Forestry Department
Food and Agriculture Organization of the United Nations

FRA 2000

PLANNING AND INFORMATION NEEDS ASSESSMENT FOR FOREST FIRES COMPONENT

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The Forest Resources Assessment Programme

Forests are crucial for the well-being of humanity. They provide foundations for life on earth through ecological functions, by regulating the climate and water resources, and by serving as habitats for plants and animals. Forests also furnish a wide range of essential goods such as wood, food, fodder and medicines, in addition to opportunities for recreation, spiritual renewal and other services.

Today, forests are under pressure from expanding human populations, which frequently leads to the conversion or degradation of forests into unsustainable forms of land use. When forests are lost or severely degraded, their capacity to function as regulators of the environment is also lost, increasing flood and erosion hazards, reducing soil fertility, and contributing to the loss of plant and animal life. As a result, the sustainable provision of goods and services from forests is jeopardized.

FAO, at the request of the member nations and the world community, regularly monitors the world's forests through the Forest Resources Assessment Programme. The next report, the Global Forest Resources Assessment 2000 (FRA 2000), will review the forest situation by the end of the millennium. FRA 2000 will include country-level information based on existing forest inventory data, regional investigations of land-cover change processes, and a number of global studies focusing on the interaction between people and forests. The FRA 2000 report will be made public and distributed on the world wide web in the year 2000.

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1 Introduction

The mission of FAO Global Forest Resources Assessment Programme is to provide the world community reliable information to describe and understand the situation of the world's forests and related resources and how they change over time. The assessments are carried out jointly by FAO, Rome, and UN-ECE/FAO, Geneva, in cooperation with member countries and partners. FAO is directly responsible for information for developing countries, as well as a global synthesis, and UN-ECE/FAO, Geneva, is responsible for the industrialized countries.

The Expert Consultation on Global Forest Resources Assessment 2000 held in Kotka, Finland, during June of 1996 recommended that FAO should provide annual statistics/estimates for the FRA 2000 for each country on the number of forest fires and the area burned over the period 1990-2000.

Just after the Kotka meeting emphasized the importance of accounting for the annual occurrence of forest fires within countries, the El Niño drought conditions of 1997-1998 garnered public, media, and political attention to the world-wide outbreak of fires that were devastating forests. The size and damage being caused by these fires was so enormous that the Christian Science Monitor called 1998 "the year the earth caught fire." At times the earth did seem to be on fire as huge smoke palls blanketed large regions, air and sea navigation were disrupted, many lives were lost, public health was adversely affected, homes were destroyed, and natural resources were severely impacted. Some ecosystems like the rain forests of Indonesia and Brazil and the cloud forests of Mexico, areas usually not seriously affected by forest fires, sustained considerable damage in 1998[1]. A world audience was hungry for detailed information about the extent of these fires, but such information was not available for some regions because many countries do not have a system in place for reporting even basic forest fire statistics. Also, fire control systems and air quality monitoring systems did not provide the information needed for government officials and others to make decisions and take related actions.[2]

Although for years FAO has provided forest fire management assistance, including data collection and dissemination, the organization recognized that current data on fires are still incomplete. Thus, it remains difficult to assess the annual degradation of forests caused by wildfires. The global fire problems witnessed in 1998 served as a catalyst for FAO to sponsor a meeting of "Public Policies Affecting Forest Fires" in Rome in October 1998 to review policies affecting fires, collect information about global fires, and produce recommendations to better protect the world's forests.[3] Seventy-one participants from 33 countries and 13 international organizations concluded, among other things, that "there is a need for reliable and up-to-date systems for national, regional, and global fire reporting, analysis, and storage of data. Such data, and information on fire causes and socio-economic and environmental effects, are required as a sound basis for policy making." International organizations also were urged "to support the design and implementation of a global fire inventory or reporting system, in close collaboration with the fire science community and end users."

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[1] Public Policies Affecting Forest Fires in the Asia-Pacific Region, James Schweithelm; and Public Policies Affecting Forest Fires in the Americas and the Caribbean, Robert W. Mutch et al; In FAO Meeting on Public Policies Affecting Forest Fires, FAO Forestry Paper 138, Rome 1999.

[2] Wildland Fires and the Environment: a Global Synthesis, Joel S. Levine and others, UNEP/DEIA&EW/TR.99.1, 1999, 46 p.

[3] FAO Meeting on Public Policies Affecting Forest Fires, FAO Forestry Paper 138, Food and Agriculture Organization of the United Nations, 28-30 October 1998, Rome, Italy, 369 p.

FRA 2000 provides the first opportunity for FAO to begin to define the global effects of fires on forests as a part of the forest assessment that is undertaken every ten years. This report summarizes progress in achieving the objectives stated under the Terms of Reference for the global fire data assessment (see Annex for a statement of the Terms of Reference). An attempt is being made through a questionnaire mailed to developing countries to quantify basic fire reporting statistics.

2 Objectives for Terms of Reference (FRA 2000) on Assessment of fire data availability and contingencies

2.1 Review FAO's information needs for FRA 2000 concerning forest fires

Wildfire information needs were discussed with Robert Davis, Jim Space, Gill Allard, Patrick So, and Magnus Grylle during the week of April 12, 1999. The core data desired are fire numbers and area burned for both developed and developing countries. UN/ECE/Geneva routinely summarizes fire data for developed countries; and this source will cover the industrialized countries for FRA 2000. Wildfire occurrence information also will be reported in terms of human causes, natural causes, and unknown causes.

Patrick So indicated that two workshops have been held in Africa regarding data needs for FRA 2000, including the request for fire data. No data regarding fires in African countries have been received so far; and it may be unlikely that this information is sent to FAO.

Additional information was obtained from Pascal Martinez on April 19, 1999, about the fire database functions of Silva Mediterranea.

It would also be useful for FRA 2000 to include a fire narrative that describes forest fire issues and impacts, perhaps by Region or eco-region, in the decade of the 90's.

A meeting was held with Robert Davis and Magnus Grylle on 21 April regarding the questionnaire process for developing countries and on the FORIS database system for FRA 2000. Magnus was briefed on the fire data form and he indicated it would be possible to collect such data based on a country's GEOUNITS, if the data had been collected originally in that format. This would also help to provide a mechanism for collecting fire data that resulted from a partial set of sub-national units within a country. Magnus provided a listing of countries with their GEOUNITS.

A set of instructions was prepared to accompany the fire data form. The instructions were reviewed by forestry staff officers and revised based on their comments.

The fire data tables were prepared in English, Spanish, and French and mailed in a questionnaire to developing countries in May along with instructions for submitting data (see Annex for content of fire data tables and instructions).

2.2 Conduct a summary review of potential information sources to meet the reporting needs, noting:

a) Existing information sources, their location and availability (costs if needed for procurement and means of obtaining data).
b) Geographic coverage of the information.
c) Suitability of the information to meet FAO/FRA 2000 needs.
d) Currency and accuracy of information.

(The data search was conducted using internet, FAO databases, FAO reference materials, country surveys and contacts).

2.3 Fire Data for European and other Developed Countries

The Ministerial Conference on the Protection of Forests met in Strasbourg in 1990 and promulgated Resolution S3 that called for the development of a decentralized data bank for forest fires. This resolution was signed by Ministries of Forestry from 27 European countries.

There are three sources of data for wildfire statistics in European countries:

1. The UN/ECE office in Geneva, Switzerland, collects and reports fire data for approximately 46 developed countries, including Canada and the United States.

2. The European Community in Brussels tracks fire data for 15 countries and submits data to UN/ECE in Geneva.

3. Silva Mediterranea, which compiles wildfire statistics for Mediterranean countries. Currently they are collecting data for 10 countries and will add two more in the near future.

The Silva Mediterranea's commitment to an integrated data base common to countries in the Mediterranean Region began with 5 countries agreeing to work together on such an effort: France, Spain, Italy, Portugal, and Greece. The database provides consistent protocols to report a "common core" of data consisting of fire numbers, area burned, and fire causes. Since the development of the original database for these 5 countries, workshops have been held to prepare 5 additional countries to participate: Tunisia, Morocco, Lebanon, Syria, and Cyprus. During the week of April 26, 1999, Pascal Martinez of FAO and others will be conducting another workshop in Morocco for representatives of Turkey and Algeria to become familiar with the protocols to produce the "common core" of fire data for their countries.

Turkey, however, already has a considerable history of fire reporting data. A detailed report on the fire situation in Turkey cited 62 years of fire statistics for the period 1937-1998, indicating that a total of 63,804 fires had burned a total of 1,447,186 hectares of forest land.[4] This represents 1046 fires that burned an average of 24,210 hectares annually. Turkey also maintains a database on the causes of fires, which helps in the development of fire prevention campaigns. These are the kinds of data continuity that allow a country to better define their fire problems, monitor fire management performance, and better develop fire prevention programs.

CIHEAM (International Centre for Advanced Mediterranean Agronomic Studies) and FAO cooperated in sponsoring a workshop on computerized databases for forest fires in France in 1993. The results of this workshop were published and the publication listed the minimum core of information needed on forest fires:

- First alert: Date and Time.
- First intervention: Date and Time.
- Extinction of fire: Date and Time.
- Location of fire: State, Region, Province or Department, Vegetation Type.
- Total area burned: Hectares.
- Breakdown of area burned: Forested Area:_____ & Unforested area:_____

[4] Forest Fires and Fire Management Policies in Turkey, FAO Meeting on Public Policies Affecting Forest Fires, October 1998, Rome, Italy, pp. 357-361.

- Presumed cause of fire: Unknown, Natural, Accidental/Negligent, Intentional or Willful

The Global Fire Monitoring Center in Freiburg, Germany, also records and reports fire data from different regions of the world. The Center may be able in the future to position a graduate student to compile global wildfire data. This work could be carried out in cooperation with FAO.

2.4 Remote Sensing of Fire Information

Some centers use remote sensing data based on NOAA's AVHRR imagery to determine the extent of fires during the dry season. Some of these studies have been carried out by the European Commission's Joint Research Centre located in Ispra, Italy. For the Brazilian Amazon, similar studies using AVHRR have been carried out by the Brazilian National Institute for Space Studies (INPE). INPE disseminates daily information on "hot spots" that occur throughout Brazil during the dry season. However, these "hot spots" cannot be equated with statistical fires, since they are simply a register of 1 km² pixels that contain heat. There could be more than one statistical fire within a pixel; or many pixels may describe a single large fire.

On April 23, 1999, Gill Allard and Bob Mutch attended a briefing given by Ron Witt and Pascal Perduzzi, UNEP/GRID, at FAO on GRID's activities in creating the first Web Page in the UN on global fires. Reports on global fires are available at GRID-Geneva's website (http://www.grid.unep.ch/fires/). These reports are updated on a weekly basis. The various ongoing activities involved with the remote sensing of fires highlight the need for the international coordination of such efforts. The UNEP personnel also indicated their interest in developing a global risk rating system for wildland fires to help predict where serious fire outbreaks might occur in the future.

Some of the fire detection limitations associated with AVHRR data have been noted[5]:

- The imagery only represents a snapshot of the total number of fires that burn in any 24 hour period.
- Cloud cover inhibits the detection of fire.
- Low intensity fires under a closed canopy of trees might be missed.
- Depending on land-cover type and conditions, in some places fire counts may be overestimated or underestimated.
- The burned area for individual fires cannot be directly derived from the number of "hot spots" recorded.
- Sun-glint from water can confound the fire detection algorithm in certain cases, like swamps, heavily irrigated areas, rice paddies, and along coastlines. Reflected sunlight from bodies of water can be recorded as an elevated heat source within pixels, causing confusion with the detection of forest fires.

There also is a Global Information and Early Warning System (GIEWS) operated by the Commodities and Trade Division of FAO. GIEWS collects and archives information from many different sources. In the United States, the Normalized Difference Vegetation Index (NDVI) is computed daily and provides a measure of the relative greenness, or dryness, of vegetation.

Several agencies also provide near-real time satellite images of fires:

[5] Global distribution and characterisation of vegetation fires using NOAA AVHRR data. Edward Dwyer, Jean-Marie Gregoire, and Jean-Paul Malingreau, Joint Research Centre, Ispra, Italy. European Aerospace Symposium, London, September 1997.

http://modarch.gsfc.nasa.gov/fire_atlas/fires.html (Global Fire Monitoring).
http://ngdc.noaa.gov/dmsp/fires/globalfires.html (Fire Detection Around the World)
http://grid2.cr.usgs.gov/globalfire/indofire/firepaper.html (Global Forest Fire Watch).

2.5 Fire Data in Canada and the United States

In Canada, national fire statistics are maintained by the Canadian Interagency Fire Center in Manitoba. Wildfire data for Federal and State jurisdictions in the United States are maintained by the National Interagency Fire Center in Boise, Idaho. The wildfire databases in Canada and the United States go back to the early part of the 20th Century and include considerable detail on the causes, numbers, and area burned by wildfires. Such information on fire occurrence, causes, and area burned is useful in pinpointing target audiences in fire prevention campaigns; and in monitoring and evaluating fire management programme performance. If accurate and long-term records on fire reports are maintained in a consistent fashion, countries will have a significant basis for monitoring fire management performance and modifying policies when appropriate.

2.6 Fire Data for Developing Countries

Unfortunately many countries in the world do not have a system for routinely recording and disseminating fire statistics. Some countries, like India, record wildfire data, but the data base is unreliable because reporting a damaging fire on one's administrative unit can be career threatening. Since individuals can be punished for having wildfires, these fires often remain unreported or underreported. A.H. Moosvi reported that "in most of Southeast Asia, forest fire statistics are either non-existent or unreliable.[6] Because of lack of standardization of reporting formats and valuation norms, fire occurrence and damage data where available are of little use in policy and plan making. In India, furthermore, public accounting procedures have the effect of concealing fire occurrence/damage reports as otherwise the forest staff recording and reporting the episode will be liable for the loss as if his failure had caused the fire." Moosvi called for "fire database standardization, design, and *in situ* implementation.

The Fire Statistics report prepared by Giancarlo Calabri and W.M. Ciesla for FAO was reviewed, but it acknowledged significant gaps and fragmentary data in many parts of the world.[7] They reported that sufficient data were available to estimate area burned for only 47 countries:

Region	**Number of Countries Reporting**
Northern Europe	14
Southern Europe	8
North America	2
North Africa	3
Near East	6
Asia	6
Latin America	8
TOTAL	47

[6] Comments on the Situation in the Asia-Pacific Region, FAO Meeting on Public Policies Affecting Forest Fires, October 1998, Rome, Italy, pp. 33-34.
[7] Global Wildland Fire Statistics (1981-1990), FAO, Rome, 1992, 48 p.

These 47 countries represent about 54 percent of the world's area of forests and other wooded land. It was estimated that 6.7 million hectares of forest and other wooded lands were burned annually by wildfires in these countries for the period 1981-1990. The authors stated that there are a number of reasons for the absence of global wildfire statistics. In many countries fire management programmes are either non-existent or in the early stages of development. While wildfires may be experienced in these countries, there may be little or no institutional capacity to manage wildfires or compile statistical records. As countries improve their capacity for systematic fire management, it will be important that they recognize and implement fire reporting policies and practices.

The conference sponsored by FAO on "Public Policies Affecting Forest Fires" that was held in Rome, October 1998, included global wildfire data for some of the developing countries. In the Americas, for example, Argentina, Chile, Mexico, Trinidad and Tobago, and Venezuela have data on fire numbers and area burned that go back 10 years or more.

There are many advantages that accrue when accurate and reliable data on wildfires are maintained and reported. Such data provide a quantitative assessment of the threats to forest resources over time, allowing the analysis of trends and the development of strategies to counter such threats. Recording the causes of forest fires provides important information to agencies to target various sources of wildfires with fire prevention messages specific to actual problems. The importance of valid statistical data bases in countering negative impacts of wildfires requires an institutional approach that will transfer appropriate fire data base technology to developing countries. The potential for FAO to cooperate with the Global Fire Center in Freiburg, Germany, could provide material assistance in overcoming many of the current deficiencies in data base development and management. Pascal Martinez, currently on the FAO staff, has considerable expertise in fire data base management through his work with Silva Mediterranea and CIHEAM.

2.7 Recommended appropriate fire terminology (in agreement with other Agencies) to distinguish between types of fires i.e. vegetation; forest fires; prescribed burning; wildland fires; wildfires etc. for classification purposes

Pyne stated that in contemporary thinking there are two categories of wildland fire: wildfire and prescribed fire[8]. He defined a wildfire as an unwanted fire that requires control measures. A prescribed fire is wanted, or at least serves management goals, and is thereby promoted. Although these definitions come from his book on an "Introduction to Wildland Fire", the term wildland fire is not specifically defined other than describing its two categories. Use of the term ***wildland fire*** is a rather universal concept, at least in Canada and the United States, applied broadly to any fire that occurs in forest, shrubland, grassland, and tundra ecosystems. It is meant to be an all-inclusive term, encompassing any fire that occurs in vegetation. More specifically, the term forest fire is restricted to a fire occurring in a vegetation complex that fits the definition of a forest.

The fire itself is a manifestation of a chemical reaction that occurs when the appropriate combination of fuel, oxygen, and heat is present, the well-known fire triangle.

The following Fire Definitions[9] from FAO are proposed to guide the collection of fire data in support of FRA 2000:

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[8] "Introduction to Wildland Fire", Stephen J. Pyne et al, John Wiley & Sons, Inc., 1996.

[9] Definitions are adapted from "Wildland Fire Management Terminology", FAO 70, United Nations, Rome, 1986, 257 p.

Wildfire: Any fire occurring on wildland except a fire under prescription. (Note: wildfires are considered to be damaging and unwanted fires).

Prescribed fire: A fire burning within a designated prescription. A prescribed fire is intended to achieve specified natural resource management objectives.

Statistical fire: In general an actionable fire (wildfire) on which an agency reports and maintains specified information such as cause, date, and place of origin, size, damages, etc.

2.8 Indicate gaps in the existing information base and make recommendations for gap filling as required

Numerous sources, including the FAO study on fire statistics carried out by Giancarlo Calabri, have reported many gaps in wildfire data for developing countries. The Calabri study reported that only 47 countries, representing 54 percent of the world's forests and other wooded land, had accurate data on forest fire numbers and area burned.

Since FRA 2000 is requesting up-to-date fire information for the period 1990-1999, the best way to fill the gaps is to solicit the developing countries with a questionnaire for basic wildfire data. The questionnaire will provide information that was previously unknown, or highlight those countries that presently do not have a database reporting system in place for wildfires. Follow-up with countries in the future, perhaps along the lines of the Silva Mediterranea process, could help improve the capacity for harmonising statistics among countries on a regional level. **It is important to recognize that the countries themselves must understand the importance of an accurate fire reporting database and take the necessary steps to enact such a system on a continuing basis.** FAO could provide regional leadership in providing training workshops on the development of a fire database, similar to the type of technical support that has been given to the Silva Mediterranea project.

2.9 Propose a mechanism to involve developing countries in the generation/validation of statistics. (FAO/FRA methods generally require at a minimum a brief to each country for them to approve or resubmit statistics they themselves have gathered and at best train and utilise developing country personnel in the generation of the statistics)

The following wildfire data form was prepared for transmittal to developing countries to enlist their support in documenting and submitting wildfire information to be used in FRA 2000. This form was reviewed and approved for use by FRA 2000 staff to include in an overall questionnaire that was mailed to developing countries in May. The following fire data form with accompanying instructions was prepared in English, French, and Spanish (see Annex for the form in French and Spanish; and the instructions for completing the form):

Numbers of Fires and Area Burned[10]

Country/Sub-national Unit: _____

Year	Total No. of Fires on Forest and Other Wooded Land	Total Area Burned ha	Area of Forest Burned ha	Area of Other Wooded Land Burned ha	Human Causes No.	Natural Causes No.	Unknown Causes No.
1990							
1991							
1992							
1993							
1994							
1995							
1996							
1997							
1998							
1999							

Note: This table needs to be completed only by those countries which do not report annual data on fires using the UN-ECE/FAO/Commission of European Communities questionnaire on forest fires.

Comments:

_____

_____

_____

Definitions:

Forest: Land with tree crown cover of more than 10 percent and area of more than 0.5 hectares. The trees should be able to reach a minimum height of 5 meters at maturity.

Other wooded land: Land either with a crown cover of 5-10 percent of trees able to reach a height of 5 meters at maturity; or a crown cover of more than 10 percent of trees not able to reach a height of 5 meters at maturity; or with shrub or bush cover of more than 10 percent.

Date: _____
Source of information: _____
Country correspondent: _____
E-mail address of correspondent: _____

2.10 Evaluate the option of providing statistics at regional levels for the developing world if data gathering mechanisms are insufficient at the national levels (including coarse resolution remote sensing and linkages with the EU/JRC Programme)

The initial strategy to obtain fire data for developing countries was through the dissemination of the fire data questionnaire during the May mailing by FRA 2000. Following the return of the questionnaires, an assessment will made to ascertain the completeness of the statistical coverage of wildfires among the developing countries. If the availability of fire data for the developing

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

countries is found to be inadequate, the contingency plan would be to prepare a more qualitative Special Studies Report describing the impacts of wildfires by region or eco-region. If the fire database for developing countries is weak, it is unlikely that there will be quantitative information at the regional level.

It might be argued that remote sensing data on fires could be used to describe the situation at regional levels. But due to the limitations related to remote sensing fire data mentioned earlier, it is difficult to describe definitive parameters for fires occurring in a region. However, a discussion of global fire data derived from remote sensing platforms could be presented in the Special Studies Report.

Under either scenario, an adequate database or an inadequate database, it would be useful to include a narrative account of fire impacts on forests by region; and potential solutions to resolving these impacts.

2.11 Elaborate a draft layout for presentation of the statistics for FRA 2000, including recommendations for complementary text to support or frame the statistics

The following tables indicate the suggested format for entering the results of the questionnaire being sent to the developing countries (fire statistics for the developed countries will be provided by UN/ECE in Geneva.

Table __
Total Number of Wildfires
Forest and Other Wooded Land

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999

Table __
Total Area Burned by Wildfires
Forest and Other Wooded Land

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999

Table __
Number of Wildfires by Human Causes
Forest and Other Wooded Land

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999

Table __
Number of Wildfires by Natural Causes
Forest and Other Wooded Land

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999

Table __
Number of Fires by Unknown Causes
Forest and Other Wooded Land

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999

2.12 Recommend a framework for collecting fire data, including the causes of fire, at the national level

2.12.1 Fire Statistics

At the Fourth Seminar sponsored by the Joint Committee and held in Siberia 2-13 August 1996, participants concluded that "the lack of, and need for, a global statistical fire database, by which the economic and ecological impact of fires could be spatially and temporally quantified, was identified. Such a reliable database is essential, under current global change conditions, to serve sustainable development and the urgent needs of fire management agencies, policy makers, international initiatives, and the global modelling community." The seminar participants made the following recommendation to the Joint Committee related to the issue of a global database:

> "Quantifiable information on the spatial and temporal distribution of global fires is urgently needed relative to both global change and disaster management issues. Considering the recent various initiatives of the UN system in favour of global environmental protection and sustainable development, the ECE/FO/ILO Seminar on Forest, Fire, and Global Change strongly urges the formation of a dedicated United Nations unit specifically designed to use the most modern means available to develop a global fire inventory, producing a first-order product in the very near future, and subsequently improving this product over the next decade. This fire inventory data will provide the basic inputs into the development of a Global Vegetation Fire Information System."

There are many reasons supporting the maintenance of an accurate and reliable database on wildfire statistics. Such information as fire numbers, area burned, and fire causes is absolutely essential to the efficient operation of a systematic fire management program. The following examples from Canada and the United States underscore the importance of a long-term database on wildfire statistics. Also, note the numerous purposes cited by Simard related to the application of fire statistics. However, it must be recognized that many countries of the world do not presently have a system for systematically recording wildfire statistics. FRA 2000 can serve as a catalyst to begin to establish the importance of such data; and request these data through a questionnaire.

Surprisingly, correspondence to FAO from Phil Cheney, CSIRO, Australia, dated 8 April 1992, indicated that there are no national fire statistics maintained in Australia. Although some State fire services still maintain fire statistics for wildfires burning on land under their control, the

position at the National level is that it is not worth the effort to collect such information in Australia. Other developed countries do not share this position, as the examples from Canada and the United States will demonstrate.

2.12.2 Fire Statistics in North America

(See Annex for detailed statistical information on number, size, cost, and causes of forest fires in Canada and the United States)

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

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

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

2.12.3 Conclusions from Analysis of Canadian and U.S. Wildfire Databases

The general conclusions that can be drawn from the Canadian and U.S. examples of wildfire databases (See Annex) are that larger areas are being burned now than in the earlier part of the 20th Century and that wildfire suppression costs have been increasing significantly in the last 10 to 20 years. These two facts have prompted both countries to re-assess their fire management programme strategies and adopt new strategies for the future that emphasize policies for more sustainable forms of resource management.

Much of the increase in area burned since the 1980's can be attributed to significant drought conditions, unnatural accumulation of fuels due to fire exclusion, increase in stand densities and change in species composition in the absence of fire, and widespread insect and disease epidemics. The year 1994 in the United States marks the first time in history that the Federal wildfire expenditures approached one billion dollars; and 34 fire-fighters died during the 1994 fire season. Based on the insights provided by the simple statistic of area burned since the early part of the century, both Canada and the United States are developing programs for a substantial

increase in prescribed burning to reduce the fire hazard in the forests of these two countries. Thus, a commitment by these two countries to consistently record basic fire statistics since the early 1900's has provided far-reaching insights as to the nature of today's wildland fire crisis. Based on an evaluation of the statistics, both countries are instituting significant changes in fire policies and practices to reduce the current fire hazards to more acceptable levels.

2.12.4 The Silva Mediterranea Model for a Fire Database

The importance of reliable databases for reporting wildfire statistics cannot be over emphasized. Although FAO may be able to solicit short-term assessments of wildfires from some member countries in time for FRA 2000, the longer term goal should be one of developing a process that will ensure the commitment of countries in developing an integrated system of wildfire data that is compatible across entire Regions. A suitable model exists today for helping other countries and Regions achieve reliable databases on wildfires. The model is the one that has been used successfully by Silva Mediterranea (joint cooperation by CIHEAM and FAO) to establish an effective wildfire database for the original 5 countries; and the addition of 5 more countries recently.[11] The next two target countries to be included in this effort are Algeria and Turkey. This model is based on a "hands-on" workshop format where participants are encouraged to work at harmonizing country data within a computerized system. FAO has assisted in applying this approach to record and maintain the "common core of data" through facilitation at country workshops. FAO could apply this in-house advantage in taking the Mediterranean process to other parts of the world, perhaps in cooperation with the Global Fire Center in Freiburg, Germany.

Objectives for the Silva Mediterranea fire database consist of the following:

- Provide a fire situation report with comparable data for a large area of Europe.
- Provide for the exchange of information among countries to strengthen fire protection programs.
- Make information readily available to all without causing technical difficulties or disrupting national databases.
- Provide an open-ended data system that will gradually acquire more and more information over time.
- Develop a system of collecting information that is compatible with the UN/ECE data collection and processing system in Geneva.

Such criteria as the above would be equally valuable in guiding wildfire database development in other regions of the world as well.

The initial emphasis under FRA 2000 will be to request basic information on wildfires in terms of fire numbers, area burned, and causes (human, natural, and unknown). Once the pattern has been established to annually record these basic data about wildfires in a consistent way, the data collected can be expanded to include a more definitive set of fire causes. For example, FAO/ECE requests the following kinds of fire cause information from developed countries:

- Human-causes
  - Arson
  - Negligence

[11] Forest Fires in the Mediterranean Region--Constitution and Use of Databases, Options Méditerranéennes, Series A, No. 25, 1995, Proceedings of the Montpellier Workshop, November 30-December 4, 1993, Editors R. Chevrou, P. Delabraze, M. Malagnoux, and R. Velez, 195 p.

- Natural causes
- Unknown causes

Negligent fires are further sub-divided into these categories:

- Agricultural operations
- Logging and forest operations
- Other industrial activities
- Communications (railways, electrical power lines, etc.)
- General public (campers, visitors, children)
- Other (military, etc.)

Refinements such as these can be added at a later time. Also, an expanded database in the future should include information on the prescribed fire programs within countries. It is useful to track this type of information separately from the wildfire data. A suggested stratification for prescribed fire data will be presented at a later time.

2.13 Recommend contingency plans for FRA2000 reporting in the event that existing information sources are insufficient for proposed reporting elements

The following outline was developed to describe a narrative assessment of global fire issues and proposed solutions to the ever-increasing threat of wildfires to people, property, and natural resources during the decade of the 1990's. FRA 2000 staff may want to consider the development of such a Special Report on Fire similar to the Special Report on Plantations. This assessment, or Special Report on Forest Fires, would complement available statistics and narratives that are submitted by developed and developing countries:

Forest Resources Assessment 2000
Special Report on Forest Fires

Draft Outline

I. Introduction
   A. Purpose
   B. Catastrophic Fires: 1980's vs. 1990's
   C. Fire Exclusion and Fire Use in Management of Forests

II. Global Fire Issues (See listing below of key issues affecting the world's forests and human populations in the 1990's)

III. Effects of Fires on the World's Forests (Stratified by Regions or Eco-Regions)

IV. Fire Regimes: a Basis for Determining Forest Protection Strategies

V. Systematic Fire Management: a Model for Operational Safeguarding of Forest Resources

VI. Fire Reporting (Based on statistical and narrative information received from countries)

VII. Public Policies Affecting Forest Fires (Summarizing key points from Public Policy Conference)

VIII. Sustainable Land Use Practices to Reduce Fire Hazards

IX. Conclusions and Recommendations

X. Appendix

Issues covered in this Special Studies Report on Forest Fires would include:

1. Declining forest health in fire-adapted ecosystems due to the past attempts to exclude fires (resulting in unnaturally large fuel accumulations, higher intensity fires, widespread insect and disease epidemics, shift in species composition towards less fire tolerant ones, and denser stands of trees).

2. Greater threats to homes in the wildland/urban interface where homes and wildland fuels are intermingled. (For example, more than 70,000 people were evacuated from their homes in Florida during the 1998 fire season, including everyone in one county). Numerous villages also were threatened in Mexico and other countries.

3. Significant negative fire impacts to tropical rain forests in Indonesia, Brazil, Mexico, and elsewhere due to El Niño induced drought conditions in 1997-1998.

4. Widespread damage to forests and natural resources from unregulated agricultural burning.

5. Global health impacts as air pollutants from wildfires caused numerous transboundary human health problems.

6. Numerous fatalities among fire-fighters and other individuals as a result of wildfires.

7. Wildfires caused significant disruption of air and sea transportation in Indonesia, Mexico, and Central America due to poor visibility.

8. The cost of fire suppression and the damage from wildfires has been increasing in the 1990's, due to prolonged drought conditions, unnaturally high accumulations of fuel, and widespread insect and disease epidemics that have contributed to forest mortality.

9. Contribution of combustion gases to global climate change.

10. The need to link sustainable land use policies and practices with emergency preparedness measures to reduce the negative impacts of wildfires in the long run.

11. The need for community participation and involvement in sustainable land use practices and fire management programs.

12. The need for a quantitative fire database in fire-prone countries to identify fire problems, identify treatment priorities, guide fire prevention programmes, and monitor progress of resource management and fire management objectives.

2.14 Develop a budget and work plan for the development of the information set with FAO Officers

Budget implications of acquiring a fire database for developing countries was discussed briefly with FAO staff during the closeout of the April assessment in Rome. It generally was felt that FRA 2000 had sufficient funding to accommodate the inclusion of instructions and fire data forms in the questionnaire that was mailed to developing countries in May; and to process returned forms to incorporate the information in the fire assessment. However, once developing countries respond to the request for fire data, FAO staff will be in a better position to determine the completeness of such information. If fire data for developing countries is inadequate, then it would be appropriate to develop a work plan and budget for conducting Silva Mediterranea type workshops in various Regions to gain national commitment towards a consistent and reliable database in the future.

Also, in the absence of detailed fire statistics for developing countries, FRA 2000 personnel are considering the development of a Special Report on Fire that would describe the impacts of global fires on forests in a narrative fashion. A narrative report on fire might serve in the same manner as does the Special Report on Plantations.

2.15 Summarize findings in a report

This final report summarizes the results of the fire data assessment that took place under the Terms of Reference for the period April-July 1999.

3 Conclusions

Through the FRA 2000 process FAO is in the enviable position of closing out the 20th Century by instituting a process for the collection of meaningful fire data for developing countries. Even if the request for wildfire data on fire numbers, area burned, and causes falls short of expectations, at least the importance of regularly recording and evaluating such information will have been established with member countries. Strategic advantages accrue to countries when they regularly report, record, evaluate, and disseminate fire statistics on national, regional, and global levels. Examples have been presented in this report demonstrating that even the most basic annual information on area burned by wildfires can provide insights into making appropriate fire management program adjustments directed at more sustainable resource management.

It is apparent in observing the results of fire database development efforts like those enacted by Silva Mediterranea that individual country data needs can be met while still providing a consistent format in regional reporting. Also, the Silva Mediterranea process underscores the value of establishing the initial database with basic and essential information, with the realization that more complex requirements can be added at a later time. Another principle demonstrated by Mediterranean countries is that an effective fire database is dependent on countries developing an internal commitment to regularly recording and reporting fire statistics to satisfy national and regional needs.

Many developing countries may still not have a process in place for recording and reporting wildfire data. If that is the case, it would be highly desirable for FRA 2000 to implement its plan to produce a Special Report on Forest Fires documenting the effects of fires on forests during the last decade of the 20th Century. This Special Report could supplement available wildfire statistics with a narrative account of fire effects by Region. The Special Report could serve as an incentive for other countries to recognize the importance of adding their wildfire experiences to the worldwide database in the 21st Century.

Appendix 1: Instructions for Completing Wildfire Data Form for FRA 2000

Form title: Numbers of Fires and Area Burned

For the first time, wildfire statistics for developing countries will be included as a part of the Forest Resource Assessment 2000. We would be very grateful, if you would fill in the requested information in the wildfire data form and return it to FAO/Rome by the deadline indicated.

We take this opportunity to remind you that FAO member countries, through such fora as the recent FAO ministerial meeting on forests and the COFO meeting in Rome, March 1999, have stressed the importance of understanding and controlling wildfires. A reliable and accurate database of wildfire statistics is essential in understanding what needs to be done, setting protection priorities, and monitoring progress by FAO member countries.

Forms are enclosed for you to submit wildfire data on fire numbers, area burned, and causes by administrative sub-units of your country. You may also submit these data for the country as a whole, if that is how your fire information is recorded. Negative feedback is also valuable to us. Please enter N/A in the data form for any values that are not recorded. We understand that some countries do not presently have a system in place for recording wildfire data on an annual basis. If that should be the case for your country, please make that notation in the Comments' section and return the form.

If you have any questions or problems related to the completion of this form, do not hesitate to contact:

Robert Davis (tel. 39-06-570-53596, e-mail robert.davis@fao.org)

Thank you very much for your help.

Sincerely,

Forest Resource Assessment 2000

Numbers of Fires and Area Burned[12]

Country/Sub-national Unit (e.g. State, Province, or District): _____

Year	Total No. of Fires on Forest and Other Wooded Land	Total Area Burned ha	Area of Forest Burned ha	Area of Other Wooded Land Burned ha	Human Causes No.	Natural Causes No.	Unknown Causes No.
1990							
1991							
1992							
1993							
1994							
1995							
1996							
1997							
1998							
1999							

Note: This table needs to be completed only by those countries which do not report annual data on fires using the UN-ECE/FAO/Commission of European Communities questionnaire on forest fires.

Comments:

_____
_____
_____
_____
_____

Definitions:

Forest: Land with tree crown cover of more than 10 percent and area of more than 0.5 hectares. The trees should be able to reach a minimum height of 5 meters at maturity.

Other wooded land: Land either with a crown cover of 5-10 percent of trees able to reach a height of 5 meters at maturity; or a crown cover of more than 10 percent of trees not able to reach a height of 5 meters at maturity; or with shrub or bush cover of more than 10 percent.

Date: _____
Source of information: _____
Country correspondent: _____
E-mail address of correspondent: _____

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

Evaluation des ressources forestières 2000

Nombre des incendies et surface brûlée[13]

Pays/Unité territoriale: _____

Année	Total incendies de forêt et d'autres terres boisées No.	Total de la surface brûlée ha	Surface de forêt brûlée ha	Surface d'autres terres boisées brûlées ha	Cause anthropique No.	Cause naturelle No.	Cause inconnue No.
1990							
1991							
1992							
1993							
1994							
1995							
1996							
1997							
1998							
1999							

Note: A remplir seulement par les pays qui ne fournissent pas d'information annuelle sur les incendies sur les questionnaires de la Commission de la Communauté Européenne (UN-ECE/FAO).

Commentaires:

_____
_____
_____
_____
_____

Définitions:

Forêt: Terre avec un couvert arboré supérieur à 10 pour cent et d'une superficie supérieure à 0,5 hectare. Les arbres doivent être capables d'atteindre une hauteur minimum de 5 m à maturité.

Autre terre boisée: Terres ayant soit un couvert arboré de 5 à 10 pour cent d'arbres capables d'atteindre une hauteur d'au moins 5 m à maturité; ou un couvert arboré de plus de 10 pour cent d'arbres d'une hauteur inférieure à 5 m à maturité; ou de plus de 10 pour cent d'arbustes et formations arbustives.

Date: _____
Source d' l'information: _____
Correspondant dans le pays: _____
Adresse électronique du correspondant:_____

[13]Information recueillie de tous les incendies de forêt ou d'incendies de terres non cultivées à l'exception du brûlage dirigé.

Evaluación de los Recursos Forestales 2000

Número de Incendios y Área Quemada[14]

País/Unidad territorial: _____

Año	No. Total de Incendios de Bosques y Otras Tierras Boscosas No.	Total Área Quemada ha	Área de Bosques Quemada ha	Área de Otras Tierras Boscosas Quemada ha	Causas Humanas No.	Causas Naturales No.	Causas Desconocidas No.
1990							
1991							
1992							
1993							
1994							
1995							
1996							
1997							
1998							
1999							

Comentarios:
_____
_____
_____
_____
_____

Definiciones:

Bosques: Tierra con una cubierta de copa de más del 10 por ciento del área y una superficie superior a 0,5 hectáreas (ha). Los árboles deberían poder alcanzar una altura mínima de 5 metros (m) a su madurez.

Otras Tierras Boscosas: Estas abarcan ya sea tierras donde la cubierta de copa tiene entre 5 y 10 por ciento de árboles capaces de alcanzar una altura de 5 m a su madurez; o tierras con una cubierta de copa de más del 10 por ciento en la que los árboles no son capaces de alcanzar una altura de 5 m a su madurez; o aquellas donde la cubierta arbustiva abarca más del 10 por ciento.

Fecha: _____
Fuente de la información: _____
Corresponsal en el país: _____
Dirección electrónica del corresponsal: _____

[14] Información registrada de todos los incendios libres, o de cualquier incendio que haya ocurrido en tierras vírgenes excepto de los incendios bajo prescripción.

Appendix 2: Planning and information needs assessment for forest fires component

Background

The mission of FAO's global forest resources assessment programme is to *provide the world community reliable information to describe and understand the situation of the world's forests and related resources and how they change over time*. The assessments are carried out jointly by FAO, Rome, and UN-ECE/FAO, Geneva, in cooperation with member countries and partners. FAO is directly responsible for information for developing countries, as well as a global synthesis and UN-ECE/FAO Geneva is responsible for the industrialized countries.

To carry out this mission, FAO's Forest Resources Assessment Programme:

1. Supports capacity building by providing technical assistance to developing countries in the conduct of national forestry assessments;

2. Co-ordinates forest resources assessments for both developing and industrialised countries; and

3. Produces global forest resources assessment databases and periodic reports.

The immediate objectives for the Global Forest Resources Assessment 2000 will be to:

1. Carry out an assessment of forest resources (including information on the goods and services provided by forests) on a global basis referenced to the year 2000;

2. Estimate the changes in forests that have taken place during the decade 1990-2000;

3. Compare to the changes during the decade 1980-1990;

4. Provide information that helps understand the reasons for and the effects of change, including the social, economic, and environmental implications;

5. Disseminate results, data bases, and methodologies to interested national and international institutions, world-wide.

Forest Fire Component for FRA 2000

The Expert Consultation on Global Forest Resources Assessment 2000 held in Kotka Finland during June of 1996 recommended that FAO should provide annual statistics/estimates for the FRA 2000 for each country on the number of forest fires and the area burned over the period 1990 – 2000.

Objectives

Within the context of the reporting needs for the FRA 2000 concerning developing countries, the consultant will:

1) review FAO's information needs for FRA 2000 concerning forest fires

2) conduct a summary review of potential information sources to meet the reporting needs, noting:

    e) existing information sources, their location and availability (costs if needed for procurement and means of obtaining data)
    f) geographic coverage of the information
    g) suitability of the information to meet FAOs FRA 2000 needs
    h) currency and accuracy of information

    (data search will be conducted using internet, FAO databases, FAO library, country surveys and contacts to be arranged by the consultant and FAO officers)

3) recommend appropriate fire terminology (in agreement with other agencies) to distinguish between types of fires i.e. vegetation; forest fires; prescribed burning; wildland fires; wildfires etc for classification purposes

4) indicate gaps in the existing information base and make recommendations for gap filling as required

5) propose a mechanism to involve developing countries in the generation/validation of statistics, noting that FAO FRA methods generally require at a minimum a brief to each country for them to approve or resubmit statistics they themselves have gathered and at best train and utilise developing country personnel in the generation of the statistics

6) evaluate the option of providing statistics at regional levels for the developing world if data gathering mechanisms are insufficient at the national levels (including coarse resolution remote sensing – and linkages with the EU JRC programme)

7) elaborate a draft layout for presentation of the statistics for FRA 2000, include recommendations for complementary text to support or frame the statistics

8) recommend a framework for collecting fire data including the causes of fire at the national level

9) recommend contingency plans for FRA 2000 reporting in the event that existing information sources are insufficient for proposed reporting elements

10) develop a budget and workplan for the development of the information set with FAO officers

11) summarize findings in a report

Duration: 3 months
Location: 16 days in Rome and remainder in home station

Appendix 3: Fire database examples from North America

Canadian Example

There can be considerable variability in the number of fires and area burned each year, (Figure 1). Not all fires are fully suppressed in Canada, with some fires receiving a modified response. Eight percent of the fires in 1995 received a modified response, but accounted for 60 percent of the area burned. On average, 10,000 fires burn 3 million ha annually (Figure 2), of which approximately 750 000 ha is commercial forest (an area equal to 3/4 of the annual area harvested).

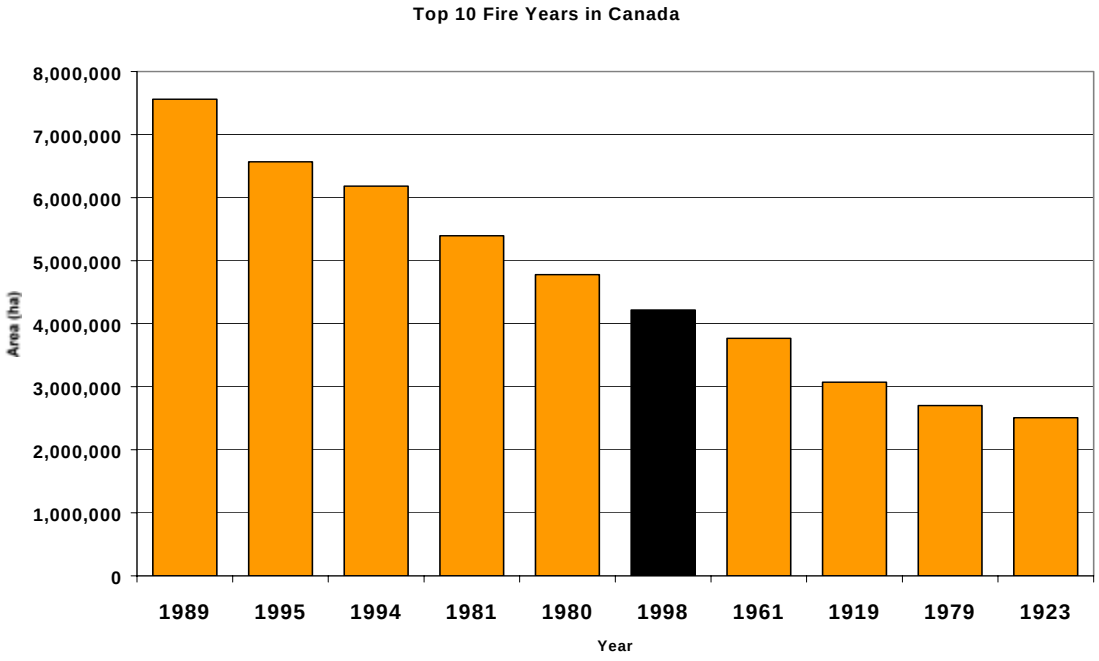

Figure 1. Top ten years for area burned in Canada (hectares).

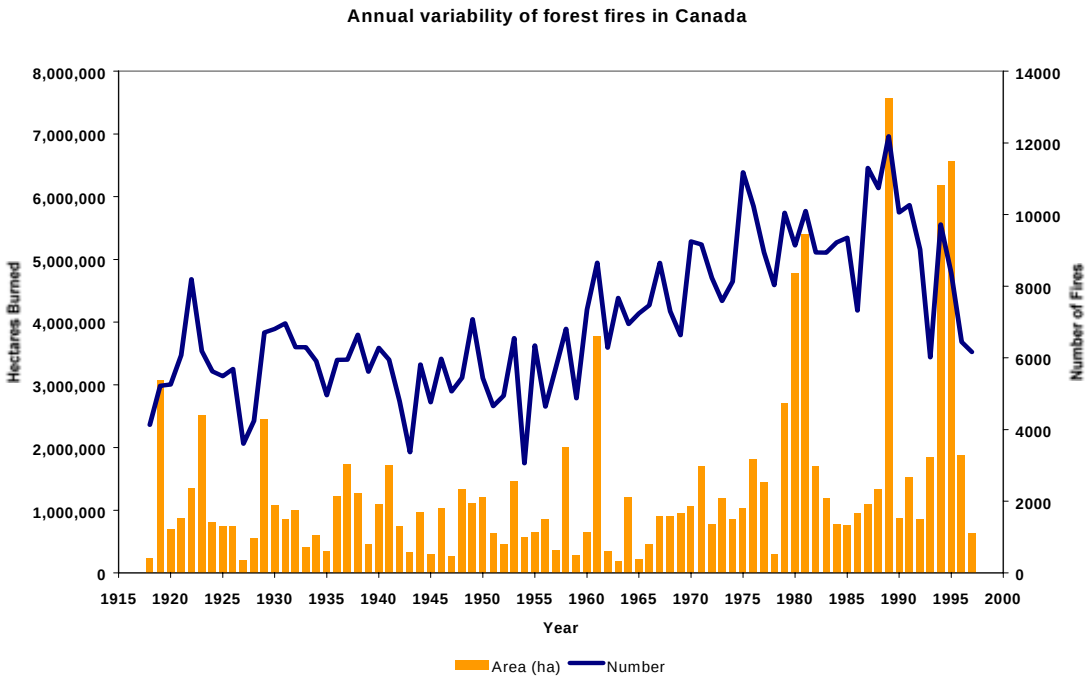

Figure 2. Annual variation of forest fire sizes and numbers 1918-1997.

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

Fire management is big business in Canada with over 500 million dollars spent each year. The 10-year average shows that close to 10,000 fires per year burn 2.3 million ha of forest land. Both fixed costs and suppression costs have increased dramatically over the past 25 years (Figure 3) and the trend is for further increases in the future. In addition, over 365 communities in Canada are dependent on forest resources for their livelihood.

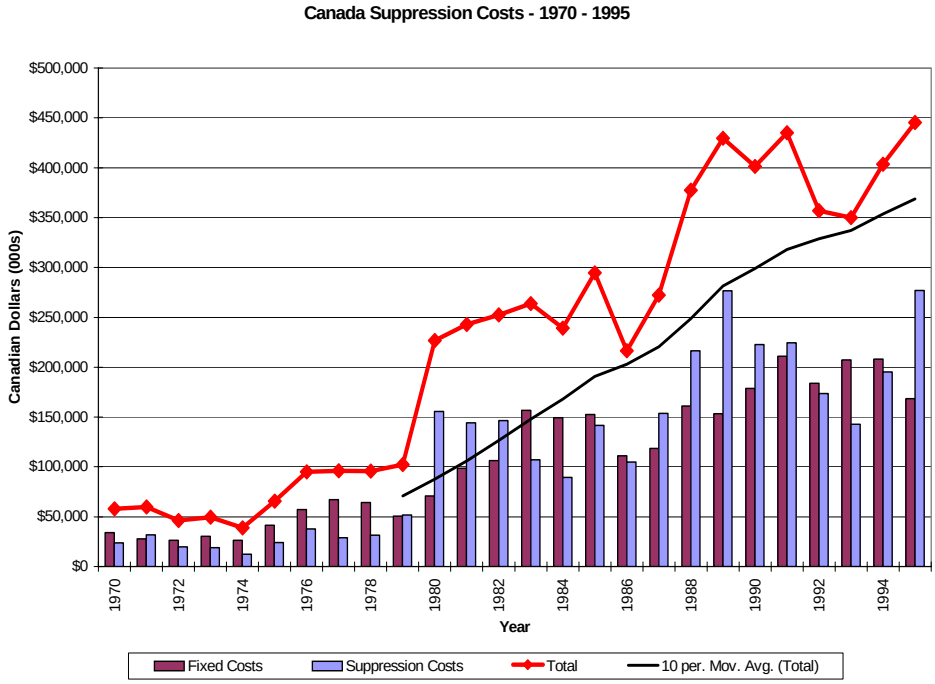

Figure 3. Canada suppression costs, 1970-1995.

United States Example

It is not surprising in the aftermath of the extensive 1910 wildfires that public policies were developed that emphasized fire suppression programmes over prescribed fire programmes; programme emphasis that was universally accepted by society and politicians. But since 1910, a large body of scientific knowledge has developed regarding fire history, fire regimes, and fire effects; the decline in the health of ecosystems has reached alarming proportions; and large, high intensity wildfires are increasing in size since the mid-1980's (Figure 4).

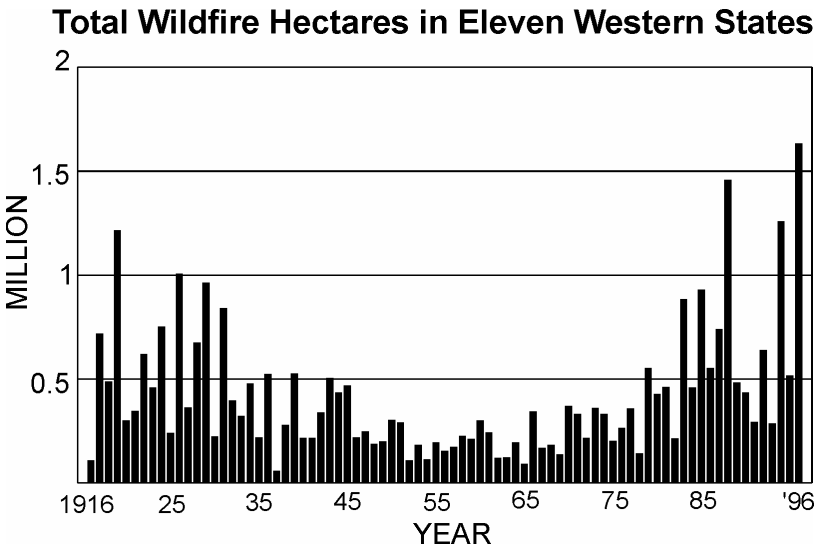

Figure 4. Total wildfire hectares burned in the 11 western states on all Federal lands between 1916 and 1996.

Wildfire Occurrence and Cause in the United States

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

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

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

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

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

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

FRA Working Papers

1998

1. *FRA 2000 Terms and Definitions* (18 pp. - E/F/S/P)

2. *FRA 2000 Guidelines for assessments in tropical and sub-tropical countries* (43 pp. - E/F/S/P)

1999

3. *The status of the forest resources assessment in the South-Asian sub-region and the country capacity building needs.* Proceedings of the GCP/RAS/162/JPN regional workshop held in Dehradun, India, 8-12 June 1998. (186 pp. - E)

4. *Volume/Biomass Special Study: georeferenced forest volume data for Latin America* (93 pp. - E)

5. *Volume/Biomass Special Study: georeferenced forest volume data for Asia and Tropical Oceania* (102 pp. - E)

6. *Country Maps for the Forestry Department website* (21 pp. - E)

7. *Forest Resources Information System (FORIS) – Concepts and Status Report* (20 pp. E)

8. *Remote Sensing and Forest Monitoring in FRA 2000 and beyond*. (22 pp. - E)

9. *Volume/Biomass special Study: Georeferenced Forest Volume Data for Tropical Africa* (97 pp. – E)

10. *Memorias del Taller sobre el Programa de Evaluación de los Recursos Forestales en once Países Latinoamericanos* (S)

11. *Non-wood forest Products study for Mexico, Cuba and South America* (draft for comments) (82 pp. – E)

12. *Annotated bibliography on Forest cover change – Nepal* (59 pp. – E)

13. *Annotated bibliography on Forest cover change – Guatemala* (66 pp. – E)

14-17 (In preparation)

18. *Forest plantation resource in developing countries* (75 pp. – E)

19. *Global forest cover map* (14 pp. – E)

20. *A concept and strategy for ecological zoning for the global forest resources assessment 2000 – Interim report* (23 pp. – E)

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