin mining pools and rivers.

Although the fires in some areas were put out by the Fire Department, the fires recurred. In such areas, although the fires on the surface were controlled, the peat fire underneath was not fully extinguished. This was also the case for the beris forests. In this regard, the Director of FRD reported that 800 gallons of water had to be used to douse the fire in an area of about 10 square meters. During the dry ENSO period, such large amounts of water is difficult to obtain.

In many of the affected areas, there were logistical problems that arose from poor access. The Fire and Rescue Department's vehicles were designed for structural firefighting and not for travelling in forested areas and thus they were unable to venture into interior areas that were affected by fires. There was a serious lack of water sources to enable the Fire Department to fight the fires effectively. Even in cases where pits and canals were dug, they dried up quickly.

Some of the firefighting equipment used needs to be improved, e.g. the conventional water pumps used were too heavy and could not work for long hours. In Kelantan, however, firefighters tested a new pump provided by Canada. Apparently the pump was not only lighter, it could also work for long hours.

Under such conditions, according to the FRD, the best way to tackle forest fires is to contain them by preventing their spread, especially to sensitive areas and communities. This is undertaken by creating fire breaks.

There is no specific legislation on forest fires under the Malaysian National Forestry act of 1984 (revised 1993). However, there is a provision prohibiting fire-related activities in the permanent reserve forests and there are penalties for such offences. Likewise, the Environmental Quality Act of 1974 explicitly prohibits open burning without a permit to curtail air pollution and the occurrence of haze.

**Control Measures**

From past trends, the possibility of recurring fires in Malaysia is very likely in the natural and plantation forests. The severity of future fires will depend on weather conditions as well as the awareness and discipline of the public at large. Past experience shows that the possibilities of fires occurring in fire prone areas are very high during ENSO periods. Steps need to be taken to identify these areas and institute prevention and control measures. There seem to be sufficient measures in place to prevent and combat fires in the forest plantations. However, similar measures are grossly lacking for the natural forest areas as managers still view lightly the threat of fires in such forests.

Some of the immediate steps are to ensure that surrounding communities are informed of the detrimental effects of open burning and uncontrolled land clearing practices. There also is a need to adopt conservation measures while in or near the forest, build fire breaks and develop permanent water sources. It will take a combined effort of government agencies, private agencies and others to overcome fire problems in the future. The severity of the 1998 fire season and the involvement of various agencies and the community in fighting the fires should have increased the awareness for the need to take precautionary measures in the future.

**Some of the recommended control measures include:**

- **Increasing public awareness** The FRD has an on-going program of creating awareness among the public. However, such programmes need to be improved and intensified. It should also involve other agencies and should reach a wider range of people. This is a long-term, but very effective strategy.
- **Sustainable forest management** Natural forests that are managed in a sustainable manner, where the structure and overall integrity are not compromised, are very resilient to fires. It is when they are disturbed that they become prone to fire as indicated clearly in the statistics provided in Tables 1 and 2. Most of the secondary and degraded forests that were burned were not forest reserves but state forests that were earmarked for conversion. Often the spread of fire halts when it reaches the undisturbed forests.
- **Creating buffer zones** There should be an effective buffer zone or fire breaks constructed surrounding Permanent Reserved Forests and State Forests adjacent to agricultural lands and communities. This would help to ensure that the forests are protected from fire which often originate from more populated areas.

- **Construction of canals** In degraded peat forests where fires are likely to recur, canals should be constructed. The canals could be used to collect water and facilitate firefighting in the future.
- **Notification of FRD and DOE** In any land preparation involving burning, the FRD and Department of Environment (DOE) will have to be notified for approval.
- **Development of Forest Fire Squads** The FRD should endeavour to set up a forest fire squad. This squad should have the necessary training and skills in forest/bush firefighting. They should also be equipped with the necessary equipment. The use of suitably equipped helicopters should be further explored. In this regard, initial efforts have already been implemented when training was provided for the FRD in basic forestry knowledge.
- **Development of Risk Index** Fire prone areas will have to identified and located. An early warning system together with a risk class index should be developed. With such a system, mobilisation of resources could be optimised and targeted to areas with higher risks of fire.
- **The Forest Fire Prevention and Control Plan** The State Forestry Departments of Peninsular Malaysia have developed a plan on the prevention and control of fires within the natural and plantation forests (Annex I). Each state also has assigned a forestry officer to handle all matters pertaining to forest fires. The plan details precautionary measures to prevent fire in forest areas in natural and plantation forests, allocation of equipment and personnel and forest firefighting protocols. The development of this plan began in 1999 and is an excellent effort undertaken by the Forestry Department.
- **Rehabilitation of degraded areas** Forest areas affected by fire, be it in the Permanent Reserved Forest or state-owned land, should be rehabilitated quickly to prevent further degradation of the area through soil erosion and colonisation of pioneers and weeds. The burned area needs to be regenerated to restore the area into a productive forest again.
- **Forest fire research** To date, research efforts have not given sufficient focus into issues related to forest fires. The reason for this may be that in the past no serious fires had occurred in the Permanent Reserved Forest. It is also felt that issues concerning forest fires are mainly social and management in nature. However, the current situation warrants that priority be accorded to undertaking research in order to address such issues as:
  - Impacts of fires on the forest vegetation and environment
  - Water management of peat lands
  - Socio-economic implications of forest fires
  - Development of zero burning techniques in land preparations for plantations
  - Development of fire risk classes and early warning systems.
- **Networking** The transboundary nature of forest fire problems has suggested a network approach for sharing of information and experience. Networking is a cost-effective mechanism for strengthening institutional capacity, facilitating transfer of technology and enhancing cooperation. For example, Indonesia has more experience in combating forest fires and is also more advanced in research in forest fire management. As such, a country like Malaysia would be able to identify and use some of this knowledge and expertise available in addressing similar issues.

**Conclusions**

Problems caused by forest fires in the ASEAN region have assumed a new and serious dimension that needs to be addressed sufficiently. Large areas of forestlands have been devastated, resulting in economic losses that run into billions of dollars, degradation of our environment and irreversible losses of valuable biological diversity. The episodes of forest fires and haze in the last two decades, namely in 1982/83, 1990, 1991, 1994 and 1997/98 should serve as useful lessons to be more cautious and undertake all efforts to ensure that we are prepared in the future. The ENSO dry spells will come and the fires will recur. The intensity of the problem will then depend on our state of preparedness to face the crisis, as well as the degree in which we are able to implement the various preventive measures.

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**Annex**

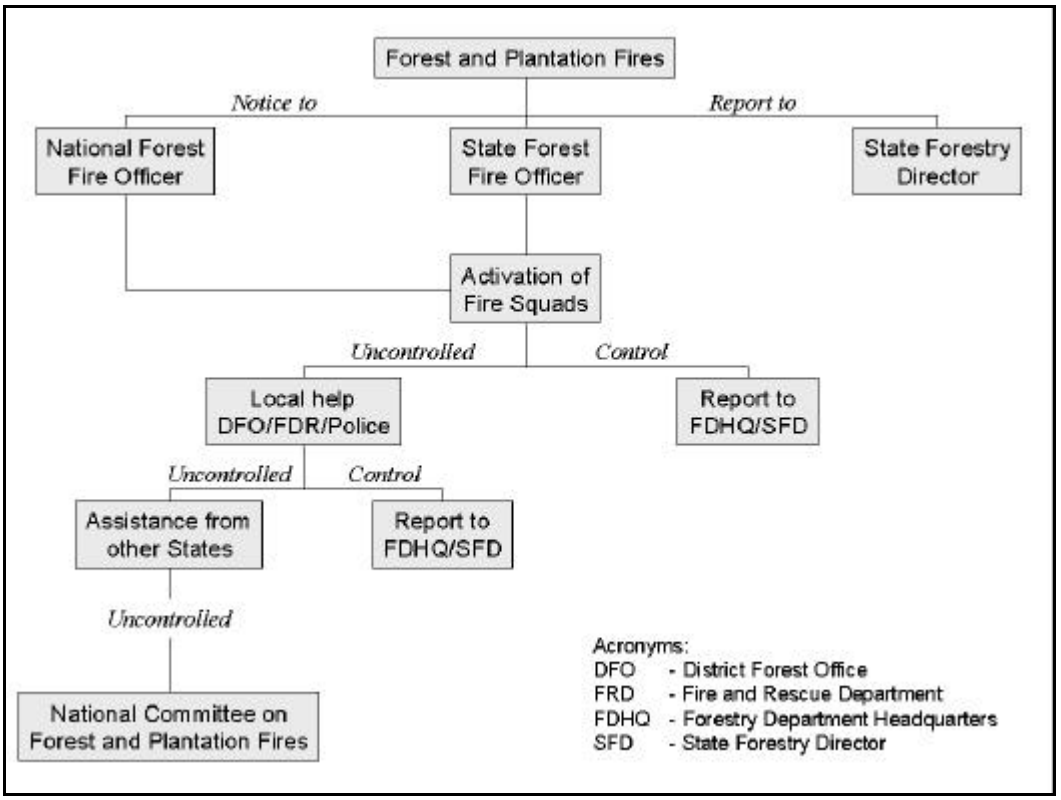


**Figure 1**. Forest fire management organization in Malaysia

# MONGOLIA

## Fire Situation in Mongolia

### Introduction

Mongolia is located in Central Asia with an area of 1 565 000 km$^2$ and a population of 2.3 million, which makes Mongolia one of the least populated countries in the world. The country borders Russia in the North and China in the South. Mongolia is a highland country located deep within the interior of Eurasia and has a marked continental climate with poor soil fertility, scanty surface water resources and harsh natural conditions.

Forests and grasslands play an important role in the economic development of the country. Forest cover is 12.5 million ha or 8.1 percent of the Mongolian territory. Forests consist mostly of larch (*Larix sibirica*), pine (*Pinus sylvestris*), birch (*Betula platyphylla)*, cedar (*Pinus sibirica*), spruce (*Picea* spp.) and saxaul (*Haloxylon ammodendron*). Grassland covers 70 percent of all territory. It is assumed that most of today's steppe vegetation is on former forest sites that have been degraded by fire. The Mongolian climate and geography, coupled with its economic and social structure, account for its considerable vulnerability to natural disasters. Winters are often very cold and springs are difficult with blizzards, tornadoes and regular wildfires. Heavy rains and floods occur in summer and heavy snowfalls occur in autumn; frosts and blizzards are common. Thus, throughout the year the country is under pressure from these natural disasters.

Wildfires constitute a major factor that determine spatial and temporal dynamics of forest ecosystems. Out of the total of ca. 17 million ha of forest land, 4 million ha are disturbed to varying degrees, either by fire (95 percent) or by logging (5 percent). Logged areas have increased drastically over the past 25 years. More than 600 000 ha of timber harvest have not recovered.

### Fire environment, fire regimes and the ecological role of fire

The highest fire hazard is found in the submontane larch (*Larix sibirica*) and pine (*Pinus sylvestris*) stands growing on seasonally freezing soils. These stands are distributed on Khentey, East Khentey and Khubsugul foothills that are characterised by an extremely continental climate. During the year, air temperature fluctuations can amount to 90°C, with the summer maximum being +40°C. Annual precipitation ranges from 250 to 350 mm. In exceptionally dry years, precipitation is less than 200 mm.

Forest fire statistics for the period 1963 to 1997 (see also Fig.1) reveal that the majority of fires burned 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. Moreover, economic activity is much higher here as compared to other parts of the region. Extreme fire seasons are caused by long droughts. Fires burn from April to July under such conditions. The average fire season usually has two peaks. One peak is during spring (from March to mid June) and accounts for 80 per cent of all fires. The other fire peak falls within a short period in autumn (September to October) and accounts for 5 to 8 percent of all fires. In summer, fires occur very rarely (only 2 to 5 percent of the total) because of heavy rains.

The intra-annual distribution of fires has been documented by seven forest protection air bases for the Khanngai and Trans-Baikal forest zones for the period 1985 to 1994 (Table 1). In these zones, fire activity is the highest in April and May with 33.3 percent and 48.1 percent of their total number in a fire season, respectively. Fires start in late March and early April, immediately after snow melt when forest fuels are drying rapidly on southern- and western-facing slopes.

Steppe fires under certain weather conditions often invade the adjacent forest-steppe and sub-taiga zones. In the mountain forest belt, especially in the high elevations, lightning fires are most common. Lightning storm activity increases considerably at the end of May and in early June. High fire danger is largely due to the prevalence of light-needled conifers in stands adjacent to steppe areas. These are mainly pine stands with mixed herbaceous ground cover, which are characterised by high fire danger in spring and autumn. Steppe vegetation and surrounding pine stands attain high flammability practically simultaneously. Fire occurrence depends on forest type, precipitation distribution and availability of ignition sources. Fires are frequent in pine and larch stands of the forest-steppe and sub-taiga zones, while they are more rare in larch and Siberian pine stands of the mountain taiga.

**Table 1.** Intra-annual distribution of forest fire distribution in Mongolia, 1985-1992.

| Local Airbase | Month | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | March | April | May | June | July | Aug. | Sep. | Oct. | Nov. | Total |
| **Ar. khalgai** | 2 | 18 | 8 | | | | 2 | 4 | | 34 |
| **Khovsgol** | | 19 | 23 | 11 | | | 2 | 2 | | 57 |
| **Bulgan** | 11 | 58 | 117 | 5 | | | 3 | 3 | | 197 |
| **Selenge** | | 27 | 52 | 8 | | | 3 | 9 | 1 | 100 |
| **Khentij** | 10 | 19 | 23 | 3 | | | | | | 55 |
| **Dornod** | 1 | 9 | 6 | | | | | 1 | | 17 |
| **Ulan-Baatar** | | 25 | 24 | 7 | | 2 | | 7 | | 65 |
| **Total** | **24** | **175** | **253** | **34** | | **2** | **10** | **26** | **1** | **525** |
| **Percentage** | **4.6** | **33.3** | **48.1** | **6.5** | | **0.4** | **1.9** | **5.0** | **0.2** | **100** |

In one of the most sparsely populated countries in the world, it is difficult to get accurate information on fire causes. It is known, however, that during the main fire seasons (spring and late fall), no natural fire causes exist. The recent increase in the number of fires is related to the opening of markets once highly controlled or restricted. The vast majority of fires are not deliberately set to clear land. Rather, it is a function of carelessness. One example is the collection of elk antlers for sale to European and Chinese markets. During the previous regime, a single, state run enterprise managed this market under strict controls and guidelines. Today, it is open to virtually anyone.

Fires start for three reasons:

1. Antler collection starts in the bitter cold of February when fire is simply a survival tool.
2. Sparks from vehicle exhaust pipes in remote forests.
3. Tracer bullets left by the Russian military have entered the game hunting market and are used to hunt elk for the blood antlers which have a higher value in the market place.

The most obvious consequence of frequent and intense fires is the loss of forested land. The current fire pattern is affecting 14 percent of this resource annually. The brief growing season and low growth capacity of the trees means that these forests may take 200 years or more to regenerate. In addition to their commercial value, these forests are a precious ecological resource. They contain the sources of virtually all rivers in the country including the inflow to Lake Baikal (Russia), the largest fresh water lake in the world. They protect soil, rangelands, provide habitat for wildlife and serve as windbreaks.

Narrative summary of major wildfire impacts on people, property, and natural resources during the 1990's

In an average year, 50-60 forest fires and 80-100 steppe fires occur annually. About 95 percent of steppe and forest fires in Mongolia are caused by human activities. Winters and springs from 1996 to 1998 were extremely dry and were lacking snow in most areas. From late February to early June of these years, Mongolia suffered from large-scale forest and steppe fires that devastated large parts of the country. During these fire episodes 29 people died, 82 people were injured and 11 700 livestock were killed. Also, 218 family houses, 1066 communication facilities, 750 fences and 26.3 million ha of pasture and forest burned. The total costs of property losses amounted to 820.2 million MN¥ (Mongolian Tughrik). Ecological and economical damage were estimated as 1 850.5 million MN¥ (December 1999 value: ca. $US 1.8 million).

**Fire management organization**

Until recently, a branch of the military known as the Civil Defence centrally managed fire events in Mongolia. The military maintained all training regimes, equipment and personnel with virtually no support to local communities. With the transition and associated economic difficulties, this centrally managed firefighting system has collapsed. Perhaps the single most important contributor to the *increase in fire spread* is the grounding of the Aerial Patrol Service. In 1969 the Mongolian Fire Protection and Aerial Patrol Service was established to provide early detection and rapid initial attack on fires. This Service was a Soviet-style aerial detection and airborne firefighting programme. The Service was staffed by 200 to 300 smokejumpers and helicopter rappellers; including a fleet of helicopters for helitack and tactical aerial support. The aerial forces operated out of seven bases distributed throughout the fire-prone regions of northern Mongolia. Smokejumpers on routine aerial patrols detected a high percentage of the fires and handled approximately 90 percent of the suppression workload. In the early 1990's, when the communist government and Soviet financial support abruptly disappeared, the Mongolian aerial

programme sharply declined. At present, Mongolians cannot afford to maintain and fly their aerial patrol aircraft. Instead, they must rely on NOAA satellite imagery as their primary early warning system with a spatial resolution of 1.1 $km^2$. The decline of the aerial program through the mid-1990's resulted in the creation of a "fire suppression void" and no doubt greatly contributed to the horrendous fire losses experienced in the 1996 and 1997 fire season

Immediately following the 1996 fires, Mongolia received assistance from international organizations to help local people recover from the losses. 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 improve fire management. In a first step, the parliament passed a law designed to organize and improve firefighting 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, provided long and short-term experts, support staff, training and equipment.

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 was the establishment of a fire management plan compatible with the protected area goals and the responsibilities of the local communities. Fire Management Units in the local communities received professional training and basic hand tools suitable for the regional conditions. Information and Training Centres provided the necessary infrastructure for fire prevention activities, management information, training exercises, dispatch and field organization.

**Community involvement in fire management activities**

The IFM project supported Mongolia by strengthening local capacities to effectively address the issues of fire prevention, pre-suppression and suppression. This is accomplished by helping to organize cooperative efforts between protected area staff and local and national administrations responsible for fire management. Additional goals include establishing the necessary infrastructure, providing training in-country and abroad and by including all stakeholders in the planning and implementation of fire management activities.

Integrated Fire Management, like other community-based programs, focuses on flexible, pragmatic approaches designed to support local people's role in resource management. Specifically it entails the application of the art and science of modern wildland fire technologies and practices to the local fire problem – i.e. the community level.

In the development of the program, the IFM Project started with the philosophy that an ounce of prevention is worth a pound of cure. Hence, the most effective fire suppression strategy is an effective fire prevention program. In the summer of 1998, the IFM project began pilot activities in the buffer zone communities surrounding the Khan Khentii Special Protected Area. Specifically targeted were the potential multipliers including Information Training Centre (ITC) "extension" officers, educators, protected area rangers and key community persons. This cooperative effort led to a number of educational materials that were developed and introduced:

- A fire prevention curriculum for school children.
- A fire prevention video.
- A ranger's handbook to be used as an outreach tool in remote areas.
- A colouring book for small children.
- A fire mascot to carry the prevention message.

The central focus of pre-suppression work has been the drafting of a fire management plan for the protected area administration and local communities.

Suppression goals include (1) the establishment of fire management crews, (2) provision of equipment and (3) the development of a locally run "Fire Training Programme" adapted to Mongolian conditions of fuels, fire behaviour and available suppression resources and logistics. In the spring of 1998, six Soum (district) governors in the protected area buffer zone formed fifteen-person (15) fire management units (FMU's – or suppression crews) for their respective Soums. Each crew consists of a crew boss, assistant crew boss and thirteen unemployed volunteers. The crew is jointly managed through a Memorandum of Understanding between the local community and the protected area administration. After establishment of the crews, the project identified equipment to match the fuel conditions. Fuel conditions throughout northeastern Mongolia closely resemble the fuel types of the western United States, British Columbia and interior Alaska: tough steppe grass with deep dense roots, brush, larch, pine, spruce, birch, moss and muskeg like valley bottoms. GTZ equipped the crews with fire swatters, fire shovels, pulaskis, adze hoes, Council-type fire rakes , backpack pumps, crosscut saws, chainsaw and hardhats. Each crew has been equipped with personal portable radios, a vehicle mobile radio and mobile repeaters for

communications with the dispatch centre. Stationary repeaters are being installed to link the Soum dispatch centers with the national coordination centre in Ulaan Baatar.

Starting in March 1999, the project assisted Mongolian fire specialists in developing a series of training materials, including a 32-hour Basic Firefighter Course with accompanying Instructor's Manual, Student Workbook, training videos and Crewboss Manual. The training programs were adapted from existing Mongolian training and the basic courses used to train American wildland firefighters: Introduction to Wildland Fire Behavior (S-190), Firefighter Training (S-130) and basic Incident Command System concepts. Approximately one half of the course was conducted in the field, including "practice fires" for mop-up and a live fire exercise on the final day. Crews were instructed in the bump-up progressive crew method of fireline construction. A fire instructor's training course for Mongolian instructors was established. In a subsequent phase, we observed and coached Mongolian instructors as they trained "rookie FMU crew members" and community (Soum) fire support crews. Due to unusually high precipitation during the winter, however, the project has been unable to evaluate crew performance on fires.

**Wildfire database**

Since the establishment of a NOAA satellite receiving station at the National Remote Sensing Centre of Mongolia in 1987, the staff of the Centre has developed and tested technologies for natural disaster monitoring, such as forest and steppe fire, drought, floods, meteorological phenomena etc.

The recent fire danger situation in forest and steppe zones challenged staff of the National Remote Sensing Centre to test and improve their operational technology to quickly process and transfer fire locations and other data to disaster related and administrative organizations. In the last three years, 788 fires were detected primarily by satellite data and thus millions of money was saved. The accuracy of detected hot spots as a fire is estimated to be 76.9 percent of the total number of cases between 1995 and 1999.

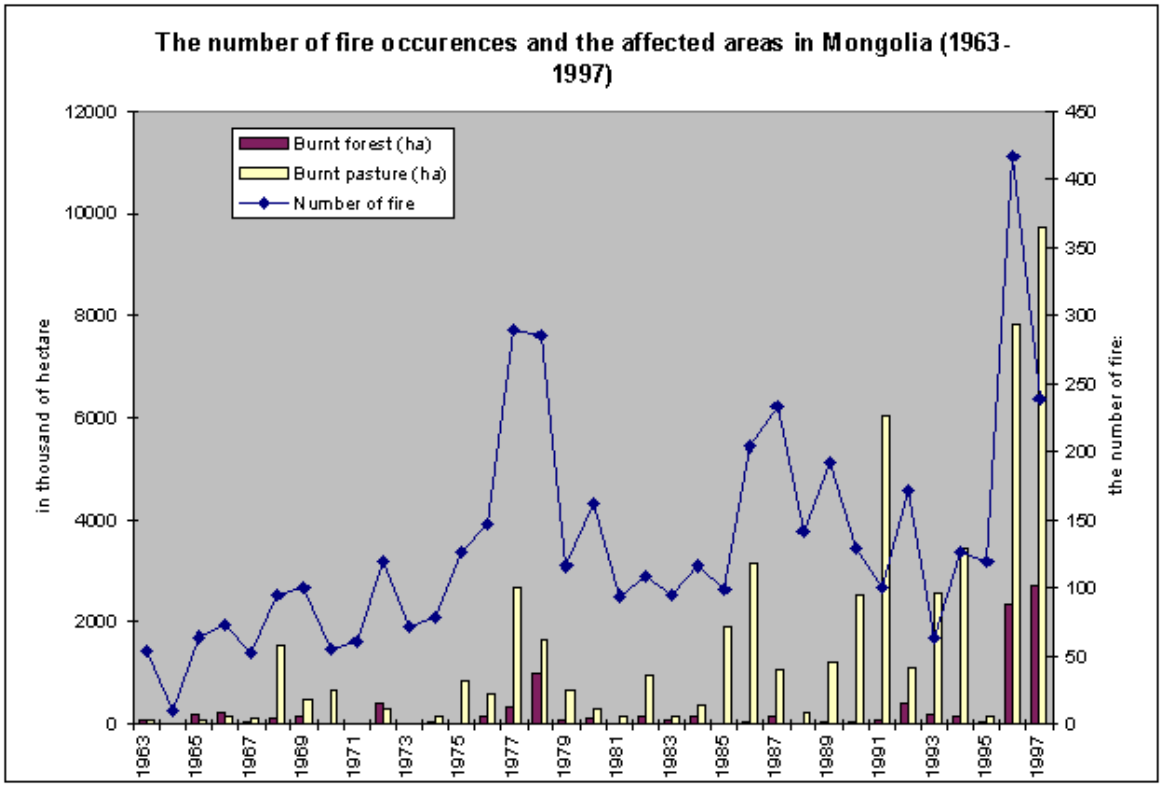


**Figure 1.** Number of fires and area burned in Mongolia 1963-1997

It is clear 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 six-fold. The areas hardest hit by these increases have been the forested regions. The typical forest fire season (1981-95) swept through some 140 000 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. Figures 2 and 3 provide maps showing the forest and steppe areas burned in 1996 and 1997. Figure 4 shows the area burned in Mongolia during spring 2000. The fire statistical data for the 1980s and 1990s are given in Tables 2 and 3.

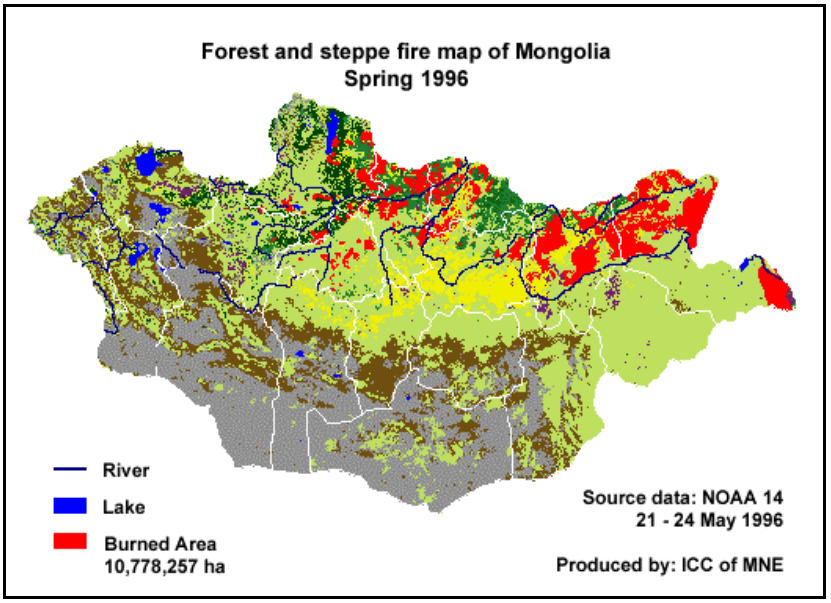


**Figure 2.** Forest and steppe fire map of Mongolia for the spring fire season 1996. Source: Computer Information Center, Mongolia.

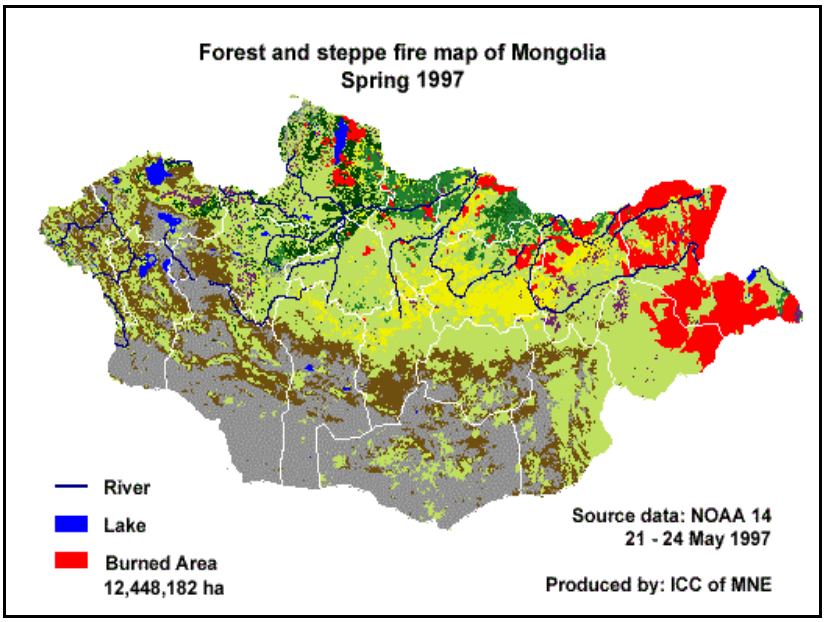


**Figure 3.** Forest and steppe fire map of Mongolia for the spring fire season 1997. Source: Computer Information Center, Mongolia.

**Table 2.** Wildfire statistics of Mongolia, 1981-1989.

| Year | Total No. of Fires on Forest, Other Wooded Land, & Other Land No. | Total Area Burned on Forest, Other Wooded Land, & Other Land ha | Area of Forest Burned ha | Area of Other Wooded Land and Other Land Burned ha | Human Causes No. | Natural Causes No. | Unknown Causes No. |
|---|---|---|---|---|---|---|---|
| 1981 | 94 | 169 200 | 4 600 | 164 600 | | | |
| 1982 | 109 | 1 100 000 | 156 300 | 943 700 | | | |
| 1983 | 95 | 245 400 | 87 400 | 158 000 | | | |
| 1984 | 116 | 513 900 | 156 200 | 357 700 | | | |
| 1985 | 99 | 1 896 700 | 3 400 | 1 893 300 | | | |
| 1986 | 204 | 3 187 000 | 30 600 | 3 156 400 | | | |
| 1987 | 233 | 1 228 000 | 143 300 | 1 084 700 | | | |
| 1988 | 142 | 243 000 | 2 300 | 240 700 | | | |
| 1989 | 192 | 1 281 000 | 51 000 | 1 230 000 | | | |
| **Average** | **160** | **1 096 022** | **82 400** | **1 060 000** | | | |

**Table 3.** Wildfire statistics of Mongolia, 1990-1999.

| Year | Total No. of Fires on Forest, Other Wooded Land, & Other Land No. | Total Area Burned on Forest, Other Wooded Land, & Other Land ha | Area of Forest Burned ha | Area of Other Wooded Land and Other Land Burned ha | Human Causes No. | Natural Causes No. | Unknown Causes No. |
|---|---|---|---|---|---|---|---|
| **1990** | 129 | 2 577 000 | 55 000 | 2 522 000 | | | |
| **1991** | 101 | 6 099 000 | 639 000 | 6 035 100 | | | |
| **1992** | 171 | 1 541 000 | 390 700 | 1 123 300 | | | |
| **1993** | 63 | 2 763 000 | 202 000 | 2 561 000 | | | |
| **1994** | 126 | 3 600 000 | 165 000 | 3 435 000 | | | |
| **1995** | 120 | 168 570 | 34 200 | 134 370 | | | |
| **1996** | 417 | 10 194 400 | 2 363 600 | 7 830 800 | | | |
| **1997** | 239 | 12 440 000 | 2 710 00 | 9 730 000 | | | |
| **1998** | 132 | 5 200 000 | 700 000 | 4 500 000 | | | |
| **1999** | 76 | 3 130 000 | 30 000 | 3 100 000 | | | |
| **Average** | **157** | **4 771 297** | **731 950** | **40 971 570** | | | |

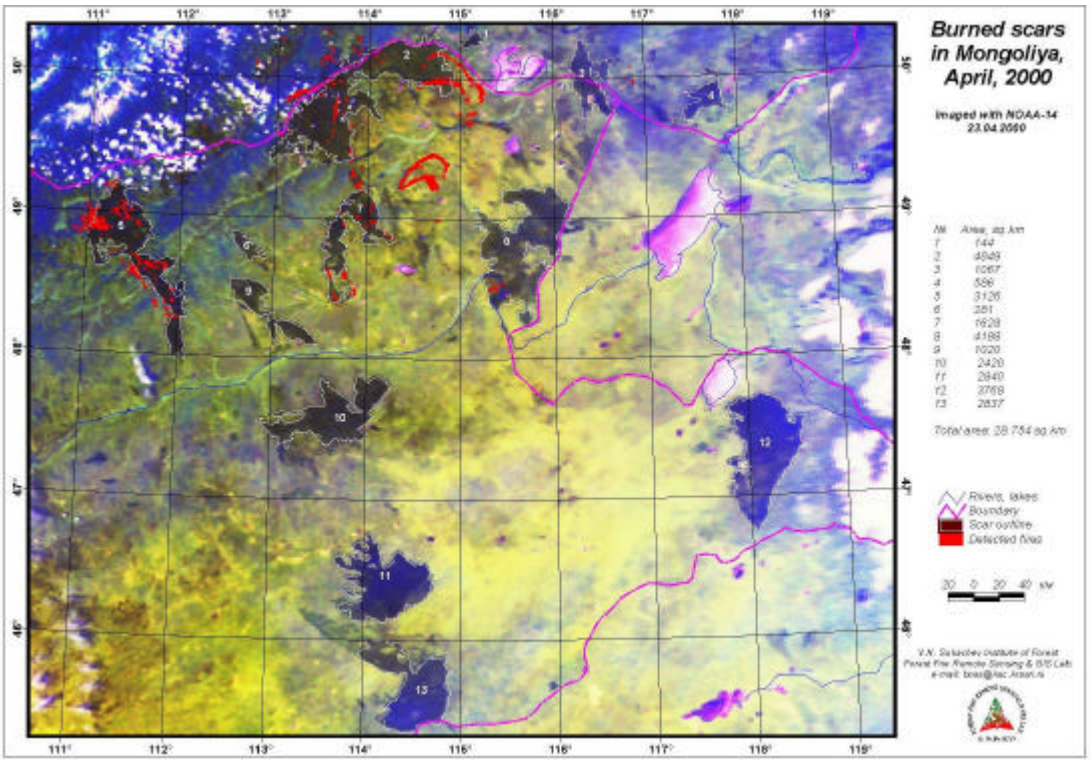


**Figure 4.** Forest and steppe area burned in Mongolia in spring 2000 (date of satellite image: 24 April 2000). The total area burned was 2.87 million ha. Source: A. Sukhinin, Sukachev Institute for Forest, Fire Laboratory, Krasnoyarsk, Russian Federation.

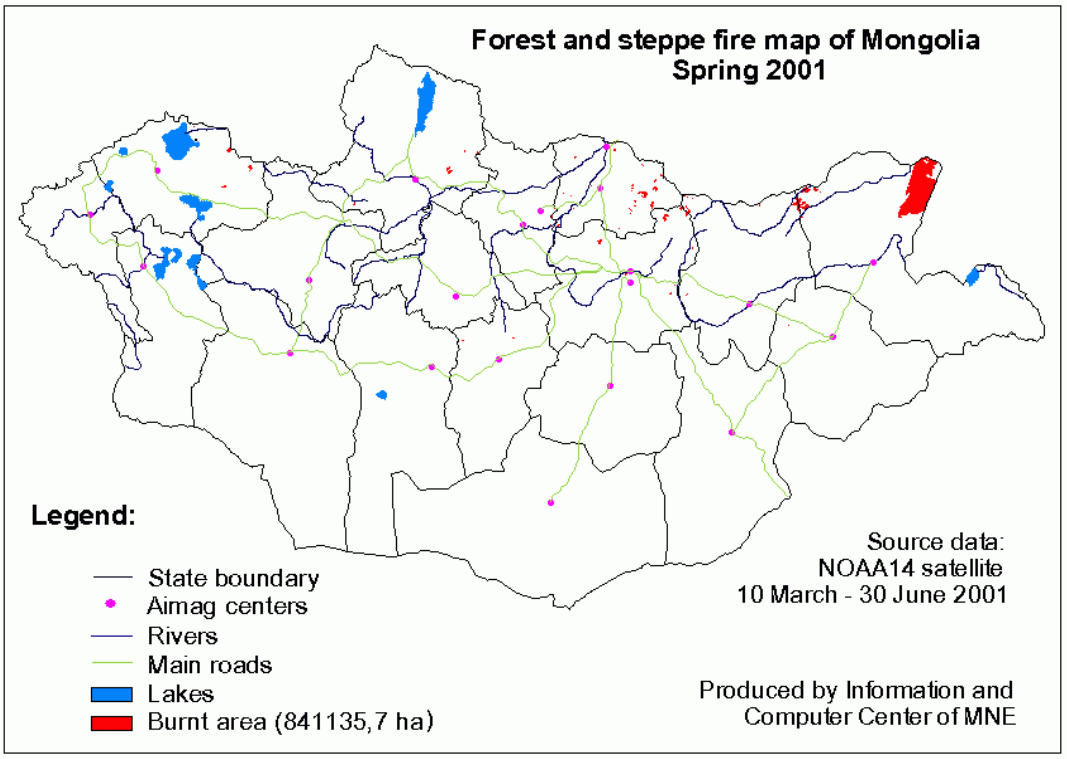


**Figure 5.** Forest and steppe area burned in Mongolia in spring2001. The total area burned was 0.84 million ha. Source: Computer Information Center, Mongolia.

**Figure** 6. Open, park-like pine stand (*Pinus sylvestris*) in the steppe-forest transition zone in Mongolia. The pine forests are regularly affected by surface fires. Photo: GFMC.

**Public policies**

The underlying causes for a dramatic increase of forest and steppe fires in Mongolia are deeply rooted in the changing socio-economic conditions of the country. The government has recently taken significant steps in this direction through the establishment of *a Fire Management Agency*. Pursuant to newly enacted legislation, the Mongolian Civil Defence and State Police will transfer their responsibilities to the new agency including associated resources (personnel, budget and equipment).

National endeavours to strengthen fire management capabilities of government institutions as well as local communities have been supported by the Integrated Fire Management (IFM) Project. The GTZ project was terminated at the end of 2000. The FAO in 2000 granted a Technical Cooperation Project (TCP) to improve fire management in Mongolia that will be implemented in 2001. It is planned that FAO and GTZ will collaborate in assisting the country to upgrade its fire management capabilities. For future development the areas of particular concern are:

- **National Oversight –** Appropriate oversight will be required: (1) to ensure quality control and preparedness; (2) to help with the standardisation of training, procedures, and safety; (3) to provide technical assistance and specialised training; (4) to facilitate cooperation/coordination among agencies; (5) to evaluate training and determine need for additional training; and 6) to determine fire management program needs.
- **National Level Training Centre** - Mongolia has a major and complex fire problem. Only a handful of firefighters has received basic fire training. To effectively fight complex and large fires requires training beyond the basic level. Wildland firefighters in developed and some undeveloped countries take several higher courses that are more specialised. Large and complex fires require a higher level of understanding of fire behaviour, strategy and tactics and organization. ICS requires multi-agency training of ICS principles.

- **Coordination and Cooperation –** A remaining challenge is the coordination of management planning with other institutions and agencies responsible for fire management at the regional and national levels. The project has not had sufficient time to adequately address this need. Nevertheless, experiences tell us that this kind of coordination is an integral part of the decentralisation process in Mongolia and will require profound changes at all levels of affected government.
- **Communications System** - All interagency team members need a common radio system - one they can program to an incident fire frequency. All agencies should be linked to local and regional dispatch centres.
- **Early Warning Systems** - Faster detection means smaller fires, a need for fewer firefighters and greatly reduced expenses associated with firefighting. A system of staffed observers, ground and air, would significantly increase detection capability and significantly speed up fire crew attack and containment time.

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# NEPAL

## Forest Fire Situation in Nepal

### Fire environment, fire regimes, and ecological role of fire

Nepal is a small country of 14.7 million hectares and 23 million people situated in the central Himalayas, covering the northern edge of the Indian Gangetic plain to the high Himalayan ridges bordering the Tibet region of China. The country has topographic variation from 150 meters above sea level at the southern border to the highest mountain in the world (Everest at 8 848 m) in the north. Due to the east-west orientation of the mountain ranges, the country has a tropical climate in the south and temperate and alpine climates in the north. Accordingly, there are many different forest types in Nepal.

#### *The Terai-Bhaber Region*

The southernmost physiographic region of Nepal, called the Terai-Bhaber region, has an average altitudinal range between 150 and 300 m above sea level. It has a tropical climate with the main forest type comprised of sal (*Shorea robusta*) with smaller proportions of moist evergreen forest, dry deciduous forest, and khair-sisoo (*Acacia catechu*/*Dalbergia sissoo*) forest. The total forest area in this region amounts to about 475,000 ha within a total regional area of 2.11 million ha. There are also some 111,000 ha of shrubland and grassland.

In this region, the accumulated glabrous sal leaf litter is burned every year and during the process naturally regenerated sal seedlings and other herbs and shrubs are burned. However, larger green trees are usually not damaged and neither are the root systems of the sal seedlings, although the aerial parts are burned. Sal forests appear to be able to regenerate only when there are no surface fires.

#### *The Siwaliks Hills and the Inner Terai Region*

The next northern physiographic region includes the Siwaliks Hills and the Dun valleys (also called the Inner Terai in Nepal) and has an altitudinal variation between 300 and 1000 m. It is characterized by a subtropical climate. The major forest types in this region include *Schima-Castanopsis* forests on the northern slopes of the Dun valley; the subtropical pine (*Pinus roxburghii*) forests on the Siwaliks ridges, dry scrubby forests on the southern slopes of the Siwaliks and moist *Lauracea* forests in the northern moist localities along with patches of sal forest. This region has 1,438,000 ha of forests and 104,000 ha of shrubland, grassland, and other non-cultivated woodlands within a total regional area of 1,886,000 ha.

Here, too, the vegetation along the southern drier slopes is burned during the dry season starting in March. Occasionally, bamboo brakes and grassy areas are destroyed, but the larger trees are usually spared. Nevertheless, the smoke created by forest fires and from agricultural burning make the valleys and the countryside very hazy and drab throughout the dry season.

#### *The Middle Mountain Region*

From 1000 m along the southern foothills of the Mahabharat Range (ridge tops up to 3000 m) to the hills of Nepal to an altitude of 2500 m is called the Middle Mountain Region. It has mostly lower temperate forests. These are mainly broadleaved forests with *Pinus roxburghii* up to 2000 m and *Pinus wallichiana* at the higher elevations. The river valleys in this region may be as low as 400 m. and sal forests (also called hill sal, a somewhat less luxuriant variety of *Shorea robusta*) and other subtropical broadleaf forests can occur here. The region has a total area of 4,442,000 ha with 1,811,000 ha of forests and 1,349,000 ha of shrubland, grassland and non-cultivated woodland.

Usually the pine forests and pine plantations, which are more susceptible to fire due to resin content, are frequently burned. As a result, the extensive chir pine (*Pinus roxburghii*) forests, which grow in the main habitat zone between 1000 to 2000 m, have become greatly fragmented.

#### *The High Mountain Region*

This region extends from 2000 to 3500 m above sea level, mostly with upper temperate forests of *Quercus semicarpifolia*, other broad-leaf forests composed mainly of *Rhododendron* spp., as well as coniferous forests of *Pinus wallichiana*, *Abies pindrow* and *Picea smithiana*. There is also a narrow belt of *Tsuga brunoniana*. This region has 1,630,000 hectares of forests together with 832,000 ha of shrubland, grassland and non-cultivated woodland within a total regional area of 2,960,000 ha.

In this region, coniferous forests are susceptible to extensive fire damage during the dry season, especially on windy days.

***High Himal Region***

This region mainly has alpine forests of birch (*Betula utilis*) as well as bushy rhododendrons and junipers. The total area of the region is 3,350,000 ha with only 155,000 ha of forests but with some 953,000 ha of shrubland and grassland. There is little cultivation here and a lot of snow- and rock-covered barren lands.

In all cases, the fire problems are acute for three to four months during the dry period between March and June every year. In most cases fires are caused by negligence. Sometimes grazers burn dry grassy areas purposely in order to get young shoots immediately after the first few pre-monsoon showers.

**Narrative summary of major wildfire impacts on people, property, and natural resources during the 1990s**

Every year wildfires destroy considerable forest resources in Nepal. Such destruction includes both timber and non-timber forest products. Although quantitative information is not available, forest fires are definitely degrading biological diversity in Nepal's forests. In addition, fires cause soil erosion and induce floods and landslides due to the destruction of the natural vegetation. Occasionally, embers from forest fires also cause fires in nearby villages, especially in the Terai region where the roofs are made of thatched grass. Many villages are burned every year with loss of lives, cattle and other property.

At least one hundred villages are burned annually in Nepal, some of which are definitely destroyed by forest fires.

**Fire management organisation used in Nepal**

There is no organisation for fighting forest fires in Nepal. The Department of Forests does not possess any special unit or team to deal with the problem of forest fire, including firefighting or management. None of the 75 district forest offices, with a number of graduate foresters and forestry technicians, has either the capacity or capability for preventing or fighting forest fires. It is probable that these offices under-report forest fire incidences and subsequent damage. Unless forest fire surveillance and monitoring are carried out by satellite imagery it will be difficult to make a good assessment of forest fire numbers, area burned and damage.

In Nepal some 10,000 local forest user groups have been formed with a total of 600,000 ha handed over to them as local community forests. Most of these community forests are located in the Middle Mountain Region where forests are severely fragmented and surrounded by villages. Here the community forest users are able to protect their respective forests from cutting and grazing. However, occasional forest fires occur due to the negligence of smoking travellers. The forest users are able to fight forest fires although they do not have proper tools and technical support. In fact, community forests are not managed properly, nor are forest fires fought in an appropriate manner.

**Wildfire database**

A wildfire database or other wildland fire statistics are not available. However, the magnitude of the forest area annually affected by fire is known. Sharma (1996) observed that in 1995 about 90 percent of the Terai forests were burned. Earlier observations by Goldammer (1993) confirmed this statement. Accordingly, the forest area burned annually must be in the order of more that 400,000 ha.

**Use of prescribed fire to achieve resource management objectives**

Prescribed fire is not used in Nepal to prevent forest fires. However, pine needles are collected for cattle bedding. Similarly, forest litter in the hills is collected and mixed with cattle dung for composting.

**Public policies affecting wildfire impacts**

Although the government devotes considerable attention in parliamentary discussions and the politicians and bureaucrats highlight the importance of forest fire prevention and firefighting, fire events are soon forgotten after the monsoon starts in June. During the fire season, Nepal Radio and Nepal Television broadcast old clips on forest fire prevention and firefighting.

**Sustainable land use practices used in Nepal to reduce wildfire hazards and wildfire risks**

In the past, district forest offices hired temporary fire guards, even though they were not effective in forest fire prevention. Of course, these temporary staff, as well as the permanent forestry staff, cannot achieve much in terms of forest fire prevention and firefighting without appropriate tools and organization.

**Community involvement in fire management activities**

Community involvement in fighting forest fires exists only in the community forests that have been established. Community involvement does not exist in the state forests and national parks, which constitute 90 percent of the Nepalese forests and related wild lands.

**Conclusions**

Forest fires occur annually in all the major physiographic/climatic regions of Nepal, including the Terai and Bhabar, the Siwaliks or the inner Terai, the Middle Mountains, and the High Mountains regions.

The main causes of forest fires are anthropogenic due to negligence and occasionally by deliberate burning to induce succulent grass growth for domestic animals.

Forest fires occur during the dry season from February to June and the nature (surface fire, crown fire, etc) as well as the severity varies greatly depending upon fire weather, fuel conditions, and physiography. Once the monsoon is established, usually by the middle of June, the fire problem disappears.

Forest fires destroy timber and non-timber forest products, although no data are available about the number of fires, severity and the amount of loss. Fires also reduce the biological diversity of the forests to a great extent. In addition, fires degrade the soil, inducing flood and landslide damage. Forest fires make the entire countryside hazy, thereby reducing aesthetic values for eco-tourism during the dry season.

Forest fire management is not practiced in Nepal. The community forest user groups control forest fires in their own forests, although they do not have a plan for systematic prevention and control of fires.

Systematic arrangements for prevention, control, and management of forest fires can be instituted in Nepal only when scientific forest management is implemented within the Department of Forests for state and community forests.

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# NEW ZEALAND

## Wildland Fires in New Zealand in the 1990s: Retrospective and Challenges

### Fire Environment, Fire Regimes, Ecological Role of Fire

The vegetation cover of New Zealand has never been static, indeed even before the arrival of humans a thousand years ago, natural processes such as volcanism, glaciation, earthquakes and high winds caused landscape-wide changes in vegetation cover.

With the arrival of humans the pace and extent of vegetation cover changes increased dramatically, resulting in a large proportion of our natural forest being destroyed. Fire, both deliberate and accidental, played a large part in these changes.

Although changes in vegetation cover continue to occur, the overall outcomes in terms of vegetation types and quantity of available fuels has been reversed in more recent times, from a reduction in overall biomass (or fuel), to an increase in biomass. Whereas before the middle of last century many of our native forest, tussock land, wetland and scrubland areas were generally converted to pasture lands, nowadays many of these pasture lands are economically non-viable and are either reverting to scrublands or have been planted with exotic forest species.

Since 1951 the area in planted production forest has increased from 338,000 ha to 1,761,000 ha, an increase from 1.3 to 6.5 percent of the total land area of New Zealand. This area is predicted to increase to 2.5 million ha by 2010; equivalent to 9 percent of the total land area of New Zealand.

Changes in the management of South Island tussock lands will see around one million hectares of these lands retired from the pastoral lease system and included in the conservation estate. This land use change will result in much greater volumes of fuel accumulating on these ex-grazing lands.

The vegetation changes in plantation forests and tussock lands, in addition to the reverting of previously productive pasturelands to scrublands, are significantly transforming the land cover of New Zealand. The change is now clearly from less complex to more complex fuel types, from low fuel loads to high fuel loads and from fragmented to continuous areas of fuel.

These changes have a two-fold impact on the consequences of wildfires on our rural lands. Firstly, the higher fuel loads and larger areas of continuous fuels will make fires harder to control and will result in larger areas being burned. Secondly, the increase in economically and ecologically valuable vegetation types will result in future fires having a greater overall impact in terms of loss of valuable assets.

The overall results of these fire environment and fire impact changes will not become apparent until a prolonged period of drought and extreme fire danger levels combined with a number of fire ignitions coincide. The average return period for these extremely damaging fire seasons, although difficult to quantify, is probably in the order of 15 to 25 years.

### Narrative Summary of Major Wildfire Impacts on People, Property and Natural Resources during the 1990s

Large and devastating wildfires occur relatively infrequently in New Zealand when compared with countries such as Canada, Australia and the USA.

The number of hectares that are burnt annually by wildfires varies considerably, being driven predominantly by the weather conditions during the summer season. The worst fire season since 1980, occurred in 1982-83 when 45,000 ha were burnt. More recently, the 1998/99 fire season resulted in 18,000 ha being burnt, half of which can be attributed to two fires around Alexandra during February 1999 that destroyed two dwellings and many sheds and outbuildings. The average area burnt per annum since 1980 is 10,000 ha. Wildfire statistics for the decade 1990-1999 are given in Table 1.

The total economic and environmental cost that rural fires impose on New Zealand is not currently measured. This figure would have to include the loss of biodiversity, the destruction of production forests and other property and the reduction in water and soil quality following fire.

**Table 1.** Wildfire statistics of New Zealand for the fire seasons 1990-91 to 1999-2000

| Year | Total No. of Fires on Forest, Other Wooded Land and Other Land<br>No. | Total Area Burned on Forest, Other Wooded Land and Other Land<br>ha | Area of Forest Burned<br>ha | Area of Other Wooded Land and Other Land Burned<br>ha | Human Causes<br>No. | Natural Causes (lightning)<br>No. | Unknown Causes<br>No. |
|---|---|---|---|---|---|---|---|
| 1990/91 | 1,234 | 7,279 | 240 | 7,039 | not available | not available | not available |
| 1991/92 | 1,153 | 1,889 | 152 | 1,737 | 1,116 | not available | 37 |
| 1992/93 | 990 | 3,129 | 151 | 2,978 | 948 | not available | 42 |
| 1993/94 | 2,198 | 7,350 | 177 | 7,173 | 2,142 | not available | 56 |
| 1994/95 | 2,023 | 4,594 | 466 | 4,128 | 1,965 | not available | 58 |
| 1995/96 | 1,646 | 4,586 | 348 | 4,238 | 1,602 | not available | 44 |
| 1996/97 | 2,374 | 6,937 | 746 | 6,191 | 2,331 | not available | 43 |
| 1997/98 | 3,610 | 6,253 | 1,296 | 4,957 | 3,563 | not available | 47 |
| 1998/99 | 3,165 | 17,699 | 213 | 17,486 | 3,107 | not available | 58 |
| 1999/00 | 2,944 | 2,054 | 141 | 1,913 | 2,880 | 5 | 59 |

Notes:

Human Causes: includes "miscellaneous" causes of fire

Natural Causes (i.e. lightning): not recorded separately until 1999/2000

1990/91: breakdown of causes not available

**Operational Fire Management Systems(s) and Organisation(s) Present in the Country or Region**

The New Zealand Fire Service Commission governs fire services in New Zealand by administering the Fire Service Act (1975) and the Forest and Rural Fires Act (1977). These two Acts provide the frameworks within which the New Zealand Fire Service, the National Rural Fire Authority and Rural Fire Authorities carry out their responsibilities.

The New Zealand Fire Service, under the Fire Service Act (1975). Is responsible for protecting life and property from fire, primarily within urban areas. Outside urban areas, the National Rural Fire Authority promotes and encourages rural fire co-ordination under the Forest and Rural Fires Act (1977), with the responsibility to prevent, detect and extinguish fires falling on Rural Fire Authorities.

Rural Fire Authorities are independent organisations with responsibilities for fire control measures including prevention, restriction and suppression of fires in forest and rural areas.

Each Rural Fire Authority falls into one of the tree following categories:

***State Areas***

The Minister of Conservation, through the Department of Conservation is the Rural Fire Authority for the lands administered by the Department. This may include a one-kilometre fire safety margin around Conservation land.

***Rural Fire Districts***

Landowners looking to provide greater fire protection for their lands, or territorial authorities that wish to amalgamate their fire protection responsibilities with neighbouring authorities, may establish a Rural Fire District. Rural Fire Districts ranging in size from several thousand hectares to three million hectares are currently in existence. The New Zealand Defence Force is the Rural Fire Authority for eight Rural Fire Districts covering their lands.

***Territorial Authorities***

Areas that are not covered by and Urban Fire District, a Rural Fire District, or a State area are the responsibility of the Territorial Authority, who becomes the Rural Fire Authority.

The National Rural Fire Authority provides support and co-ordination to Rural Fire Authorities, including the following:

- Developing and managing the Rural Fire Management Code of Practice and conduction compliance audits of Rural Fire Authorities against this Code.
- Promoting and delivering rural fire training.
- Monitoring and reporting fire danger conditions throughout the country to Rural Fire Authorities and media.
- Providing technical advice to Rural Fire Authorities.
- Providing grants to Rural Fire Authorities for equipment purchases.

**Use of Prescribed Fire**

***Forestry***

Little controlled forestry burning has been carried out in the last 10 years.

***Other vegetation management (grasslands, bushlands)***

Little prescribed burning is carried out.

***Agricultural maintenance burning***

Burning is still used quite extensively in the high country areas of New Zealand as a land management tool predominantly in tussock areas to encourage new growth and enable oversowing with grass species in an effort to improve the pasture. Burning is also carried out to remove weed species. Access for stock is also improved after burning.

Most high country burning is carried out in the spring when soil and moisture levels are generally high.

***"Let Burn" (or integration) of natural (lightning) and human-caused wildfires***

Fires are extinguished rather than left to burn.

***Research***

Research burning trials are being undertaken.

**Practices to Reduce Wildfire Hazards**

Fire hazard reduction and preventive measures of forest management include construction of bulldozer track fuel breaks, windrowing of materials, and silvicultural treatment of forests

**Public Policies Concerning Fire**

The policies of the country are included in the following legislation:

- Fire Service Act (1975)
- Forest and Rural Fires Act (1977)
- Forest and Rural Fires Regulations (1979)

A National Fire Prevention Campaign is supported by local campaigns.

**Figure 1.** Prescribed burning for site preparation in New Zealand using aerial ignition. Photo: GFMC.

**Fire Management Needs and Challenges**

Rural Fire Authorities are responsible for all aspects of fire management outside urban fire districts, including fire suppression. There are a number of options available for Rural Fire Authorities to carry out fire suppression, ranging from using their own staff or contractors, using Volunteer Rural Fire Forces, or contracting the New Zealand Fire Service. Most Rural Fire Authorities use a combination of these options to effectively protect their area and meet their statutory responsibilities.

The New Zealand Fire Service attends all fires, including vegetation fires inside urban fire districts. The New Zealand Fire Service also responds to some fires outside the urban fire district every year. There are however vast areas in New Zealand outside of New Zealand Fire Service coverage.

The Department of Conservation responds to approximately 150 to 200 fires per year, most of which are attended by the Department's staff.

Other Rural Fire Authorities respond to approximately 2,000 to 3,000 fires per year, some of which are also attended by the New Zealand Fire Service.

Most Rural Fire Authorities have mutual aid agreements with their neighbouring authorities, recognising the fact that regional co-operation is the only efficient manner to deal with larger vegetation fires.

Continued changes in the rural area, the increased use of our forest and rural lands and the greater emphasis on environmental protection necessitate the development of new strategies to adequately manage fire in the rural landscape.

These strategies need to be developed co-operatively with the rural fire sector to ensure ownership of the solutions, effective implementation and long term sustainability of any change.

Suggested strategies are:

- Develop rural fire risk management tools
- Increase the level and focus of fire prevention and mitigation activities
- Develop regional and national incident management teams
- Establish seasonal fire fighting teams

**Wildland Fire Research**

The aim of the Forest and Rural Fire Research project is predicting where wildfires are most likely to break out, what fuels them and helps them burn and how fire managers can be best prepared to fight them.

The main aim is to develop a New Zealand Fire Danger Rating System; a decision support tool that predicts likely fire behaviour based on weather, fuel and topographic variables. The programme has five main objectives:

- Development of fire behaviour models for New Zealand fuel types that predict how fast fires will spread under different weather conditions
- Development of a method of assessing curing (or die-off) of grasslands, an essential element in grassland fire behaviour prediction
- Describing New Zealand's fire climate using historical weather and fire danger data from the network of remote automatic weather stations around the country
- Using Geographic Information Systems (GIS) to combine the climatic and physical factors that influence fire behaviour, so that maps of current and expected fire danger conditions can be produced
- Combining this information into a decision support system that provides fire managers with the information to better prevent, predict and fight damaging wildfires

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# PHILIPPINES

## Fire Situation in the Philippines

### Introduction

In the Philippines, about 5.49 million ha or roughly 18 percent of the total land area are still covered with forests. The remaining old growth, or primary dipterocarp forests, comprises only about 0.804 million ha, far from the 12 million ha of old-growth forest that existed 55 years ago (Igsoc 1999). A close look at the causes of this reduction indicates that the major factors of denudation are *kaingin*, or shifting cultivation, forest fires, illegal occupancy, conversion to other uses, clearing in the process of logging, pests and diseases. Fire is obviously a very serious problem that threatens the few remaining forests of the country. Humans have caused most of the reported forest fires, either intentionally for economic gains such a *kaingin*, charcoal production, etc., or unintentionally through negligence or carelessness.

The major forest vegetation types of the Philippines include:

- Dipterocarp forest at 0-800 meters above sea level (m. s. l.);
- Mangrove and beach type forests (within the coastlines);
- Molave forest (premium hardwood at 0-800 m. s. l.);
- Pine forest (800-2 000 m. s. l.);
- Mossy forest (*Lithocarpus* and *Podocarpus* species at the higher fringes).

Four climatic zones are distinguished in the country by distribution of precipitation:

I Six months dry and six months wet.

II No definite dry season, wet from November to January.

III Dry from November to April, wet during the rest of the year.

IV Rainfall evenly distributed throughout the year.

Southeast Asia is periodically affected by the El Niño-Southern Oscillation (ENSO) phenomenon that induces prolonged dry or wet seasons. If a prolonged drought occurs, the aforementioned forest vegetation types are prone to disturbance by wildfires, except for mangrove and beach type forests.

Prior to massive land-use changes (1960s-1970s) in the different forest vegetation types, fire protection efforts were concentrated in the pine forests, predominantly in *Pinus kesiya* and *Pinus merkusii* stands. These pine forests are still the most fire-prone forest ecosystems in the Philippines, although grasslands, plantations and agricultural areas are also vulnerable and at high risk for wildfires that threaten adjacent forests.

During the drought of 1983, the first large fire was experienced in the dipterocarp rainforest in the southern part of the country (Mindanao). The massive build-up of understory fuels, coupled with drought and the presence of a large number of ignition sources resulted in an unprecedented fire situation in the Philippines and Southeast Asia. The major factors that contributed to the abnormal situation in the Southeast Asian rainforest were:

- Land-use changes brought about by forest resource exploitation;
- Agricultural expansion due to the survival needs of an ever-increasing population; and
- Erratic climatic changes with prolonged droughts.

The montane “mossy forest” stretching above the pine forest belt is not usually prone to fire. Regular burning of the pine forests in the lower slopes is slowly reducing the mossy forest area at its edges, causing the intrusion of pine and grassland vegetation. This situation threatens the valuable mossy forest with its biodiversity-rich vegetation, which is high in medicinal, scientific and ecological values. This type of forest is an important habitat of migrating birds from mainland Asia.

The indigenous pine forest on the island of Luzón is a fire climax forest due to its long history of regular fire influence. Evidence is given by dendrochronological analyses (fire scars in tree stems) and by reports of villagers on large fire events in the hinterlands of the Cordillera mountain range in the northern part of Luzon Island. According to these reports, fires could burn whole villages when houses were made with thatched grass roofs. In 1975, a sawmill and its surrounding residential houses were burned when crown fires occurred on the steep slopes of the nearby pine forest. This happened again in the same spot in 1987. In 1981, two firefighters were

killed when they were trapped in the rugged terrain of a watershed. During the drought of 1983, a vehicle was burned while at a fire scene.

**Figure 1**. Severe site degradation in the montane pine forest (*Pinus kesiya*) in the cordillera of Luzón, Philippines, due to the combined effects of trampling, grazing and fire. Photo: GFMC

Large fires in the pine forest often burn for weeks and are difficult to control due to the rugged mountainous terrain, lack of appropriate equipment and the unavailability of trained manpower. Large fires in different parts of the country, along with other neighbouring Southeast Asian countries, contributed significantly to the smoke-haze in Asia, especially during the drought of 1997-1998. Fire data for the 1990's in different regions of the country are shown in Table 1.

**Table 1.** Forest destruction in the Philippines by cause

| Year | Total<br>ha | Kaingin<br>ha | Fire<br>ha |
|---|---|---|---|
| **1993** | 17 862 | 90 | 15 329 |
| **1994** | 10 234 | 1 528 | 7 719 |
| **1995** | 24 102 | 408 | 10 330 |
| **1996** | 5 185 | 94 | 4 557 |
| **1997** | 22 321 | 4 707 | 1 368 |
| **Total** | 79 704 | 6 827 | 39 303 |
| **Annual Average** | 15 941 | 1 365 | 7 861 |

Source: DENR Annual Reports cited by Igsoc (1999).

**Fire management organizations**

Operational experiences in fire protection and management are more specialized within the pine forest area and forestry projects where external assistance has been provided. In the 1970s and 1980s, a fire control council for the pine forest area existed whereby all involved organizations (government agencies, local government, industries and private sector) were being coordinated by the Bureau of Forest Development. The reorganization of the operations of the Department of Environment and Natural Resources (DENR), which included the Bureau, resulted in the council's discontinuance. Fire protection was relegated to the regular operations of the DENR's field units.

A technical cooperation project, which focused on basic fire research and provided a fire management operational force within the Cordillera Administrative Region, was implemented with FAO assistance from 1987-1990.

With the shift of DENR's operations in the 1990s, the regular forest protection units of DENR have to contend with meagre government funds and limited personnel. While the communities in the field were enjoined to help in fire protection, operational facilities and large fire organization needs cannot be met, which in some aspects discourages volunteerism.

In the case of industries, they maintained their own organizational capabilities and on several occasions the DENR provided training at their request. The decentralization of power to the local govemments has also fostered innovation in isolated cases, depending on priorities. In Mountain Province, a fire prevention incentive mechanism was implemented with the political leadership (concept published with IFFN in 1997) for a short period.

The large fires that occurred during the 1997-1998 drought highlighted the need for a national fire organization. The Armed Forces were involved in the suppression activities that led to the declaration of forest fires as a national disaster. At present, a national coordination and operational capability is still needed in case of a drought where wildfires are expected. Research activities to improve capability and draw up a national programme are needed in the following areas:

- An appropriate fire danger rating system in various forest vegetation types;
- Fuel assessment at various locations and forest vegetation types;
- Development of appropriate technologies;
- Impact assessments;
- Development of burning prescription guidelines.

**Prescribed burning**

The use of prescribed burning as a management tool has been in use in various areas in the country, although policy guidelines for such actions have not been provided. This is most common in the areas such as:

- pasture areas to induce forage;
- fuel reduction (pine forest);
- natural regeneration (pine forest);
- debris burning in farm lots especially within forest and nearby communities.

In most forestry projects implemented by the government, hazard and risk reduction are conducted as an integral part of the activity. However, these are not being monitored and studied for proper technology improvement.

**Public policies**

The forestry policy in the Philippines is outdated with a bill on sustainable forest management yet to be passed by Congress. The discouragement of private ownership of forest resources puts pressure on government agencies with the responsibility for fire protection.

*Igsoc (1999) stated: "The Philippines has not been successful in forest protection and conservation as manifested by the present state of the Philippine rain forests. Forest fire control and management is only one of the many conservation issues that have been inadequately addressed as shown by the absence of appropriate legislation.*

*To its credit however, the government through the DENR, when confronted with problems arising from forest depletion, has demonstrated its willingness to make drastic but appropriate revisions of its forest policies. The basic lesson learned by government is that when local people possess secure land tenures, they strive hard to maintain the productive capacity of such land resources. Thus, the government logically concluded that local*

*people can be tapped as effective forest managers by granting them tenurial instruments on public forestlands that need rehabilitation and protection under the community based forest management program.*

*The full implementation of the DENR's reorganization in 1988 provided the abolition of the Forest Protection and Law Enforcement Division and transform the defunct Bureau of Forest Development (BFD) as staff bureau which is now called Forest Management Bureau (FMB). In other words there is no longer a definite Office or Division in the Central Office who will oversee, coordinate, monitor and evaluate the nationwide implementation of forest fire control and management program. Thus, it is recommended that the former Forest Protection and Law Enforcement Division be restored in the FMB who shall be given the task, among others, to see to it that field offices have adequate manpower and trained forest protection personnel; recommend appropriate fire fighting tools and communications facilities to be procured and distributed to CENROs; should take the lead in the training of forest protection personnel and firefighting crews in coordination with the DENR Human Resources Development Office.*

*While it is true that personnel training is vital for the effective forest fire prevention and control, equally important is to provide these trained firefighters with appropriate firefighting tools, vehicles for mobility and transport and communication facilities.*

*The Information, Education and Communication (IEC) campaign using a multi-media approach has made some impacts in the forest consciousness of the public that has greatly helped in curbing illegal logging but not so much in preventing and controlling forest fires. While the companies are able to advertise their consumer products on television as frequently as every 30 minutes, the government seldom used this medium in fire prevention campaign on the grounds that TV airtime is relatively expensive. It is high time now to redirect priorities and the IEC approach to create greater impact to the general public awareness in fire prevention and suppression aspects."*

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# SRI LANKA

## The Forest Fire Situation in Sri Lanka

### Introduction

Sri Lanka is a tropical island with a land area of 65,000 $km^2$. Current population is estimated at 18 million and population growth is around 1.1 percent per annum. The economy is predominantly agriculture and the per capita income is around US$ 740.

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

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

| Forest Type | Area (ha) | Share of total land area (%) |
|---|---|---|
| Montane Forests | 3 108 | 0.04 |
| Sub-montane forests | 68 838 | 1.04 |
| Lowland rain forests | 141 549 | 2.13 |
| Moist monsoon forests | 243 877 | 3.68 |
| Dry monsoon forests | 1 094 287 | 16.53 |
| Riverine dry forests | 22 411 | 0.33 |
| Mangroves | 8 687 | 0.13 |
| Sparse forests | 463 842 | 7.01 |
| Forest plantations | 72 340 | 1.09 |
| **Total** | **2 118 939** | **32.02** |

Source: Remote Sensing Unit, Forest Department (1992)

### *Land use classification*

According to the FAO classification, all of the above lands fall under the category of "forest". All coconut plantations, rubber plantations and a majority of home gardens also have more than 10 percent tree crown cover and are more than 0.5 ha in extent. The total area in each category is 326,000 ha, 230,000 ha and 835,000 ha, respectively. Under normal circumstances, these lands are not considered as forests and there is no wildfire problem in these lands as well.

There are about 1.2 million ha of lands classified as "sparsely used crop lands" that are comprised of scrub and grasslands. These lands are used for upland dry cropping, mainly under shifting cultivation. These lands fall into the FAO category of "other lands". Fires are closely associated with these lands.

### Fire environment and fire regimes

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

### *Weather*

The climate of Sri Lanka is a monsoon climate. That is, weather conditions are mainly determined by the prevailing winds. There are two major monsoons, the southwest monsoon from April to July and the northeast monsoon from September to January. The southwest monsoon is stronger than the northeast monsoon and lasts longer. During the southwest monsoon rainfall is concentrated on the windward slopes of the central highlands, so on the lee side the winds are very dry. The contrary happens during the northeast monsoon, but this monsoon is weak and shorter compared to the southwest monsoon.

Based on rainfall, the country can be divided into two climatic zones, a wet zone with annual rainfall ranging from 2500 to 5000 mm and a dry zone with annual rainfall around 1000 mm. Although the rainfall figures are quite high, the distribution of rainfall is very uneven, especially in the dry zone. Much of the rainfall in the dry zone comes with the northeast monsoon during a three-month period from October to December, leaving seven to eight months virtually dry. This considerably increases the fire hazard during the dry period.

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

***Fire hazard***

There is no significant fire hazard in most of the native vegetation of the country. The climax vegetation of the south and central highlands is tropical rain forests and sub-tropical montane forests. In the intermediate zone it is mainly evergreen forests, while in the dry zone it is tropical semi-deciduous forests. Land not occupied by permanent agriculture is mainly covered with grasses such as *Imperata cylindrica* and *Cymbopogon* spp. Fuel loads in this area are between 4-12 tons/ha (dry weight). Mean height of the grass is about one metre and grasslands are ready to burn during the dry season.

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

The number of fires reported annually ranges from 50 to 200 depending on the prevailing weather conditions. Almost all fires reported are in forest plantations.

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

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

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

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

**Major wildfire impact on people, property, and natural resources**

Forest fires in Sri Lanka are of comparatively small size and occur mainly in forest plantations and grasslands. These fires rarely pose any threat to human life or property and no fatalities due to forest fires have been reported in the recent past. Most of these fires are surface fires; crown fires are very rare even in forest plantations. There is no significant health hazard associated with forest fires due to the small size and relatively short burning period. The direct economic losses are mainly due to damage to forest plantations. Environmental damage caused by forest fires is often much greater and takes many forms.

**Forest fire database**

The following table shows the number of fire occurrences in forest plantations and estimated damage during 1990-2000.

**Table 2.** Forest fires in Sri Lanka reported during 1990-1999

| Year | Total No. of Fires on Forest, Other Wooded Land, & Other Land No. | Total Area Burned on Forest, Other Wooded Land, & Other Land ha | Area of Forest Burned ha | Area of Other Wooded Land and Other Land Burned ha | Human Causes No. | Natural Causes No. | Unknown Causes No. |
|---|---|---|---|---|---|---|---|
| **1990** | 114 | 549 | | | | | |
| **1991** | 100 | 186 | | | | | |
| **1992** | 234 | 259 | | | | | |
| **1993** | 58 | 174 | | | | | |
| **1994** | 60 | 191 | | | | | |
| **1995** | 126 | 372 | | | | | |
| **1996** | 136 | 271 | | | | | |
| **1997** | 205 | 610 | | | | | |
| **1998** | 114 | 204 | | | | | |
| **1999** | 47 | 417 | | | | | |
| **Average** | **119.4** | **323.3** | | | | | |

**Table 3.** Forest fires and economic damage in Sri Lanka, 1990-2000

| Year | Number of fires reported | Area burned (ha) | Estimated Damage ($US ) |
|---|---|---|---|
| **1990** | 114 | 549 | 9 788 |
| **1991** | 100 | 186 | 15 245 |
| **1992** | 234 | 259 | 6 861 |
| **1993** | 58 | 174 | 8 204 |
| **1994** | 60 | 191 | 18 588 |
| **1995** | 126 | 372 | 19 458 |
| **1996** | 136 | 271 | 21 465 |
| **1997** | 205 | 610 | 44 958 |
| **1998** | 114 | 204 | 7 480 |
| **1999** | 47 | 417 | 42 227 |
| **2000 (up to May)** | **8** | **36** | **3 645** |

The economic loss shown in Table 3 is an estimated figure based on the cost incurred in the establishment and management of plantations up to the time of the fire.

**Organizational setup**

All natural forests in the country are managed by the Forest and Wildlife Departments. These forests are not prone to big wildfires. Forest plantations and "sparsely used crop lands" are the most vulnerable areas. Forest plantations are managed by the Forest Department while other lands are under the purview of different state agencies. The Forest Department is the only agency at present engaged in systematic forest fire prevention and suppression activities. Most of the activities, except awareness programs, are mainly confined to areas under the purview of Forest Department.

Forest fire management activities are handled by the Silviculture Division of the Forest Department at the national level. At the provincial level the District Forest Officers are responsible for fire control activities in their respective districts. They are assisted by Range Forest Officers and Beat Forest Officers at the village level. These officers work very closely with the village communities as well.

Fire prevention is the main strategy used in forest fire control in Sri Lanka, especially in regard to forest plantations. This is mainly done by creating firebreaks around the plantations. Interior fire breaks are also used if the fire risk is relatively high.

Village communities voluntarily involve themselves in fire suppression activities whenever the assistance is needed. However, few programmes have been developed to promote community involvement in specific areas. A new approach is being tested in pilot areas, especially in *Eucalyptus* and teak plantations. Each management plan contains a "participatory management working circle" under which forest user groups are formed. Following are the main features of this approach:

- Local communities involved in fire prevention are allowed to collect dead fire wood from the plantations free of charge;
- The Forest Department informs the community of future forestry activities in the area so that they are aware of future employment opportunities in their locality;
- Agricultural and forestry activities are coordinated. This includes:
  - Finding out from villagers when they intend to burn their gardens or shifting cultivation areas so that appropriate measures can be taken to protect the plantations from fire;
  - Permitting grazing and grass cutting without charge in plantations where there is a fire risk due to a build up of grassy vegetation.

In addition, regular fire control training is provided to these communities.

Once the trial period is over the most promising communities will be selected for formal participatory forest management programs. It is expected that the fire prevention program will be more efficient through a combination of direct involvement of the Forest Department and community participation in fire prevention activities.

**Use of prescribed fire**

Prescribed fire is used in forestry only in the site preparation stage. The ground vegetation is cut and burned to clear the site for planting. The area cleared this way is around 600 ha annually.

Use of fire is the standard practice in site preparation in shifting cultivation. The area under shifting cultivation is estimated to be around 1.2 million hectares. Fire is also used in other agricultural practices to a lesser extent.

**Sustainable land-use practices to reduce wildfire risk**

Fires escaping from agricultural lands to the forests, especially to forest plantations, has been a problem in Sri Lanka, particularly in the dry zone. Farmers are encouraged to keep the Forest Department informed when they are ready to set fire to their fields so that necessary precautions can be taken. Forest plantations, on the other hand, are somewhat protected from outside fires through the use of peripheral (and sometime internal) fire breaks.

**Public policies concerning forest fires**

The current forest policy clearly states that all forests must be brought under sustainable management. Management plans have been developed for both natural forests and forest plantations and forest fire prevention

is one of the activities in these plans. Depending on the status of each forest, these plans contain different strategies to be used in forest fire management.

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# THAILAND

## Special Report on Forest Fire

### Introduction: Fire environment, fire regimes, and the ecological role of fire

In Thailand, 25.28% of total land area which are equivalent to 12.97 million hectares are covered by forests. The Deciduous forests share 53.46% of total forested areas, while the rest are 46.54% of evergreen forests. Fires have long been a human-caused component in various forest ecosystems. They occur annually during the dry season from December to May with the peak period in February and March. In normal year, the most common surface fires mainly take place in Dry Dipterocarp forests and in Mixed Deciduous forests. During extended drought related to the El Niño-Southern Oscillation (ENSO) event, fires spread, to a certain extent, in to Dry Evergreen, Hill evergreen or event in some parts of the Tropical Rain forest. In certain extreme dry sites it is common that forests burn twice per fire season. Although other types of fire are not typical to the forest of Thailand, in the recent El Niño episode of 1997-1998, a notable numbers of crown fire took place in Pine (*Pinus* spp.) plantations. Peat-swamp forests desiccated extremely and a number of ground fires occurred.

Fire has long been playing the significant role in most of our forest ecosystems, and the impacts caused by fire are very significant. However, the degree of damage caused by fire depends on the type of fire as well as the type of forest burnt. The deciduous forests are prone to fire and have long been subjected to annual burn by surface fire. Therefore these forests are well-adapted to fire and are fire-resistant. Surface fire is usually not lethal to mature tree. However, too frequent burn impedes and retards the natural regeneration, and alters the forest structure. Repeatedly burned forests will gradually deteriorate, change into more arid community and eventually into grassland dominated by *Imperata cylindrica*.

In evergreen forests fires cause abrupt and very severe damages. Fires kill more that 50% of mature trees, and completely destroy all sapling and undergrowth. In addition, fires drastically increase soil erosion as well as surface runoff. Fires also destroy food and habitat of wildlife, hence jeopardize the functioning of the whole forest ecosystem.

### Summary of major wildfire impacts during the 1990s

The most severe fires took place in 1998 when the country was hit by the last El Niño. During that time, A numbers of large fires broke out in various parts of the country. The major fires which should be mentioned include:

#### *Doi Intanon Fire*

This fire took place at Doi Intanon National Park in Chiangmai Province, Northern Thailand in mid March. The fire which lasted for five days consumed 480 ha. of Dry Forest as well as Hill Evergreen Forest in the sensitive watershed area. About 20% of mature trees were killed by the fire. Damages caused to the watershed area were far beyond the assessment capabilities.

***Phu Kadong Fire***

This fire took place at Phu Kadong National Park in Leoi Province, Northeastern Thailand in early March. 1,920 ha. of Pine Forest as well as Hill Evergreen Forest were severely burnt. Impacts caused by this fire were tremendous due to the fact that the burnt site is not only watershed area but also one of most famous tourist spots of the country.

***Kao Yai Fire***

This fire took place at Kao Yai National Park in Nakornrachasima Province, Northeastern Thailand in late March. This fire lasted for seven days and burnt down 1,440 ha. of Dry Evergreen Forest. Aside from killing 30% of mature trees, the fire caused high mortality of wild animals, mainly wild chickens and their eggs, snakes as well as others small reptiles.

***Pru Todang Fire***

This fire took place at Pru Todang Swamp forest which is the country only sound Peat-Swamp Forest. This peat fire lasted for nearly two months from late April to late June. Fire destroyed 1,280 ha. of invaluable Peat-Swamp Forest. About 80-90% of mature trees were killed, along with all undergrowth. The affected area was nearly denuded after this fire. Smoke emitted from this fire covered the sky over Naratiwat Province in southern Thailand for almost two months. Hundreds of patients mainly children and elderly were treated in hospitals for their respiratory problem. A number of fire fighters including the correspondent who command the fire suppression operation were also treated due to the same sickness.

**Forest fire database**

**Table 1.** Wildfire statistics of fire numbers, area burned and fire causes for the period of 1985-2000. Source: Forest Fire Control Office, Royal Forest Department of Thailand

| Year | Total No. of Fires on Forest Lands | | Area of Forest Burned (ha) | | Human Causes % | Natural Causes % | Unknown Causes % |
|---|---|---|---|---|---|---|---|
| **1985** | | | 3,535,110 | - | 100 | - | - |
| **1986** | | | 3,797,289 | - | 100 | - | - |
| **1992** | | | 2,030,160 | - | 100 | - | - |
| **1993** | | | 1,459,617 | - | 100 | - | - |
| **1994** | | | 763,648 | - | 100 | - | - |
| **1995** | | | 643,799 | - | 100 | - | - |
| **1996** | | | 490,303 | - | 100 | - | - |
| **1997** | | | 660,208 | - | 100 | - | - |
| **1998** | | | 1,145,452 | - | 100 | - | - |
| **1999** | | | 407,964 | - | 100 | - | - |
| **2000** | | | 93,324 | - | 100 | - | - |

**Operational fire management system and organization**

There is a single organization undertaking all forest fire control activities in Thailand, called the *Forest Fire Control Office* which is under the Royal Forest Department (Fig.1). This office is composed of

- Divisions
- Forest Fire Control Centers (FFCC)
- 92 Forest Fire Control Stations (FFCS)
- Forest Fire Control Development Camps (FFDC)

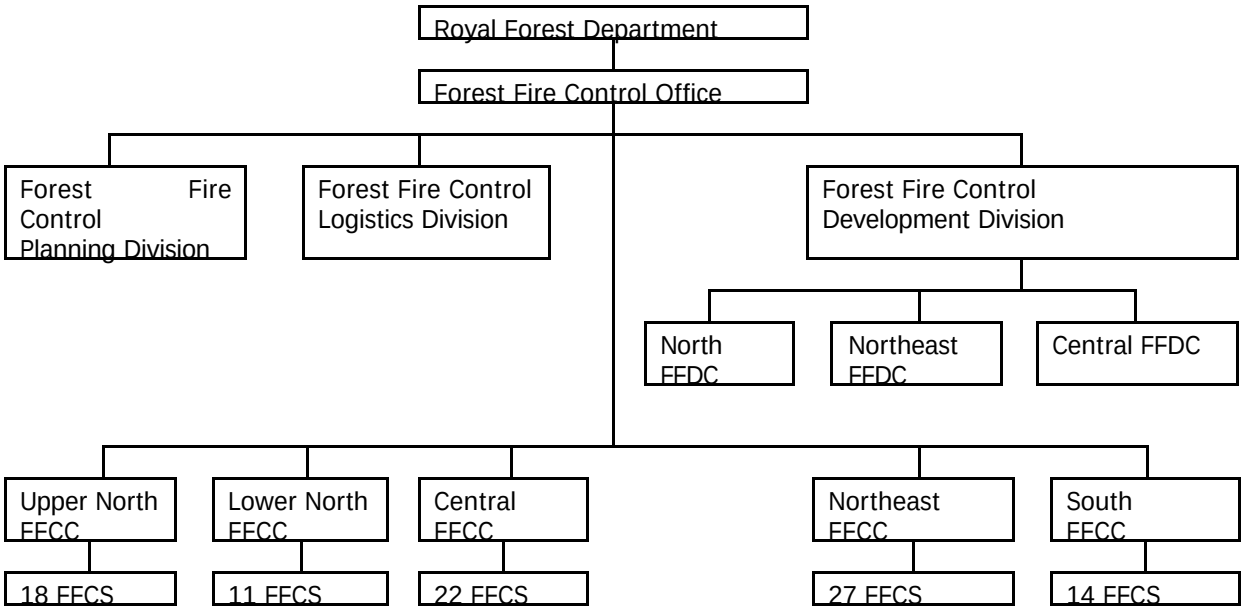


**Figure 1.** Organizational structure of the Forest Fire Control Office, Royal Forest Department, Thailand

***Responsibilities at different levels of the forest fire control organization***

Forest Fire Control Planning Division

- Planning and budgeting
- Supervise, coordinate, and evaluate fire control centres and stations nationwide
- General affairs

Forest Fire Control Development Division

- Develop fire prevention materials, prevention campaign strategies, fire suppression equipment as well as techniques and tactics in fighting fire
- Supervise, coordinate, and evaluate fire control centres and stations nationwide
- Train fire control personnel
- Train, maintain and command the *Fire Fighting Special Task Force (Fire Tiger Unit).*
- Research and study
- Coordinate with concerned organizations locally and internationally

Forest Fire Control Logistics Division

- Procure and mobilize all human and technical resources to support fire suppression operations
- Logistics, first aids and rescue during large fire suppression operations

Forest Fire Control Centers (FFCF)

- Supervise fire control stations under its responsibility
- Support the operation of its fire control station
- Coordinate with all agencies concerned

Forest Fire Control Stations (FFCS)

The FFCS is the executing unit of Forest Fire Control Office. Each station has subordinate units called *Forest Fire Suppression Mobile Team.* The number of Forest Fire Suppression Mobile Teams of each Fire Station varies depending on amount of responsible area of each Station. It carries out two main tasks which include:

- Forest fire prevention campaign. This campaign is carried out throughout the year, and comprises these following activities :
  - Mobile campaign unit (direct contact)
  - Campaign via mass media
  - Billboard and printed materials
  - Education programme
  - Exhibition
- Forest fire suppression. This task is carried out by the Forest Fire Suppression Mobile Teams. There are 272 teams nationwide. Each team is composed of 15 fire crew and generally responsible for suppression operation within 10,000 hectares of forest. Due to budget limitation, only 4.68 million hectares or equivalent to 35.7 % of total forest land are placed under fire suppression programme. The suppression activities include :
  - Training of fire crew as well as fire volunteer brigades
  - Fuel management (fire break, control burning etc.)
  - Fire detection and report
  - Pre-suppression
  - Fire suppression
  - Evaluation

Forest Fire Control Development Camp

It is the executing unit of Forest Fire Control Development Division. It carries out all kinds of development task, including:

- Develop and produce fire prevention campaign materials
- Develop and produce fire suppression equipment
- Train fire crew as well as fire prevention campaign personnel
- Train and operate *the Fire Fighting Special Task Force (Fire Tiger Unit)*
- Conduct research and study

***Responsibilities at the different levels of government***

Central level (national)

The *National Forest Fire Management Committee* is appointed by the prime minister and is responsible for fire management policy at the national level.

State (provinces)

The *Provincial Forest Fire Management Committee* is appointed by the National Forest Fire Management Committee and implements the fire management policy at the provincial level. There are committees in each of the 63 provinces where forests still exist. The local administrations have a mandate to protect the forest resources in their respective areas, including the protection of forest against fire.

Voluntary fire fighters / brigades

The fire problem will not be solved without full cooperation with local people. The Royal Forest Department has devoted all its efforts to obtain people's participation in fire management. Approximately 10,000 fire volunteers are

trained annually. Unfortunately, without financial incentive, the concept of fire volunteer does not work well in this country.

**Figure 1.** Thailand's Royal Forest Department is giving highest priority to efficient public information and education on forest fire problems at local and global levels. Photo: GFMC.

**Figure 2.** The threat of habitats for local animal species is one of the major topics addressed by national fire awareness campaigns. Source: Royal Forest Department.

**Main forest fire research issues**

A few fire research program has been conducted since 1980. The main research are on fire behaviour, fuel characteristics and attitude of people toward fire problem. However since 1999, a national *Forest Fire Research Centre* was established and a Master Plan for Forest Fire Research was formulated. It includes the research on fire impacts, fire prevention, fire suppression, and the use of fire.

**Use of prescribed fire to achieve management objectives**

***Forestry***

Early burning has long been practised in all areas under fire control programs as a mean to prevent forest fire and to reduce the hazard of fire. However the practice are mainly in small scale due to the inadequacy of know how as well as experience in this field.

***Other vegetation management (grasslands, bushlands)***

Prescribed fire has been used in some very specific areas in order to maintain grassland for wildlife management purposes.

***Agricultural maintenance burning***

Open burn in farmlands to eliminate residue after harvesting still the common practices of all local people throughout the country.

***"Let burn" (or integration) of natural (lightning) and human-caused wildfires***

100% of the forest fires are caused by humans. There is no “let burn” policy in place.

**Sustainable land-use practices employed in the country to reduce wildfire hazards**

As of the moment there is no dedicated programme underway to involve land-use practices for wildfire hazard reduction.

**Public policies concerning fire**

***Policies in place***

The National Forest Policy: The latest National Forest Policy No.18 (1985) states that a substantial plan for tackling the deforestation problem (e.g., shifting cultivation, forest fire) must be determined. Suppression as well as law enforcement measures must be clearly set.

The Royal Forest Department Policy: The Royal Forest Department policy states toward forest fire control in practical aspect as "to minimize damages caused by forest fire by using all means either prevention or suppression strategy."

***The needs of fire management***

The management of forest fires in Thailand has been intensively carried out for almost two decades. Considerable amounts of knowledge and experiences have been obtained during this long period. To a satisfactory level, Thailand has developed her own unique fire management system which is proved to be fit to the local situation. However some aspects of management and especially the fire research arena is still insufficiently developed. In this regard assistance from the fire science community is badly needed.

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## VIETNAM

### Fire Management Assessment

### Tram Chim National Park, Dong Thap Province, Viet Nam

**Executive Summary**

Tram Chim National Park (TCNP), Vietnam, is one of the last remaining remnants of freshwater wetland habitat in the Mekong Delta. The park receives international recognition as seasonal habitat for endangered wildlife species, including the Sarus crane, and as an extant portion of the Plain of Reeds. Objectives of restoration and biodiversity conservation conflict with local people's need for economic subsistence and development. Arson is a major cause of fires and will require an economic incentive based fire prevention program. Management objectives of fire exclusion drive decisions relating to water levels, thus impacting all ecological processes within the park. Maintaining high water levels as a tool for fire exclusion conflicts with other management objectives integral to the park. There is opportunity for development of a fire use program within the park, in conjunction with fire effects research to expand the knowledge base. Although fire fighters are aggressive and professional, suppression capability is constrained due to limited equipment.

**Introduction**

Upon request of the International Crane Foundation in collaboration with Dong Thap Province, Vietnam, the United States Forest Service conducted a fire management assessment in Tram Chim National Park, Vietnam. A United States Forest Service fire management specialist visited TCNP during the period 1-12 March 2000, to conduct the assessment. The information presented in this report is based on a review of available literature; site visits within the park; observations; and interviews with park staff, scientists, and provincial officials. The information presented may reflect slight distortions based on nuances of translation.

**Background**

The Mekong River seasonally inundates 3.9 million hectares of land in the delta, including the area originally known as the Plain of Reeds. The Plain of Reeds was a vast wetland depression covered with a thick mat of vegetation. Over the last half century, the majority of the Mekong Delta seasonally flooded grassland and forests have been fragmented by canals, drained, and converted to agriculture production. In the Plain of Reeds area, much of this activity is relatively recent, with approximately 700,000 hectares converted to agriculture during the period 1975-1995.

In 1975, the People's Committee of Dong Thap Province chose Tram Chim as a site for restoring the original Plain of Reeds ecosystem. Since that time, the area has gradually elevated in status as a conservation reserve to reach its current, designated status at the national level. Tram Chim National Park was established on 29 December 1998, with an objective to protect and restore the natural landscape of the Plain of Reeds and conserve biodiversity. The 7,588 hectare park area is one of the last remaining remnants of freshwater wetland habitat in the Mekong Delta. Over the last couple of decades, several thousand hectares of Melaleuca forests (*Melaleuca cajuputi*) have been planted within the park. TCNP receives national and international attention as a seasonal feeding and resting area for endangered bird species including the Sarus Crane, the tallest flying bird in the world.

**Hydrologic Regime and Fire Issues**

Tram Chim National Park is surrounded by 53 kilometres of dikes built in the mid-1980s. Water gates (four constructed in 1991 and two in 1995) control the outflow of water from canals within the park. Canals fragment the interior of the park into five separate management zones, identified as A1- A5. Water levels within each zone can be controlled as a separate unit. Thus, the water level during dry season within each zone of the park is regulated to a large extent by management decision. The hydrologic regime within the park has a fundamental relationship with fire management issues. Moreover, the hydrologic regime impacts all functional aspects of the ecosystem. The annual determination of water level within each zone is a critical management decision, with impacts on all aspects of the park.

The question of appropriate water level at TCNP is a complex and challenging issue. The historic hydrologic regime of the Mekong delta was characterized by a seasonal inundation of water followed by a dry season (December - May), with a gradual recession of water levels. Natural freshwater wetlands store water during times of flood and release it slowly as floodwaters recede during the dry season. The shallow depression morphology of the Plain of Reeds trapped floodwaters, further slowing the release of water. It is reported the surface of the soil was still moist even at the end of the dry season (Safford et al. 1997).

However, restoration of the "natural hydrologic cycle" within TCNP is difficult, as the larger Mekong Delta wetland system has been irretrievably altered by channelization and conversion of land to agriculture production. There is limited data available in Vietnam to re-establish water levels to the historic natural wetlands regime. The issue becomes more complex with the lack of definitive knowledge of the original vegetation occupying the site. Without this information, it becomes difficult to model rates of evapotranspiration and the effect of root systems and ground litter on floodwater retention that would have played a part in the historic hydrologic regime. Annual variability in the amount and timing of precipitation further complicates the principles of water management in TCNP.

In spite of these obstacles, there has been significant progress towards defining the original hydrologic regime. Aerial maps and interviews with long-term inhabitants have yielded valuable information on pre-canal vegetative distribution and abundance. Available hydrologic data has helped in modelling the system. The current water management plan for the park was developed by an international team of hydrologists and is a best guess approximation of historic levels. The plan is described by park staff as highly technical and difficult to implement. In practical terms, the gates are shut sometime shortly after the end of the rainy season. The general principle is that at the end of dry season, evaporation will have left a majority of dry area (moisture just below the surface) interspersed with areas of shallow water.

Implementation of this general water management principle is altered significantly in areas of the park, where water levels are used as a management tool for fire exclusion. This tool has been used extensively since 1995, when a total of 225 hectares of Melaleuca and 306 hectares of grassland burned. For the Year 2000, the fire prevention plan shows 6,758 hectares (zones A1, A2, and A5) of the total 7,588 hectares of land in the park maintained at high water levels for the purpose of fire prevention. Thus in the Year 2000, 89% of the park area is deliberately maintained at high water levels, in response to a fire exclusion management objective. Over the next few years, it is the intent of park managers to gradually lower water levels during the dry season to better simulate the historic hydrologic cycle. However, this intention may be dissuaded with continued pressure for fire exclusion within the park.

The long-term ecological consequences of perennial high water levels on plant and associated wildlife communities are unknown. However, some short-term impacts on crane habitat and Melaleuca stands, two key features of the park, can be evaluated.

Water level is one factor in Sarus crane selection of feeding and resting sites. Sarus crane feed in very shallow water or dry (moisture below the surface) Eleocharis sites with nearby forests with open patches for resting sites (Hoang Van Thang, personal communication). The seasonal presence of Sarus crane at TCNP is the primary tourist appeal, and contributes to the increasingly higher profile of the park, both nationally and internationally.

Of the total 7,588 hectares of park area, approximately 3,000 hectares is currently Melaleuca forest. It is envisioned that Melaleuca forests will constitute approximately 50% of the park area with future planting efforts focused in zone A5 and the strips of land along Phu Hiep and Dong Tien canal. A study of Melaleuca growth rates inside and outside TCNP conducted by the Forest Inventory and Planning Sub-Institute No 2, Ho Chi Minh City concluded the following. “Growth rates of Melaleuca forest differed strongly inside and outside the core and this is assumed to reflect difference in hydrology. In all age classes, growth of Melaleuca forest was considerably faster outside than inside the core. Therefore, water level and flooding duration requires detailed consideration in the management plan of Melaleuca forest.” (Safford et al. 1997). Other evidence of high water stress on Melaleuca trees is the number of trees that have fallen in locations inside zone A1 (Jeb Barzen, personal communication).

With such high stake consequences to key park features, it is critical to identify and address the underlying issues driving the fire exclusion motivation for water level management decisions.

**Fire Prevention And Local Communities**

All fires in TCNP are human caused. Park staff estimates that ninety percent of fires in the park result from arson, motivated by revenge of local people apprehended for exploiting resources within the park. Five percent is caused by carelessness and the remaining five percent is caused by fire used to smoke out bees or rats. Laws prohibit local people’s access to the park’s natural resources, unless operating under a specific utilization permit compatible with park objectives (removal of *Mimosa pigra*, collection of dead and downed woody material, etc.). As a result, relations between the park and local communities have been tense since the park’s establishment. Objectives of restoration of the original landscape of the Plain of Reeds and biodiversity conservation conflict with local people’s need for economic subsistence and development. The conflicts created by these two seemingly incompatible land use objectives have been a dominant community theme over the last two decades.

Five impoverished villages surround TCNP. Many of the people from these villages depend on natural resources for survival. Vietnamese local custom allows free use of the forest and wild land resources. Despite laws prohibiting trespass and use of resources within TCNP, impoverished local people routinely exploit accessible resources in the park. This exploitation includes: land development for agriculture (primarily rice); cutting Melaleuca for cooking fuel and lumber; extracting snails, snakes, fish, frogs, and water birds for food; cutting grass for vegetable garden mulch; and utilizing grazing land for livestock. Evidence of poaching activities abound (fishing nets, batteries for electro-shocking, cut stumps, fishing poles, cut grass, etc.) and local people were routinely observed exploiting resources inside TCNP. Although there is a fish harvest plan for the park, it is not implemented because estimates of illegal fishing harvest far exceed the amount authorized within the plan. Resentment against TCNP guards, who are allowed to utilize park resources, further fuels the tension. In a recent

act of violence, apprehended local electroshock fishermen threw battery acid into the faces of two park guards when directed to leave the park.

A number of efforts are planned or in progress to improve relations with the community and lessen pressure on the natural resources of the park. A donor funded small loan program has been initiated to improve economic conditions in the impoverished communities around the park. The fund is coordinated by the district Women's Union and used to support small-scale economic enhancement activities. A pilot project will be implemented next year to encourage community involvement in an anti-poaching patrol. Designated family units would have limited and specified utilization rights to five hectares of park land, in exchange for protection of that land. As part of a poverty alleviation program by the central government, the district has proposed to use the border strip along the edge of one side of the park as a utilization zone for people who currently live there. Although these people were officially "displaced" when the park was established, they remained in place and the strip is currently a de facto utilization zone. It is hoped the change in occupancy status of these people from illegal to legal will create goodwill and cooperation between the villagers and the park.

A commonality of successful fire prevention programs in developing countries is the linkage of fire prevention with some type of economic incentive. Communities must have a vested interest in fire prevention. In the case of TCNP, options for economic incentive of limited utilization of park resources must be balanced with minimal disturbance to park wildlife. In discussions with park staff and managers from commercial Melaleuca forests the following options seemed feasible.

1. Establish a community-monitored scheme to distribute benefits (extra rice, labour assistance, etc.) to local communities for successful prevention of fires during a dry season. The proposed scheme should be evaluated for efficiency, equitability, and sustainability before implementation.
2. Establish a small loan program (seed money of US$25,000) with eligibility requirements linked with successful performance of fire prevention.
3. Allow limited utilization rights within the park contingent upon successful fire prevention.

In evaluating program options, consideration must be given to local people's confidence in the validity of the proposed long-term outcome, and local capacity for project management and oversight. If an effective community fire prevention program can be established with linkages to vested economic interests, the pressure to maintain high water levels as a means of fire exclusion will be lessened.

A TCNP fire prevention plan is prepared annually by the Coordinating Committee, which consists of the four TCNP department heads and other key staff. The Year 2000 fire prevention plan for the park contains four main elements.

1. Maintenance of high water levels in specified areas of the park.
2. Prescribed burning in high grassland to establish fuelbreaks around the Melaleuca stands.
3. Education to the surrounding communities.
4. Establishment of fire brigades at each hamlet with assistance from the district People's Committee.

A section of the fire prevention plan lists each park zone and identifies the high-risk fuel complexes. Proposed fuels management activities for the Year 2000 include construction of 400 hectares of firebreak in A1, 200 hectares of firebreak in A2, and prescribed burning of 200 hectares in A4.

Community fire prevention education is accomplished through social structures. The Women's Union, Farmer's Union, and Youth Union give public service messages containing fire prevention messages and advise concerning forest protection laws.

There is a national standard of fire danger rating using a scale of 1-5. The fire danger rating is determined based on climate and fuel load. Every 15 days during the dry season, province level officials work with personnel at TCNP to determine the fire danger rating. Signs indicating the fire danger rating are posted at many of the access points to the park. A high fire danger rating is not linked with commensurate levels of prevention activities, as there are not enough resources for such a program.

**Fire Ecology and Use of Fire**

Of the total 7,588 hectares within the park, approximately 3,000 hectares are *Melaleuca cajuputi* forest. The remaining hectares are grasslands composed of a mixture of species that can be divided into five main plant communities.

Although there is little scientific research of fire effects on *Melaleuca cajuputi*, long-term park employees and scientists have considerable knowledge based on observations. In 1997, a dense mat of Melaleuca propagules was observed in a Melaleuca forest area that had burned in 1995. The seeds had germinated following the fire (Tran Triet, personal communication). On that same site, trees that had been salvage logged after the fire re-sprouted naturally from the stumps. As of March 2000, the stand was approximately 2 meters tall. In another Melaleuca site, there was little evidence of regeneration from a 1994, six-hectare, high intensity fire. At a third site, young Melaleuca trees regenerated from seed were plentiful in the area of a 1998 grassland fire. Park staff conjectured that scattered, large Melaleuca trees had seeded following fire stress. The seeds had then been transported by water and germinated.

These observations are consistent with fire effects research on *Melaleuca quinquenervia* found in Eastern Australia, New Caledonia, Papua New Guinea, and Irian Jaya. A summary of studies indicates the following (Coladonator 1992):

*"Melaleuca is well adapted to fire. It has a thick, spongy bark that insulates the cambium. The outer layers of bark are flakey and burn vigorously, which conducts the fire into the canopy, igniting the oil-laden foliage. The leaves and small branches are killed, but dormant lateral buds on the trunk germinate within weeks after the burn. This prolific sprouting increases the surface area of small branches and therefore the tree's reproductive potential. Melaleuca can flower within weeks after a fire. Each serotinous capsule contains about 250 tiny seeds which are released after a burn, frost, or any other event that severs the vascular connections to the fruit. A burned Melaleuca tree can release millions of seeds, which are dispersed a short distance by wind and water. Seedlings that are less than 3 to 6 months old, or only 4 to 8 inches (10-20 cm) high are often killed by hot surface fires. Death may occur as a result of lethal temperatures, insufficient food reserves to produce new shoots, or drying of the sediments due to increased exposure. Older seedlings are top-killed by most fires but recover quickly often with multiple shoots sprouting from the root collar. A mature Melaleuca tree will respond to fire by releasing millions of seed that are held in the capsules on the twigs and branches. Adults damaged by fire may also sprout vigorously from the roots, bole, or branches. The proliferation of branches on a burned adult tree often results in more twigs, and thus more capsules and more seed production than was the case prior to the burn."*.

Studies of *Melaleuca cajuputi* in Thailand indicate a fast growing shade tolerant species with high tolerance to fire and flooding (Safford et al. 1997).

Park staff has expressed interest in thinning as a silvicultural treatment in Melaleuca, followed by low intensity prescribed burning. However, park regulations at the national level prohibit cutting of live standing trees. A variance for a small pilot project would be useful to determine applicability towards meeting management objectives.

Experiments using prescribed fire to create firebreaks in the park were initially conducted in 1992. During the dry season of 1999, a prescribed burn experiment was conducted in five grassland communities (Khanh et al. 1999). The objectives of this preliminary research were to: 1) determine the range of fire intensities and appropriate techniques for cost effective fuelbreak construction, and 2) determine fire effects on species composition and abundance. This experiment lays the groundwork for future prescribed burning experimentation and program implementation. Anecdotal observations of Sarus crane observers indicate that feeding habitat is enhanced after a burn, where cranes readily feed in recently burned areas. These observations support the notion of fire effects research linked with an objective of wildlife habitat enhancement. Experiment design should incorporate variables such as burn seasonality (early/late dry season), burn severity (low moderate, high), burn frequency interval (3 months, one year, two years, five years, etc.), and vegetative communities (five different grassland communities and Melaleuca stands of varying age class/densities). Vegetative response characteristics should include such measurements as shoot height, density, weight, growth rate, and nutritional composition; aboveground standing crop; residual organic materials; mortality; and reproductive effort.

Given the pilot projects using fire to establish fuelbreaks, there exists ample foundation to establish a larger scale program of fire use and research experimentation at TCNP.

**Fire Suppression Organization and Capabilities**

The TCNP Forest Protection Unit is a special unit within the province Forest Protection Department. This unit has 34 employees (potential for 40), staffing twelve guard stations and the headquarters office. There is one 5-person mobile patrol, with motorcycle or boat transport. The province Forest Protection Department provides two days of fire suppression training annually. The training covers laws and regulations relating to forest fire, and new

equipment and methodologies in fire suppression. In addition to fire suppression, the Forest Protection Unit is responsible for anti-poaching actions and planting contract administration.

The TCNP Forest Protection Unit has the following fire equipment:

- 10 pressurized agriculture sprayers (12 liter Kubota)
- 1 Professional Toyota portable pump
- 2 Honda portable pumps
- 1 Vanguard Briggs and Stratton 6 horsepower portable pump *
- 1 Industrial Plus Briggs and Stratton 5 horsepower portable pump*
- 3 larger pumps
- 300 meters of hose, 7.6 cm (3 inch) diameter in 20 meter lengths*
- other handtools
- 2 Wajax drip torches
- 2 motorcycles
- 1 boat
- 7.6 cm (3 inch) quick-lock, haemophrodite couplings (possibly Storz or French variation)

The unit has no radio equipment. There are telephones at the headquarters and three of the guard stations. The other guard stations have no means of communication with headquarters. This is a critical safety concern not only in a fire response situation, but also during other protection activities. The lack of personal protective equipment, particularly hardhats with some type of face shield, was also noted as a safety concern.

Mechanized equipment is used in fire suppression efforts. Tractors, rented from local farmers, are used to construct firelines around grass fires. Park staff expressed an interest in a water tank trailer with spigot that would hitch to the back of a locally constructed all-terrain vehicle. The water trailer would be strategically placed along a fire perimeter to eliminate the need for labour intensive, hand-carried water.

The district government is responsible for organizing and mobilizing resources from the local villages to assist in fire suppression efforts within the park. By law, the village head is responsible for deployment of locals to fight fire. Each village designates one family as a focal point to assist with fire prevention and suppression efforts. One day of training is provided annually to these families. It was noted that local farmers usually bring their own tools or agriculture sprayer when responding to fires.

When a fire in TCNP exceeds the capability of the Forest Protection Unit, the province level Forest Protection Department assists the park. The province level Forest Protection Department is structured as follows: Director, Vice-Director, a 5-person Fire Protection Unit, 5 mobiles units, Policy and Regulation Unit, Administrative Unit, and the special Fire Protection Unit at TCNP. There are district and province level command centres. Smaller fires are handled locally, but if a situation exceeds the capability of the district, requests for assistance is sent to the province central command and resources deployed from that level.

**Figure 1**. Freshly burned *Melaleuca leucodendron* L. stand in Long An, Viet Nam (Mekong delta region). Fires in Melaleuca are often set to obtain permission to salvage the stems and to bring them to the local markets. Photo: GFMC.

**Figure 2**. Local transport and trading of freshly salvage-logged Melaleuca poles. Photo: GFMC.

There is no formal fire fighter training. Although fire suppression tactics safety is taught, they have no personal protective equipment. In 1999, the province Forest Protection Department responded to a total of 88 fire incidences in the province.

During the dry season of 1998, there were a total of 40 fires in Tram Chim National Park. Three of those were large fires requiring significant deployment of fire suppression resources. The largest fire, 600 hectares of grassland, required mobilizing 300 fire fighters including police and army personnel. On March 8, 2000, the TCNP Forest Protection Unit responded to the first fire of the dry season. The fire was burning in grassland (0.7 meter high *Penicum*) and scattered, 2-year-old Melaleuca. Nine firefighters responded on initial attack using boats for transportation. Equipment included: 1 Vanguard Briggs and Stratton 6 horsepower portable pump, 1 Industrial Plus Briggs and Stratton 5 horsepower portable pump (Model 133432), fifteen 20-meter lengths of 7.6cm (3 inch) diameter hose with quick-lock haemophrodite coupling, 1 Kubota pressurized agricultural sprayer, and plastic buckets. A wetline anchored from the canal failed to contain the fire. All available hose (300 meters) had been deployed and the fire burned around the end of the hoselay. With winds around 16 kph, the fire burned back towards the canal, and soon spotted across. The fire fighters attempted a wet line along one flank but the fire was too intense. After retreating to the canal dike for a short period, they attempted a hose lay attack from the black side of the flaming front. The wind had slowed and the wet line was successful this time in stopping the fire. The firefighters deployed all available hose and then resorted to beating the edge with Melaleuca boughs and carrying water in plastic buckets from the end of the hose lay. The firefighters wore sandals or were barefoot and had no personal protective equipment of any kind. Local people from the communities were conspicuously absent in the fire suppression efforts, although the fire clearly exceeded the suppression capabilities of the limited park personnel.

The fire fighters were very aggressive, hard working, and professional. Although they lacked personal protective equipment, safety was clearly a factor in selecting tactics. The limited water handling equipment was utilized as effectively as possible. Additional pumps, smaller diameter hose, adapters, couplings, nozzles, training in hose packs and hose lays with laterals, fold-a-tanks, and personal protective equipment would maximize the effectiveness and safety of this firefighting unit.

**Analysis - Management Dilemmas and Tradeoffs**

Fire exclusion as a management objective is a high priority with district, province, and national officials. Fire exclusion is the primary driving factor in determining water levels at TCNP. Succinctly displayed, the tradeoffs associated with the decision to utilize high water levels as a means of fire exclusion, are summarized as follows.

I. High water levels maintained for the purpose of fire exclusion
- No fires
- Reduced area of bird species habitat
- Slow Melaleuca growth
- Unknown other ecological consequences

II. Water levels allowed to recede “normally” during the dry season as per the water management plan:
- Higher risk of human-caused fire
- Larger proportion of park area suitable for bird species habitat
- Increased Melaleuca growth

For the year 2000, high water levels were maintained in 89% of the park area, substantially limiting potential crane habitat. Paradoxically, the park logo, tourist brochures, and public relations material, all feature the crane as a centrepiece. From a political, managerial, and accountability perspective, hectares of Melaleuca forest and grasslands protected from fire is an easily measured target. In contrast, the temporal presence of Sarus cranes in TCNP is dependent on a number of variables, many of which are not within the control of the park (availability of suitable habitat along the migration route, poaching outside of TCNP, reproductive success, etc.).

Another recent management decision generated by wildfire concerns was the construction of new canals through some areas of the park. This action was justified by the need for access by fire suppression resources. Although canals do allow access by fire suppression crews, they also increase ease of access by locals exploiting resources within the park. Since all fires are human caused, this increased access by locals will likely result in more fire ignitions. Construction of additional canals has adverse impacts on soil acidity and the hydrologic regime, and is also contrary to objectives of the park to protect and restore the natural landscapes of the Plain of Reeds. Although canal construction was halted before completion, this management decision is another indicator of the high value placed on fire exclusion within the park.

Fire prevention in an atmosphere of tense and occasionally hostile community relations presents another daunting management challenge. In commercial Melaleuca plantations in Dong Thap province, utilization permits for locals and community benefits (rice distribution) purchased with profits from the plantation ensures positive relations with the community. In TCNP, unrestricted utilization rights in reward for fire prevention is not an option due to park objectives. The park does not generate revenues nor currently receive a budget for improving community relations, thus it is difficult to find incentives that could serve as a bridge for improved community relations. Yet improved relations with local communities is a critical step in reducing the risk of unwanted fire.

The issues faced by managers at Tram Chim National Park are complex and challenging. Outcomes of potential decisions should be evaluated carefully, within the continuum of single species management and biodiversity conservation. The concepts of disturbance factors and the role of fire in the ecosystem are poorly understood by officials at all levels and there is little research on fire effects in the ecosystems within the park. The current paradigm of fire exclusion as a management objective should be re-evaluated within the context of natural disturbance factors.

In summary, moving from a strict fire exclusion policy towards recognition of fire's role in the ecosystem, augmented by a program of fire use in the park would allow for greater flexibility in management options. A deliberate strategy of fire use, in combination with an effective community fire prevention program, based on economic incentive extraneous to park resources, would result in a decrease in unplanned ignitions. Improving the capacity of fire fighting forces to suppress unwanted fires would be the final step in enhancing the overall fire management program.

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