ECE/TIM/IFFN/2003/2

INTERNATIONAL FOREST FIRE NEWS

No. 29
July – December 2003

UNITED NATIONS
New York and Geneva, 2004

NOTE

ECE/TIM/IFFN/2003/2

UNITED NATIONS PUBLICATION

ISSN 1020-8518

INTERNATIONAL FOREST FIRE NEWS (IFFN)
IS AN ACTIVITY OF THE TEAM OF SPECIALISTS ON FOREST FIRE OF THE
JOINT FAO/ECE/ILO COMMITTEE ON FOREST TECHNOLOGY, MANAGEMENT AND TRAINING
AND THE GLOBAL FIRE MONITORING CENTER (GFMC)

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The International Union of Forestry Research
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→ Due of the time lag between editing and print/distribution of IFFN, readers interested in meeting announcements are kindly requested to visit the Internet version of this issue for update and short-term announcement of meetings (continuously updated) on http://www.fire.uni-freiburg.de

International Forest Fire News (IFFN) is published on behalf of the Joint FAO/ECE/ILO Committee on Forest Technology, Management and Training and its secretariat, the Timber Section, UN-ECE Trade Division. Copies are distributed and available on request from:

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All current issues of IFFN are posted on the homepage of the Global Fire Monitoring Center (GFMC) and can be accessed @

http://www.fire.uni-freiburg.de/

All IFFN contributions published between 1990 and this current issue are accessible through 77 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 or 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.

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

Preface

Fires are one of the major causes of ecological, social and economic damage to forests in Europe, especially southern Europe, and North America, destroying or severely damaging every year hundreds of thousands of hectares, causing major damage to property, sometimes loss of life, and often preventing the establishment of ecologically balanced and resilient ecosystems. The causes of fires are complex, with sociological, economic, climatic and forest management aspects. The importance of fire issues, and the necessity to take an international approach has been widely recognised, and there are a number of major initiatives under way, some of which are described in this issue of International Forest Fire News.

Communication between experts, and with policy makers and opinion formers is of the greatest importance to spread knowledge of the situation, its causes and possible solutions, and to promote synergies at the interagency level. UNECE and FAO, with the eight co-sponsors whose logos appear on the inside front cover, are happy to offer International Forest Fire News as a communication vehicle to the international forest fire community. Its usefulness is evident from the strong and continuously growing demand there is for IFFN.

I take this opportunity to thank the editor of IFFN, Professor Johann G. Goldammer and his team, for their important contribution.

Brigita Schmögnerová
Executive Secretary
UN Economic Commission for Europe

EDITORIAL

With reference to the outcomes of the World Summit for Sustainable Development (WSSD) (Johannesburg, South Africa, 2002) an International Wildland Fire Summit was held in Sydney, Australia in October 2003 (immediately following the third International Wildland Fire Conference). The theme of the summit was "Fire Management and Sustainable Development: Strengthening International Cooperation to Reduce the Negative Impacts of Fire on Humanity and the Global Environment".

The summit theme was selected to underscore the need to address the increasing vulnerability of ecosystems and human populations to uncontrolled wildland fires as well as the inappropriate or excessive application of fire in modifying vegetation cover. High priority was given to defining solutions and to enhancing international cooperation in the arena of wildland fire management.

The summit recognized that solutions must be based on practical and realizable approaches and instruments leading to common strategies, frameworks for implementation and financing mechanisms. Most crucial is the development of mechanisms that will result in concrete action, including both informal and formal agreements at the bilateral and international levels. The agreed "Strategy for Future Development of International Cooperation in Wildland Fire Management" provides a number of recommendations aimed at harmonization and standardization of approaches and enhanced international cooperation. Two of the summit's outputs are particularly practical and ready for implementation:

- An international agreement template which can be used by agencies wishing to form a cooperative or mutual aid arrangement with one or more other countries for cooperation in wildland fire management;
- A recommendation that an Incident Command System (ICS) should become the international standard for wildland incident management in international or interagency agreements and exchanges.

A priority area of the ISDR Working Group on Wildland Fire was the establishment of the Global Wildland Fire Network, aimed at enhancing existing capabilities in fire monitoring, early warning and impact assessment, and facilitating international cooperation in fire management. The International Wildland Fire Summit endorsed the global network as a means of consolidating, developing and promoting the work of the Regional Wildland Fire Networks through active networking in information sharing, capacity building and preparation of bilateral and multilateral agreements. This process is facilitated through regional wildland fire conferences and consultations. On behalf of ISDR, GFMC is acting as the global network's convener and secretariat, supporting the establishment of Regional Wildland Fire Networks and facilitating cooperative efforts with existing bodies, including FAO and others such as:

This special issue of IFFN contains the recommendations and strategic papers of the International Wildland Fire Summit. The delay in finalizing this issue was due to the fact that some of the Summit outputs had to be written and agreed in the months after October 2003.

In 2004 a series of the above-mentioned regional consultations will be held. The next issue will report on the outcomes of the follow-up process of the summit, notably on these regional consultations on cooperation in wildland fire management:

- Northeast Asia (Seoul, Korea, 5-6 March 2004)
- Eastern Mediterranean, Near East, and Central Asia (Antalya, Turkey, 30 March – 1 April 2004)
- Baltic Region (Helsinki, Finland, 10 May 2004)
- The IUCN-WWF-TNC Global Fire Partnership (Sigriswil, Switzerland, 16-18 May 2004)
- South America (Curitiba, Brazil, 14-17 June 2004)
- Central America and the Caribbean (October 2004)
- FAO Western Hemispheric Wildland Fire Conference (Costa Rica, 23 October 2004)

Meanwhile the readers of IFFN are encouraged to visit the website of the Global Wildland Fire Network for updated information: http://www.fire.uni-freiburg.de/GlobalNetworks/globalNet.html

Freiburg – Geneva, April 2004

Johann G. Goldammer

Outcomes of the International Wildland Fire Summit

Sydney, Australia, 8 October 2003

Editorial Remarks

The outputs of the International Wildland Fire Summit are the result of more than two years of preparation by the International Liaison Committee (ILC) and a number of contributions from international organizations and individuals. The work of the ILC has been conducted jointly with the Working Group on Wildland Fire of the UN Inter-Agency Task Force for Disaster Reduction (UN International Strategy for Disaster Reduction – ISDR). The complete set of background materials and references to earlier international wildland fire conferences and related processes, including international cooperative agreements in wildland fire management that are in place, have been published on the Summit website of the Global Fire Monitoring Center: http://www.fire.uni-freiburg.de/summit-2003/introduction.htm

The following documents provide the main outputs of the summit:

1. Summit Communiqué (summary of recommendations, without technical follow-up action items and lists of invited countries and attendees)
2. Guiding Principles for Wildland Fire Management (Strategic Paper 1)
3. International Wildland Fire Management Agreements Template 1 (Strategic Paper 2)
4. Incident Command System (ICS) (Strategic Paper 3)
5. Community-Based Fire Management (Strategic Paper 5)
6. A Strategy for Future Development of International Cooperation in Wildland Fire Management (Strategic Paper 4)
7. Background Paper to the Summit
8. Opening address by the United Nations
9. Statement by the UN Convention on Biological Diversity

PART I

Summit Communiqué

Introduction

The Summit was convened following the 3rd International Wildland Fire Conference to proposed and agree on pragmatic and sustainable solutions to the human health, environmental, and economic consequences of unwanted wildland fires. Each person attending the Summit provided valuable experience and insight that contributed to developing synergistic solutions intended to strengthen international cooperation in order to reduce the negative impacts of wildland fires on humanity and the global environment. The Hon Tony Kelly, MLC, NSW Minister for Emergency Services hosted the Summit. The Hon Neville Wran QC, former Premier of NSW, chaired the Summit.

The drive to hold a Summit came from a widely held concern that more needed to be done to improve cooperation at an international level in the prevention and suppression of wildland fires. The overall goal of the Summit is in line with, and supported by, the UN International Strategy for Disaster Reduction (ISDR).

The Summit participants reviewed, and discussed four papers tabled to stimulate ideas, solutions, and strategies to improve communication and coordination between agencies and organizations, and to improve fire management practices for the sustainable use of natural resources and the safeguarding of food security. Adoption of the principles and outcomes provided in the papers will assist organizations attempting to build a coherent response in reducing the negative impacts of wildland fires on humanity and the global environment, while encouraging ecologically and socially beneficial fire use where this is appropriate

Participants

The Summit was for invited participants with a key interest in the outcome. Invitees were selected for their expertise in wildland fire management and their capacity to influence the implementation of the outcomes of the Summit within their own domestic jurisdiction. In all, 92 people accepted the invitation from 34 countries and 12 international organizations.

Summit Outputs

The Summit participants discussed and agreed either in principle or in substance to a series of strategies that will build on the work of many groups, conferences and regional summits: (An agreement in principle means that the participants agree that the strategies have merit and will begin to discuss and/or implement the strategies either within their agency or work with local partners to implement the strategy in the region.)

- An agreement that the ***principles*** presented in Summit Paper 1 should apply to international wildland fire management projects and exchanges when adapted to local ecological and social conditions.

- An agreement that an ***international agreement template*** presented in Summit Paper 2 can be used by agencies wishing to form a cooperative or mutual aid arrangements with one or more other countries for.

- An agreement that an ***Incident Command System (ICS)*** presented in Summit Paper 3 should become the international standard for all wildland incident management participating in international or interagency agreements and exchanges.

- An agreement to a ***strategy for future development*** as presented in Summit Paper 4.

Specific Actions by Summit participants

- Agreement with the concept that a series of regional conferences, summits, or roundtables will be held and lead into the 2nd Global Wildland Fire Summit no later than 2007, and the 4th International Wildland Fire Conference and Exhibition in Spain in 2007.

- Agreement to work individually and collectively to secure resources and funding for hosting the regional sessions and implementing other Summit outputs. The regional summits will be hosted and supported financially by local agencies or organizations. The agenda and themes will be developed locally. The meetings can be held in conjunction with established conferences and meetings.

- Agreement that the Summit outcomes will be transmitted to the following organizations: The United Nations through the International Strategy For Disaster Reduction (ISDR); the Food and Agriculture Organization (FAO); and the International Tropical Timber Organization (ITTO).

- Agreement to request the assistance from the UN to lead the implementation of the outcomes of this strategy, including securing funding in support of the establishment of regional networks, conferences, and summits.

Other Issues and Business Carried Forward

In addition to the actions noted above, a number of other issues were identified that require further attention, possibly at a future Summit. These issues carried forward include:

- The role of gender in fire management;
- Fire danger rating and fire early warning systems
- Linking Incident Command System with community-based fire management systems
- Fire investigation and management of causes of fires.

Funding Support

Funding support for the Summit was provided by:

- The International Tropical Timber Organization (ITTO)
- The Department of Agriculture, Fisheries, and Forestry of Australia (AFFA)
- Telstra, Australia
- The Global Fire Monitoring Center (GFMC)
- The United States Department of Agriculture Forest Service
- The United States Department of the Interior Bureau of Land Management
- Emergency Management Australia

Photograph of the participants of the International Wildland Fire Summit, Sydney, Australia, 6 October 2003

PART II

Strategic Paper
Guiding Principles for Wildland Fire Management [1]

Introduction

As the world's demand for resources to meet the needs of the global community increases forests, rangelands, farmlands and other ecosystems provide an important share of those resources. How we manage those resources now will affect their availability for future generations. Wildland fire is a critical factor in the health and sustainability of global vegetation.

This paper offers guiding principles for international cooperation in the management of wildland fires on forests and rangelands throughout the world.

It is hoped that these principles will act as a catalyst for discussions in many forums with the goal of leading to better methods for providing sustainable resources for the global community today and in the future.

These guiding principles are intended only as a guide. As such they will necessarily only be a starting point. They may need alteration for some developing countries and non-governmental organizations.

Preamble

The world as we know it today has been shaped by the forces of nature over millions of years. Fire is one of nature's powerful forces. It may be creative or destructive, or both at the same time in its environmental impacts. The occurrence, frequency and intensity of fire, both natural or human caused, or its exclusion either through natural or human intervention are determining factors for maintaining, enhancing, or reducing the health and sustainability of ecosystems.

Landowners, land managers and communities must be cognisant of the impacts of their actions and inactions on the environment when using fire. Since fire has such impacts on the potential for sustainable development, communities must take a generational view of the use of fire as a sustainable land management tool. Sustainable development requires communities to consider the collective impacts of their actions now and in the future. Sustainable fire management must certainly be a part of those considerations.

There is a need to integrate management of ecosystems and sustainable development as well as social objectives into fire management planning and practices. In many countries, wildland fires are symptoms of larger socio-political stresses. Agricultural practices in many countries are responsible for ignition of fires, lit for land clearing, weed control or regeneration.

It is critical that communities be engaged with the management of the fires they experience. Community involvement in sustainable land management is critical in all nations, especially where there is dependence on the ecosystem for livelihoods, and should determine how land managers and wildland fire agencies, address the management of fire consistent with environmental care and community standards. Meeting the community's expectations needs a carefully considered approach. Fire management interests need to balance the land management, fire management, social, cultural and environmental objectives. Those managing lands should recognize that fire adapted and fire sensitive ecosystems require policies, tactics and techniques that are ecosystem specific.

Framework considerations for balanced fire management include the Johannesburg Plan of Implementation and the Millennium Development Goals including Goal 1 (Eradicate extreme poverty and hunger), Goal 6 (Combat HIV/AIDS, malaria and other diseases) and Goal 7 (Ensure environmental sustainability).

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[1] Strategy Paper No. 1 has been prepared on behalf of the ILC by Larry Hamilton (Director, National Office of Fire and Aviation, Bureau of Land Management, Department of Interior, USA), Gary Morgan (Chief Fire Officer, Fire Management, Department of Sustainability and the Environment, Victoria, Australia), Jerry Williams (Director, Fire and Aviation, USDA Forest Service, USA)

Key existing multilateral agreements, include: the Convention on Biological Diversity in particular the target set down within the Plan of Implementation: "the achievement by 2010 of a significant reduction in the current rate of loss of biological diversity", Ramsar, the World Heritage Convention, the UN Framework Convention to Combat Desertification, the UN Framework Convention on Climate Change and the Final Statement of the recent XII World Forestry Congress. There is a need to consistently communicate relevant wildland fire issues to the secretariats and participants of multilateral environmental agreements.

The following guiding principles for international collaboration of wildland fire management are presented as a basic framework for landowners, land managers and communities to consider in their approach to complimentary and integrated fire management.

International Cooperation in Wildland Fire Management Guiding Principles

International cooperation projects and initiatives should be based on the following considerations:

- Systematic monitoring, accurate reporting and accessible information archiving are integral components of effective fire management. Open, transparent sharing of data and information on fires, their extent and distribution, causes and impacts is fundamental to effective international cooperation;
- Initiatives should be appropriate to the culture, technology, environmental conditions, educational and economic circumstances of the recipient country, given the need for long-term sustainable outcomes;
- Developing countries are especially challenged by the management of fires because of their important links with land use practices, socio-economic and social issues and food production. Any management strategies must take account of the principles of poverty alleviation and sustainable development;
- Consideration must be given to the cultural context in-country, where, in many instances, fire is an established part of land management and agricultural practice, and where alternatives to the use of fire may be either unacceptable to the local community or unfeasible.
- Community-based fire management will usually form the basis of effective fire management programs at the community level, in both developed and developing countries. Some communities may benefit from a better understanding of the role and impact of fire on the environment, including situations involving the deliberate use of fire;
- Projects and programs should be undertaken within the context of a cooperation agreement or similar arrangement that makes clear the contributions, commitments and responsibilities of all those involved, especially in relation to accountability, command and control, and financial, human resource and other non-financial inputs of the project;
- Projects should, in most cases, seek to achieve sustainable institutional strengthening and capacity building within government agencies that are responsible for forest fire management. In appropriate circumstances this enhancement work will include Non-Government Organisations and the private sector;
- Wildland fire management projects and initiatives should have as one objective the delivery of sustainable outcomes for end users at the local community level, including improvement in the capacity of local communities to manage wildfires;
- Wherever practicable, fire suppression projects and initiatives should be undertaken using agreed international procedures and protocols which facilitate effective and safe cooperation and coordination on the fireground; and
- The outcomes and outputs of wildland fire projects and research should be made available to the international community to enhance advances in wildland fire management globally.

Wildland Wildfire Management Guiding Principles:

The following guiding principles for wildland fire management are presented as a basic framework for landowners, land managers and communities to consider in their approach to complimentary and integrated fire management undertaken for international collaboration.

General Guiding Principles

1. Land and resource management objectives, and the society's expectations that they reflect, should be compatible with the dynamics of the fire regime for which they apply and be consistent with community and firefighter safety considerations.

2. The management of wildland fire should be based upon the holistic approach of fire protection planning, prevention, suppression and rehabilitation.

3. All wildland fire management activities should be safe, cost effective and support sound natural resource management.

Consistent with a more inclusive style of fire management that incorporates the needs and expectations of local people, ***fire management and suppression plans must incorporate and understand the needs and expectations of communities and local stakeholders***. Effective engagement of communities is essential. Also, fire managers in developed nations are increasingly held accountable for firefighter health and safety by agencies responsible for fire suppression. This will inevitably flow to emerging nations. This applies not only to the firefighters within their agency but also for all personnel engaged in suppression and support activities. At the same time many agencies find that they are not resourced at a level to meet peak fire loads. Hence, in recent times there has been a greater sharing of resources on the land where the wildfire is burning to assist the agency primarily responsible for fire suppression. To effectively manage such co-operative resources, agencies need to conduct fire suppression operations in accordance with a, ***previously agreed command and control structure***. The response must satisfy all legal requirements, be thoroughly planned, safe, effective, cost efficient, and environmentally sensitive.

Fire management should consider:

- Having in place appropriate ***fire protection plans*** to deal with the inevitable occurrences of wildfire. Such plans must include an assessment of the threat to human life, property, forest, other wooded land and other land assets and values[2], and must consider these in conjunction with the management objectives for the area where fire suppression actions will be implemented;
- Undertaking actions of ***fire prevention*** to minimize, as far as practicable, the incidence and extent of unwanted fires (i.e. wildland fires of human origin both deliberate and accidental);
- Basing preparedness[3] for fire suppression[4] on ***designated performance criteria*** and reflecting the variable nature of fire danger[5];
- Developing ***early warning capability*** of wildland fire danger;

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[2] **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. **Other land:** Land with less crown cover, tree height, or shrub cover as defined under "Other wooded land". Indication is desired if recurring wildfires affect "Other land" by inhibiting regeneration to the "Forest" and "Other wooded land" categories.

[3] **Preparedness:** All activities undertaken in advance of wildfire occurrence to decrease wildfire area and severity and to ensure more effective fire suppression including (1) The state of being ready to cope with a potential fire situation (syn. readiness), and (2) Mental readiness (awareness) to recognize changes in fire danger and act promptly when action is appropriate (syn. readiness)

[4] **Fire suppression** (= fire control, response): The activities connected with restricting the spread of wildfire controlling and extinguishing a fire following its detection and making it safe.

[5] **Fire danger:** A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control, and fire impact; often expressed as an index.

- Insuring ***prevention activities*** are in place to reduce the hazards and potential losses from wildland fires;
- Stating ***fire suppression objectives*** clearly and insuring they are communicated;
- Insuring a ***measured fire suppression response*** that reflects the threat, the safety of firefighting personnel and the public, and the impact on the environment and costs;
- Formalizing ***a single management structure*** for all personnel;
- Insuring that ***suitably trained, equipped, assessed, and accredited personnel*** are appointed to appropriate positions within the management structure at all levels from the fireground up;
- Insuring ***principles of environmental care*** guide all preparedness and suppression activities;

- Basing ***rehabilitation of disturbance*** resulting from suppression works and rehabilitation activities, which are part of a broader post-fire recovery[6] strategy, on sound principles of environmental care;
- Basing management planning on ***scientific and field research***;
- ***Cooperating and sharing*** with other countries, agencies, jurisdictions and communities that face similar wildland fire management challenges;
- Striving for ***consistent funding*** that enables fire managers to adequately meet the goals of the guiding principles safely and efficiently.

Fuels Management Guiding Principles

Fuels management programs should be planned to provide for the protection of human life and property, by reducing the potential hazards associated with wildland fires while maintaining the environmental integrity of the landscape and preserving cultural resources. Reducing fuels through mechanical or physical means or through the use of prescribed burning[7] to achieve management objectives must satisfy legal requirements, be thoroughly planned, and when conducted, be in accordance with clearly defined procedures providing for safe work practices and manageable fire behaviour; be environmentally sensitive; and have the outcomes monitored and recorded.

In conducting fuels management operations the following should be considered:

- Integrating fire prevention and land management aims to the maximum extent practicable for all fuels management within a given area;
- Balancing fuels treatment plans with the often competing objectives of the role of fire in the maintenance of biological diversity, the responses of different ecosystems to fire; natural patterns of succession, and the risk of wildland fire;
- Using or excluding prescribed fire based on scientific knowledge;
- Basing prescribed burning operations on clearly defined objectives and prescriptions, providing a safe working environment, and minimizing the risk of fire escape;
- Incorporating during the fuels management planning process, the principles of environmental care, in accordance with approved standards, prescriptions and guidelines;
- Community engagement of those who benefit from use of fire and who benefit from more control.

Environmental Care Guiding Principles

Fire management activities should be based upon good science and follow sound management principles. These activities should be planned and conducted in an environmentally sensitive manner taking into account:

- Fire regimes[8] and fire management[9]activities appropriate to maintain the vigour and diversity in populations of species and communities of the area's indigenous flora and fauna, particularly the ancient primary forest and wildlife fauna described in the UN Convention on Biodiversity;

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[6] **Recovery:** The post-fire phase where damaged assets are salvaged repaired or replaced; sites disturbed by fire control operations are rehabilitated; the natural response of the ecosystem is monitored, and managed if necessary; health and safety issues arising from the fire control operation are addressed; and lessons learned from the incident are incorporated into planning for future wildfire events. necessary; health and safety issues arising from the fire control operation are addressed; and lessons learned from the incident are incorporated into planning for future wildfire events.

[7] **Prescribed burning:** The controlled application of fire under specified environmental conditions to a predetermined area and at the time, intensity and rate of spread required to attain planned resource management objectives.

[8] **Fire regime:** The season, intensity and frequency of fire in a given area over a period of time.

- Water quality and quantity being protected by measures which minimize the impact of fire management activities on streams, springs, soaks, swampy ground and bodies of standing water, and their physical, chemical, and biological quality;
- Soil being protected by measures which prevent inappropriate destruction of its physical and chemical properties or which promote stabilization of bare or disturbed earth following disturbance;
- Landscape values, geomorphologic features, cultural and historical sites being considered when planning operations;
- Indigenous flora and fauna being protected following wildfire suppression by measures which promote the re-establishment of the ecological processes existing prior to the wildfire;
- Avoid the possible introduction and spread of pest plants and animals, plant diseases, and insect pests; and
- Air quality being addressed by measures which balance the impacts of smoke generated by prescribed burning.

Conclusion

These guiding principles for international collaboration on fire management projects and activities are presented for consideration by countries and communities faced with managing wildland fire. In an increasingly complex global environment, they are presented with the knowledge that other countries and organisations are facing the issues of fire management. This set of principles has been prepared as a step in providing a clearer basis of engagement between those involved in fire management.

Many organisations, bodies, governments, agencies and institutions have undertaken analyses, documented expectations, prepared guidelines and created materials. For example the International Tropical Timber Organisations Guidelines for Fire Management in tropical forests, and the Guidelines on Fire Management in Temperate and Boreal Forests prepared by the FAO. The extent to which they have been shared, evaluated and adapted for adoption is limited. These efforts as well as those of others should be studied, compared, contrasted, and discussed. The guiding principles presented here are intended to enhance this process, so that those faced with the challenges of wildland fire will have a full spectrum of ideas and information to help in the development of approaches, processes and systems that best meet their needs.

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[9] **Fire management:** All activities associated with the management of fire-prone public land values, including the use of fire, to meet land management goals and objectives. It involves the strategic integration of such factors as knowledge of fire regimes, probable fire effects, values threatened, level of forest protection required, cost of fire related activities, and prescribed fire technology into multiple use planning, decision making, and daily activities to accomplish stated resource management objectives.

PART III

Strategic Paper
International Wildland Fire Management Agreements Template[10]

Introduction

The 3rd International Wildland Fire Conference held in Sydney, Australia 4-6 October 2003 and the subsequent Summit on 8 October 2003 provides important forums for discussions of how to manage the future of international wildland fire management and share solutions to global problems. This paper offers a template and information on cooperation in wildland fire management to countries interested in entering into formal relationships and agreements with other countries facing similar issues.

This paper is intended to enhance current international coordination and cooperation by providing information on the following:

- A Template outlining areas to consider when developing international cooperative agreements;
- Listing of the types of cooperation and assistance that may occur between countries;
- The responsibilities of countries sending assistance and of those receiving assistance;
- Websites containing information and examples of existing cooperative agreements and arrangements.

Template for International Cooperative Agreements

The following is an outline for a template of areas that need to be considered when countries are developing international cooperative agreements. There may be other areas that need definition and consideration besides those listed below. This template is drawn from an annex of a UN Food and Agriculture Organization (FAO) document *Legal Frameworks for Forest Fire Management: International Agreements and National Legislation*. This FAO document provides excellent reference materials, which should be reviewed prior to entering into international agreements.

Developing countries will require special consideration because they may not be able to reciprocate in a partnership as fully as a developed country can.

The important role of Non-Government Organisations (NGOs) should be considered as part of any bilateral or regional assistance arrangement.

It is strongly recommended that the parties to a mutual assistance agreement should exercise the agreement through exchanges, field exercises and low-level assistance prior to it being activated at a time of crisis.

Outline for International Cooperative Agreements

1. Parties to the Agreement
   - Includes governmental and non-governmental agencies and organizations at a variety of levels.

2. Purpose
   - Defines areas and forms of cooperation.
   - Define the scope of the cooperation.

3. Definition of Terms
   - Defines terms used in the agreement to insure there is no confusion or misinterpretation as to the meaning of the content of the agreement.

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[10] Strategy Paper No. 2 has been prepared on behalf of the ILC by Tom Frey (International Program Coordinator, Bureau of Land Management, Department of Interior, USA) and Ricardo Velez-Muñoz (Director; Área de Defensa Contra Incendios Forestales, Dirección General de Conservación de la Naturaleza, Ministerio de Medio Ambiente, Spain).

5. Expenses and Costs
   - Personnel- Defines how personnel costs will be set such as per person, per crew, per day or per assignment.
   - Equipment - Defines how equipment cost use will be set such as per day or per assignment.
   - Reimbursement of costs – Sets the procedures, amount, and criteria for reimbursement. Some agreements call for reimbursement only after a certain threshold of time or level of support has been reached.
   - Non-reimbursable – Under certain agreements all parties may agree to assist each other on a mutual aid, non-reimbursable basis.

6. Information and Coordination
   - Communication channels – Defines the protocols and methods to coordinate and exchange information.
   - Information exchange – Defines the types, amount and timing of information exchange.
   - Notifications – Sets the notification procedures for emergencies or for other significant events.
   - Coordination of work – Defines how and under what organizational structure the coordination of work will take place.

7. Liabilities, Claims and Compensations
   - Cross-wavier of claims/exemption from liability – Lists and defines how and when the cross-waivers and exemptions are in force for personnel that are being exchanged.
   - Exemptions to cross-wavier of claims – Lists and defines those areas or circumstances where the exemptions do not pertain to personnel that are being exchanged.
   - Damage to a third party – Outlines remediation methods and limitations for third party damage.
   - Medical assistance for injured personnel – Defines the protocols and procedures for assisting and possibly evacuating injured personnel.
   - Compensation in case of injury or death – Defines the timing, levels and limitations of compensation for injury or death. This may also be addressed above in the cross waivers and exemptions.
   - Privileges and immunities for the assisting personnel – Describes and defines the levels and limitations of privileges and immunities that the receiving country will provide to assisting country personnel.

8. Operating Plans / Operational Guidelines
   - Provision for operating plans/operational guidelines – Operating plans/operational guidelines are a critical component of all cooperative agreements. They should be carefully crafted and reviewed by all parties to the agreement. The plans and guidelines outline and define specific operational areas to insure that the agreement can implemented in a timely and efficient manner. They include items such as points of contact, procedures for requesting resources, entry procedures, annual updates of costs, reimbursements, and cross waivers, and updated standards, qualifications or training requirements Also identifies how often and by whom the plans and guidelines will be reviewed, updated and the method for revalidating the contents of the plans and guidelines.

9. Border Crossings
   - Sets protocols and procedures for simplifying of border crossing taking into account sovereignty issues, including the following:
     - Opening of alternative border-crossing points to facilitate the assistance
     - Customs provisions:
       - Concerning personnel
       - Concerning equipment and materials
       - Concerning officer responsible for equipment
       - Concerning aircraft

   Portions of this information will also be included in the operational plans and guidelines.

10. Link to Disaster Management Plan for the receiving country.
    - Explains how the fire assistance plan sits within the wider disaster management plan for the receiving country, including legislation giving the necessary powers.

11. General Provisions
    - Entry of force of the agreement - Defines when agreement is activated.

- Duration – Specifies how long the agreement will remain in force
- Withdrawal – Defines how countries or organizations can withdraw from the agreement.
- Termination – Defines under what circumstances the agreement will terminate.
- Interpretation – Provides understandings and interpretations for countries and organizations concerning under what circumstances and limitations each party is entering into the agreement.
- Settlement of disputes – Defines the method of dispute resolution.
- Amendments – Defines when and how amendments to the agreement may be submitted, reviewed, and acted upon.

12. Standard Operation Procedures
    - These procedures describe in detail the methodology to be followed when the agreement is activated, especially in relation to command and control, fire suppression procedures to be followed, communications systems and safety procedures to be used.
    - The SOPs should be tested and refined using tabletop exercises, dry field exercises and low scale operations before being deployed in a full scale emergency.

13. Other Provisions
    - Provides the opportunity for any country, agency or organization signing this agreement to define other areas of cooperation that they want to include in the agreement such as:
        - Shared training activities, including materials
        - Study tours, technical exchanges, and joint exercises
        - Relationship of this agreement to other agreements
        - Standards for personnel
        - Safety equipment
        - Limitations on the type and use of telecommunications equipment
        - Method of recall of firefighting resources

14. Participating Countries/Agencies/Organizations Signature Page
    - It is important that all potential participants review and confirm their authorities to sign such an agreement.

Types of Cooperation and Assistance

International cooperation and assistance occurs in a variety of ways. Some agreements are non-reimbursable while others call for reimbursement. Some assistance is offered on a technical non-reimbursable basis and other assistance is offered or solicited during periods of disaster. When countries develop international cooperative agreements the purpose and method of cooperation and assistance need to be clearly identified and understood between all parties. The following describes several types of cooperation and assistance that currently exist.

Mutual Assistance:
Mutual Assistance agreements often deal with fire management issues along shared borders. Assistance by one country to another is usually non-reimbursable with the understanding that both countries may benefit at different times from assistance along mutual borders

Cooperative Assistance:
These agreements are for assistance and cooperation throughout the countries or states that have signed the agreement, not just for the border areas. These agreements are usually set up on a reimbursable basis.

They may also include non-reimbursable exchanges of experts. These exchanges may include areas such as fire prevention and mitigation, prescribed fire, personnel exchanges, and broad based study tours of fire management programs.

Technical Exchanges:
Activities carried out under technical exchanges are similar to cooperative assistance agreements but are much more informal and exchanges are not always tied directly to an ongoing agreement. These are usually self-funded, non-reimbursable activities that occur on an as needed or as desired basis. They remain at technical and informational exchange level and do not include exchanges of resources to help with direct fire suppression activities.

Technical Assistance:
An offer of or a request for technical assistance may or may not be a part of a formal agreement. Technical assistance provides experts from one country to another country in need of technical assistance, to improve and strengthen the receiving country's abilities and capacity to deal with wildland fire management issues. The goal of technical assistance should be to reduce the need for outside assistance in the future. This type of assistance is usually non-reimbursable and is paid for by the country offering the assistance.

Disaster Assistance:
When wildland fires involve trans-border issues from a humanitarian, ecological, medical, economic, or diplomatic standpoint, some countries will offer immediate disaster assistance to affected countries on a non-reimbursable basis. Disaster assistance is meant to assist the affected country during a critical time period and may or may not be based on existing cooperative agreements. Disaster assistance may be the genesis for future cooperative agreements or technical assistance programs.

Responsibilities of Sending Country and Receiving Countries
Countries sending or receiving assistance through the methods and agreements identified above need to understand that certain responsibilities are inherent in these relationships. The following paragraphs identify the responsibilities of all countries, agencies, or organizations involved. There are certainly more issues than those listed below that should be discussed prior to sending or receiving assistance but the information below attempts to identify some of the key elements of the responsibilities involved in these types of arrangements.

Sending Countries:
It is important to note that as countries enter into formal cooperation agreements with other countries, the success or failure of those agreements rests just as much on the personal conduct of the sending country's representatives as it does on the effectiveness of their fire management capabilities. It is critical to always send the country's most appropriate and qualified personnel, as the receiving country will quickly detect whether they are receiving the help they need or individuals who were selected on rank or seniority and not on skills and capabilities. This is especially critical with reimbursable agreements. Of particular importance is cultural sensitivity towards the people of the receiving country. Personnel being sent will be seen as ambassadors for their country and qualities appropriate to such a role should be included in the selection criteria.

Teams and individuals must also be made aware of local issues dealing with laws, customs, language, dress, food, etc. They must also be briefed on the command and control arrangements and their role and responsibilities within the fire management system of the receiving country.

Sending countries should prepare lists of resources, funding, materials and manpower that may be made available to receiving countries. It is essential that this information is kept accurate and current.

Both sending and receiving countries should maintain and exchange data on the nature, extent and frequency of fires so that the level of assistance sought and made available can be anticipated in any particular season.

Receiving Countries:
Just as sending countries have certain responsibilities, receiving countries must also accept the responsibilities involved in hosting personnel from other countries. Receiving countries must be prepared to brief sending country teams and representatives on the issues mentioned above as well as fire issues such as fuels, weather, topography, safety, management structure on the fires, fire fighting techniques and equipment, types and lengths of assignments, etc. Of particular importance is briefing on communications and legal issues within fire management as well as political and social sensitivities within the wider community. Receiving countries must also be prepared to provide logistical and operational support including welfare support as required.

Websites with Examples of Cooperative Agreements and Arrangements

National authorities are encouraged to contribute brief case studies, based on their own national experiences, to illustrate the different types of cooperation/assistance agreements that are currently in place or being prepared. Case studies can be forwarded to the Executive Officer, International Wildland Fire Summit, at Duncan.Sutherland@rfs.nsw.gov.au and to the Food and Agriculture Organization of the United Nations (FAO), Forestry Department (FORM) at Mike.Jurvelius@fao.org. The information will be incorporated into the FAO documentation "Legal Frameworks for Forest Fire Management: International Agreements and National Legislation" which will be updated continuously. This document and other supporting reports are provided on the websites of FAO and the GFMC at:

http://www.fao.org
http://www.fire.uni-freiburg.de/emergency/int_agree.htm

Conclusion

The fire management issues identified and discussed at the 3rd International Wildland Fire Conference highlight the connections and common concerns of the global community about wildland fire. This Summit represents an extension of the work accomplished at the Conference and provides a mechanism to identify ways to continue that progress. This paper has identified issues and provided a template to encourage countries to cooperate in dealing with wildland fire.

PART IV

Strategic Paper
Incident Command System (ICS) [11]

Introduction

As a result of severe fires over a number of years, national leaders have demanded a more coordinated approach to the management of wildfires. There have been many examples over the years of large numbers of fire suppression agencies making gallant attempts to minimize the devastation of uncontrolled wildfires. However, their ability to effectively cooperate with other fire agencies was limited by organisation and communication barriers. In the USA, State and Federal legislators, concerned at the lack of uniform emergency management protocols, directed federal, state, and local government to develop a common incident command system that would make a quantum jump in the capabilities of wildland fire protection agencies to effectively coordinate interagency actions and to allocate suppression resources in dynamic, multiple fire situations. This landmark direction created the beginning of the Incident Command System (ICS), and the ability of emergency response personnel to work together toward common objectives. Australia and New Zealand, faced with similar emergency response issues, evaluated incident management systems around the world, elected to adopt the ICS and modify it to meet their specific needs.

The community expects that emergencies will be dealt with safely, effectively and efficiently by emergency services. Experience has shown that at times parochial attitudes, internal politics, and the lack of communication result in poorly managed emergency operations. Lack of co-ordination between agencies and unclear accountabilities often results in safety issues being overlooked. There is therefore, a professional, social, political and economic demand for the management of emergency incidents to be enhanced wherever possible.

The complexity of incident management, coupled with the growing need for multi-agency and multi-functional involvement at incidents has increased the need for a standard inter-agency incident management system not only within a country/state but increasing internationally. Many countries have adopted similar or common systems of addressing emergencies. In addition a number have developed firefighting agreements based on a common system enabling interoperability when lending support to other countries. In the past this is usually to support adjoining States or Countries within the same geographical region. Since 2000 we have seen examples of this being broadened by support provision occurring from different hemispheres. In 2000 and 2002, Australia and New Zealand sent critically needed incident managers to the USA. Similarly early in 2003 the USA reciprocated sending fire specialists to Australia. Canada and the USA frequently exchange firefighting forces, especially along their borders. New Zealand sent firefighting forces to Australia in 2002 and 2003. ICS was also used during the wildland fire emergency in Ethiopia in 2000.

The Incident Command System may need to be adapted to suit a particular country's existing political, administrative or cultural systems, customs and values. Where the primary purpose is to enhance emergency management within a country, such adaptations are not only beneficial, but may be essential to have the ICS system adopted. If the purpose of adopting ICS is to enhance cooperation between countries, through the sharing of resources such as fire management teams, it is highly recommended that the sending country and the receiving country both use the same emergency management system. This paper suggests that such a system should be the ICS. Given that ICS is a proven model in many countries and given that training materials for ICS are freely available, there is considerable benefit to be gained by a country adopting this system.

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[11] Strategy Paper No. 3 has been prepared on behalf of the ILC by Murray Dudfield (National Rural Fire Officer, New Zealand Fire Service, Wellington, New Zealand) and Buck Latapie (Assistant Director, Fire & Aviation, United States Department of Agriculture, Forest Service, Washington DC, USA).

Objective

The purpose of this paper is to recommend the adoption of a common international incident command system by all countries. This action will leverage the domestic capability of emergency response managers by utilizing other trained personnel within the country, will facilitate international training of fire managers, and will enhance the global interoperability of emergency managers. In many countries, emergency responders are periodically faced with overwhelming emergency situations, and additional emergency responders, trained to common operational procedures, are difficult to locate. The global capability to support other countries is often hampered by incompatible operating procedures or organizational incompatibilities.

Background

Incident management systems in one form or another exist in many countries. In most countries, local emergency operating protocols have evolved over the years to meet the specific demands of the jurisdiction. Many have been copied from the military command and control models. Unfortunately, most of these models do not provide consistent procedures or organizations throughout each country. The ICS is the most widely used incident management system. It was specifically designed to address the majority of management problems common to most complex incidents. These problems included:

- Inefficient supervisory span of control.
- Competing organizational structures
- Inconsistent or non-existent incident information
- Incompatible communication systems
- Uncoordinated planning across agency lines
- Unclear lines of authority
- Competing agency incident objectives
- Inconsistent terminology.

It took a considerable investment of time and effort to design an incident management system that could address all of those issues. ICS has a proven record in many countries around the world. ICS has been fully implemented in Australia, New Zealand, Canada, and the USA. Mexico and Costa Rica have interpreted the ICS training course into Spanish, and have begun to teach ICS to wildland firefighters. In addition, Taiwan, Bulgaria, and Mongolia have received ICS training, and new training programs are starting in India and South East Asia. Recently, the USA has adopted ICS as the national incident management system to manage all domestic emergency threats and responses.

ICS was developed on four basic principles.

1. The system must be organizationally flexible to meet the needs of incidents of any size and kind.
2. Organizations must be able to use the system on a daily basis for routine situations and major emergencies.
3. The system must facilitate a common management structure that integrates personnel from different locations and from a variety of agencies.
4. The system must be cost effective.

ICS Framework

The ICS framework provides an effective forum for interagency emergency management issues to be addressed. By establishing a unified command of the respective agency/jurisdictional representatives together at a single interagency incident command location, the following advantages will be achieved:

- One set of objectives is developed for the entire incident.
- A collective approach is made to developing strategies to achieve incident objectives.
- Information flow and co-ordination is improved between all jurisdictions and agencies involved in the incident.
- All agencies with responsibility for the incident have an understanding of each other's priorities and restrictions.
- No agency's authority or legal requirement will be compromised or neglected.
- Each agency is fully aware of the plan, actions, and constraints of other agencies.

- The combined effects of all agencies are optimised as they perform their respective assignments under a single Incident Action Plan.
- Duplication of effort is reduced or eliminated thus reducing costs and the chance of frustration and/or conflict.

From this unified approach, a single incident action plan is developed. Success in this area requires advance planning, understanding and acceptance within respective agencies. If not fully understood, it can cause confusion or be rejected.

ICS Principles

The ICS structure is based on the following principles:

Common terminology
Common terminology is essential in any emergency management system, especially when diverse or other than first-response agencies are involved in the response. When agencies have slightly different meanings for terms, confusion and inefficiency can result. In ICS, major organisational functions, facilities, and resources are predesignated and given titles. ICS terminology is standard and consistent among all of the agencies involved.

Modular organisation
A modular organisation develops from the top-down organisational structure at any incident. "Top-down" means that, at the very least, the Control/Command function is established by the first-responding officer who becomes the Incident Controller. As the incident warrants, the Incident Controller delegates other functional areas. In approximately 95 percent of all incidents, the organisational structure for operations consists of command and single resources (e.g., one fire truck, an ambulance, or a tow truck). If needed, however, the ICS structure can be scaled up to multiple layers that are implemented to meet the complexity and extent of the incident.

Integrated communications
Integrated communications requires a common communications plan, standard operating procedures, clear text, common frequencies, and common terminology. Several communication networks may be established, depending on the size and complexity of the incident.

Consolidated Incident Action Plans
Incident Action Plans describe response goals, operational objectives, and support activities. The decision to have a written Incident Action Plan is made by the Incident Controller, dependent on the duration and complexity of the incident. Incident Action Plans should cover all objectives and support activities that are needed during the entire operational period. A written plan is preferable to an oral plan because it clearly articulates responsibilities and provides documentation when requesting assistance. Incident Action Plans that include the measurable objectives to be achieved are always prepared around a timeframe called the operational period.

Manageable span of control
A manageable span of control is defined as the number of individuals or functions one person can manage effectively. In ICS, the span of control for any person falls within a range of three to seven resources, with five being the optimum.

Designated incident facilities
It is important that there are designated incident facilities with clearly defined functions to assist in the effective management of an incident. Every incident requires that control be managed from one identifiable Incident Control location. Additional facilities are designated as the complexity of an incident increases.

Comprehensive resource management
Comprehensive resource management is a means of organising the total resource across all organisations deployed at an incident. This includes:

- maximising personnel safety
- optimising resource use
- consolidating control of single resources
- reducing the communications load

- providing accountability
- reducing freelancing
- assigning all resources to a status condition
- managing day and night shift resources
- enabling sustaining resources during long duration (campaign) incidents.

ICS Organisational Structure

Many incidents – whether major emergencies or disasters (such as cyclones or earthquakes) or more localised incidents (such as accidents, hazardous substance spills or fire incidents) require a response from a number of different agencies. No single agency or department can handle every large-scale emergency situation alone. More usually, several agencies must work together to manage multi-agency emergency response. To co-ordinate the effective use of all the available resources, agencies need a formalised management structure that lends consistency, fosters efficiency, and provides direction during a response.

The ICS organisation is built around four major components:

1. **CONTROL** – the management of the incident

2. **PLANNING** – the collection and analysis of incident information and planning of response activities

3. **OPERATIONS** – the direction of an agency's resources in combating the incident

4. **LOGISTICS** – the provision of facilities, services and materials required to combat the incident.

These four major high-level structural components (as further illustrated in Figure 1) are the foundation upon which the ICS organisation is built. They apply during a routine emergency, when preparing for a major event, or when managing a response to a major disaster.

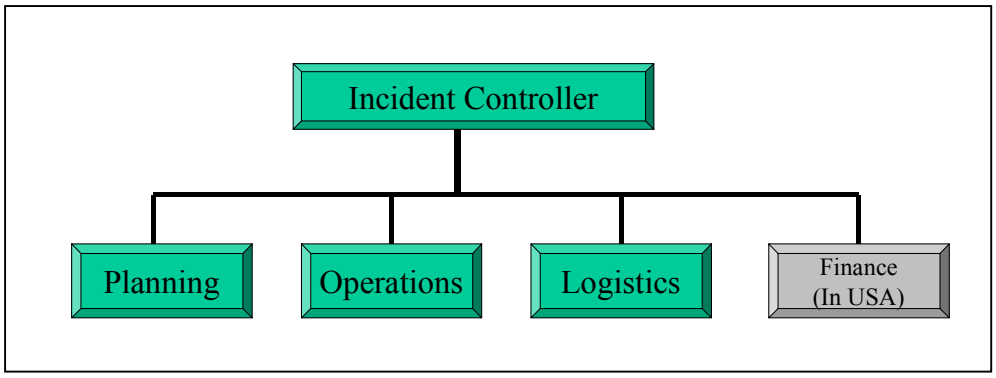

Figure 1. Four high-level structural components

The ICS structure can be expanded or contracted to manage any type and size of incident. The complexity of the incident more than the geographic size is normally the determinant for the Incident Controller establishing additional members of the Incident Management Team to fulfil management functions. ICS requires only one position to be filled – that of the Incident Controller. The Incident Controller carries out all of the management functions and responsibilities until the complexity of the incident determines that he or she assigns someone else responsible for a particular function(s). This is only done when necessary. Figure 2 illustrates a complex organisational ICS structure for managing a complex wildland fire incident.

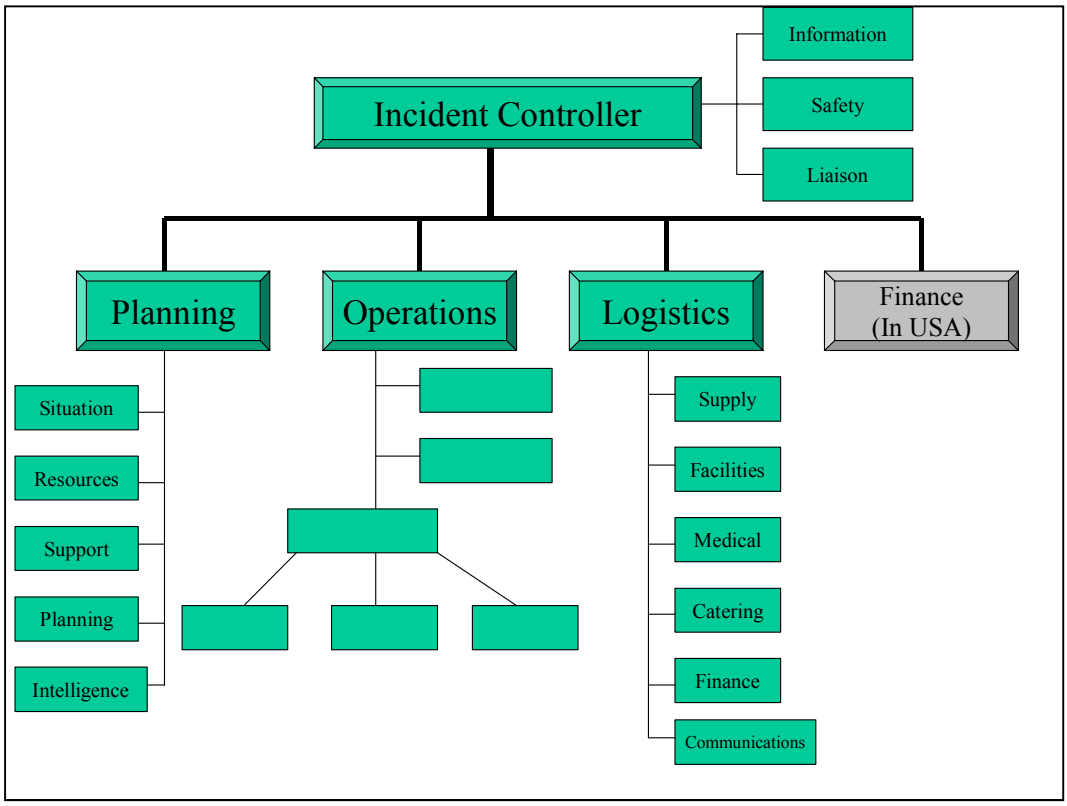

Figure 2. Complex organisational ICS Structure

Incident Management

Incident management can be viewed as a system composed of inter-related components that function together to enable the best possible management of an emergency of any scale. As such, it is necessary to understand the function of individual components, as well as how they fit together.

The Incident Controller is responsible for the overall direction of the response activities in an emergency situation and is the person in charge of an incident. The Incident Controller will carry out all management functions and responsibilities until the incident assumes such a size that it requires additional functional roles to be appointed. It is important to distinguish between Incident Control, which relates to situations and operates horizontally across agencies, and Command, which operates vertically within an agency. Under ICS an incident has only one Incident Controller but a number of line commanders may be required depending on the number of agencies involved.

Conclusions

On a global scale emergency services consume large amounts of funding each year. Safety, effectiveness and efficiency are achievable where a seamless integration of agencies is possible at an emergency. A globally implemented ICS will improve firefighter safety, efficiency and effectiveness in management response. It will also limit damage to property and, most importantly, will save lives. ICS provides the model for command, control and co-ordination of an emergency response. It provides a means of co-ordinating the efforts of agencies as they work towards the common goal of stabilising an incident and protecting life, property, and the environment. Many emergencies, from vehicle accidents to large-scale disasters, require co-ordination across several agencies. It will also reduce the risk of agency overlap and potential confusion at an emergency through poor understanding and inadequate co-ordination.

It is critical that a common global incident management system is adopted that will enable any assistance to quickly function in an effective manner. ICS is that tool which can enable that goal to be achieved.

PART V

Strategic Paper
Community-Based Fire Management [12]

Preamble

Faced with increasing fire occurrence and decreasing fire suppression budgets, government departments, local organizations, and forest users must consider the range of fire management programs from around the world. Fires have burnt around the world in the decades of the 1980s and 1990s. Increasingly the solutions to these fire problems and the persistence of them year after year is suggesting that the reaction to fires to date needs to be reviewed. In part it has been suggested that a component of a balanced fire management should include an active role for communities. By considering proactive approaches--in particular those which recognise the existing effective fire management carried out by many groups of people in civil society or engage local communities to plan and perform fire management activities--fire management entities may avoid the pitfalls and mistakes of the past. Recent studies from five developing countries chronicle a range of local fire management scenarios; each with a diverse set of land uses and desired outcomes from Laos, Honduras, China, India, Turkey and The Gambia (FAO 2003). These approaches are seen as more effective, less costly, and more sustainable over the long term.

A series of meetings, a review and an international conference have been among major efforts on Community Based Fire Management conducted by Project FireFight South East Asia (PFFSEA), an initiative of WWF and IUCN, and its partners, including many of the summit attendees among them; FAO, USFS, GTZ, IUCN, WWF, GFMC and the Royal Forest Department of Thailand. Over the last half decade, a number of concrete efforts have been made to characterize what Community Based Fire Management (CBFiM[13]) means and how it effectively functions.

Background

Analysis of CBFiM began in Africa and South East Asia in the early 1990s where the last few decades have seen persistent fires arising from a complex set of circumstances. While the underlying causes continue to be investigated and analysed some general themes and ideas have evolved for fire in South East Asia that may have wider application. As well as the need for improvements in legal and regulatory frameworks (Abdullah 2002), options for changes in economic factors and policy incentives (Gouyon & Simorangkir 2002, Simorangkir et al. 2002) the potential for local communities to play an ongoing role in fire management has been recognized.

In 1998, relevant, high quality, published or unpublished, information on community involvement in fire management was difficult to find and some argued that communities did not have any role to play in managing forest fires, other than as causes of them. Project FireFight South East Asia and RECOFTC sought to outline a series of steps to gather the information available and assess the interest in CBFiM. In December 2000, a regional workshop was held in Bangkok, Thailand, and then due to the wide spread interest prepared a larger conference held in July 2001 in Balikpapan, Indonesia, entitled 'Communities in Flames' (Moore et al 2002).

The attendance of over 120 people from 21 countries was a strong endorsement of the view that communities can and do play an important role in the management of fires.

A series of publications was also prepared:

- A Review of CBFiM for South East Asia (Karki 2002)
- Proceedings of the Communities in Flames Conference (Moore et al 2002)
- FAO Global Series of Case Studies on CBFiM produced in cooperation with PFFSEA and RECOFTC (FAO 2003)

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[12] Prepared by the Food and Agriculture Organization of the United Nations (FAO), based on a paper by Peter F. Moore, using the paper by Ganz et al. (2003) as a key resource and the joint work of Project FireFight South East Asia, Regional Community Forestry Training Centre for Asia and the Pacific and FAO.

[13] We use the acronym CBFiM to differentiate Community Based Fire Management from Community Based Forest Management, for which CBFM has become a well accepted abbreviation

- CBFiM paper prepared for the XII World Forestry Congress, Quebec 2003 (Jurvelius 2003)
- Paper on CBFiM to International Wildland Fire Conference, Sydney 2003 (Ganz et al 2003)

The collected case studies and investigations of CBFiM perhaps frame the full range of situations and circumstances of communities and their fire. Manifestations of CBFiM range across service as fire fighters (Fredriksson 2002) to fire management without any interaction or support from government agencies or non-local institutions (Darlong 2002).

Due to the documentation and intervention mainly being external the writing and resources available, and much of the discussion, has not been entirely successful at placing the people of communities in the forefront.

CBFiM – What is it?

Definitions

During the last few years, there has been quite a lot of discussion about what is now referred to as Community-Based Fire Management (CBFiM). The term has been used to describe such a wide variety of different ways in which communities are involved in fire management, that it is difficult to make any systematic comparisons or generalisations. A definition should be precise enough to enable us to make useful generalisations about somewhat similar things, while being flexible enough to accommodate a variety of approaches, a definition based on essential features.

The definition proposed in recent work (Ganz et al 2003) is:

> *CBFiM is a type of land and forest management in which a locally resident community (with or without the collaboration of other stakeholders) has substantial involvement in deciding the objectives and practices involved in preventing, controlling or utilising fires.*

This definition defines CBFiM, without confusing the definition by incorporating a separate definition of fire management, "fire management" is taken to be any fire prevention or "management" practice.

The essential feature of the definition is that it takes seriously the idea of fire management being community-*based*. It does not include situations where people simply carry out paid work for a fire control agency or another agency outside the community. CBFiM as an approach to the management of fire in the landscape rests on communities in decision-making roles for the application and control of fire, so that:

- They have sufficient tenure (formal and informal) to ensure their rights are considered along with broader (e.g., national, provincial and district) production and environmental protection aims and objective.
- They consider that involvement in land and fire management decision-making and activities will improve their livelihood, health and security (Abberger & Marbyanto 2003).

This is consistent with a trend in Community Based Forest Management (and various other terms with similar meanings), which sees the essence of genuine community participation in terms of some element of community power over decision-making.

The identification and analysis of CBFiM to date has been in a developing and emerging nation context. There some key differences between this and the circumstances of developed nations. The examples cited are in developing countries where the role of government and land use activities differ from those in developed countries. The definition of 'community' ('live in a particular locality' or 'a community of interest') essentially has a different meaning in developed countries, with media and interest groups having tremendous influence and power. In developing countries land use activities are more often tied to personal livelihood and existence without other choices being available.

Recent examples of 'Community Engagement' in developed countries could be seen as an element of CBFiM, as the community is increasingly invited to participate in fire management decision making and the importance of 'local knowledge' is being recognised and valued. However, there is little evidence that 'Community Engagement' ensures community empowerment in the context of land use management. In fact there is no common understanding apparent of 'Community Engagement'. The definition in this paper of CBFiM may help

to establish a common understanding of what is needed in the process of working with communities in developed nations for fire management. Notably in such countries if CBFiM requires government involvement it will require considerable resources and training within the organisations and communities involved at least initially.

There is evolving recognition of a continuum of CBFiM[14]. In general terms it can be considered as having three nodes:

1. Local scale fire management where traditional or indigenous knowledge plays the major role in informing and undertaking fire management, which is also planned, conducted and controlled by local people. Livelihoods and maintaining the landscape are probably key to this node of CBFiM. The practices of Australian aborigines are an example of this node of CBFiM.
2. Community involvement in fire management that involves a range of local actors, including agencies and NGOs, that work on fire management. Livelihoods dependence, some traditional practice and community institutions may be characteristics. Elements needing support may include; analysis of the fire problem, technical capacity, regulatory framework or logistical assistance.
3. Volunteers from the community, perhaps with agency involvement, conduct fire management on behalf of the community across private and public lands. Volunteer Bushfire Brigades in Australia are an example of this. There is perhaps very little direct involvement of local people in the rural landscape and livelihood dependence on lands or forests is low.

In this CBFiM continuum a clear example of any node may not be obvious in any particular country or context. It is likely that any clearly understood CBFiM situation can be characterised as being similar to a specific node or a combination of characteristics from more than one.

Terminology

Arnstein (1969) points out that the word "participation" is used in many ways, ranging from forms of non-participation (such as manipulation), through tokenistic forms of participation ("consultation", "informing") to forms of real participation such as "partnership", "delegated power" and "citizen control". CBFiM requires some real degree of community empowerment. In this sense "power" is defined as the capacity to have a genuine input into making real implementable decisions. Decision-making of this kind involves input into the setting of fire management objectives and deciding practices. It is important to understand here that a community role in decision-making does not necessarily mean total control, but that the community has a real input, perhaps in partnership with other stakeholders (such as forest departments) in the decision-making process.

It is necessary to be clear about what is meant by "community" as the word is commonly used in two completely different ways. One sense carries with it the idea of a group of people who live within a particular locality. The second sense is that of a "community of interest" (the "international community", the "arts community", the "conservation community"). This definition of CBFiM relates to a group of people resident in a locality. It would be possible to refer to any approach to fire management that involves a wide group of stakeholders (a "community of interest") as community-based, but it seems more useful not to confuse two rather different types of situation in a single definition. The boundaries of this local group and its territory depend on local conditions and it can be thought of as the local group who would need to act together in some collective way for fire management. In some situations this might be a single village, in others a group of villages surrounding a forest or grassland, in yet another it might be the residents of a local government unit.

In many nations there are multiple ownerships that result in multiple goals, objectives and laws being intermingled. Many areas have National Parks and public forests created with goals or objectives that are perhaps contrary, perhaps consistent with the local people's aspirations. Fire management involves imposing the management, rules and laws for a National Park or public forest, not CBFiM. In such countries there are broader, national laws and regulations that take priority over local rights, but there are programs in many cases that require local participation in order to develop programs across multiple ownerships and jurisdictions, each dependent on the cooperation of the other for a fire protection and management plan to work. The core differences are the dependence by local people on forests or natural areas for livelihoods and the degree of government management over the land tenure.

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[14] The authors are extremely grateful to Florensius Steven, GIS Officer, District Government of East Kutai, East Kalimantan, Indonesia, who came up with the concept of a CBFiM continuum.

It is important to stress that the use of the word "community" does not imply homogeneity. On the contrary, all communities have some degree of heterogeneity in terms of economic interests, power and many other characteristics. These differences often have important consequences in fire management as fires that negatively affect others may advantage one interest group. In CBFiM, the community identifies a group of people who need to cooperate (and negotiate) in order to act effectively according to agreed (and negotiated) objectives. There is no assumption that cooperation will occur.

Gender and fire

An intrinsic aspect of communities is gender and in developing nations the roles of women, men and children. These can be quite specific, detailed and different. One example that illustrates this well comes from North-eastern Namibia (Namibia-Finland Forestry Programme (NFPP); Progress Report 2000. Data collected in North-Eastern Namibia in 1996 was similar to the data from the neighbouring countries of Angola, Zambia, Zimbabwe and Botswana: From 50 to 85% of the forests, woodlands and savannah was reported to burn each year. In meetings with traditional leaders, technical staff discussed possible fire management strategies and steps that should be taken to reverse the trend of increasing, uncontrolled fires, aimed at restoring the situation to one in which the use of fire in the region was practiced in an environmentally sustainable manner.

When collecting data to serve as a basis for a study underpinning the above discussions, it was found that when men were interviewed, the main reason given for burning was because of "traditions", inherited from father to son Virtanen (2000). When women were asked the same questions, they stated that most wildfires had escaped from controlled agricultural burning, a task that was exclusively carried out by women. Similar interview data was collected in Mozambique in 2001 in meetings with traditional leaders and local farmers associations held in the province of Zambezia (Virtanen et al. 2002). Although the clearing of new land for shifting cultivation was carried out by men, it was found that spot-burning to kill and remove stumps and trees from clearings was mainly done by women, who also carried out all agricultural burning following the harvesting of crops. It is evident that in order to prepare a viable strategy for sustainable fire management in which local people are involved, gender aggregated baseline data is needed.

Gender aggregated data from pilot regions showed that 80% of all fires were lit by women and 20% by men; but for primarily different reasons. It was concluded that in this case fire programmes should to a large extent target women not men as had been previously done by the donor community. This targeting of men arose from the focus of all efforts on detection and suppression, activities dominated by men; instead of on prevention which was a women's domain.

The people, women fire users, know very well that fire outbreaks threaten the very resources they need for survival in addition also their housing, children and elderly people. In the baseline study in Mozambique 17 % of women said that their crop had burned during the last year and 16% that their house had burned down; all in all 39% of women confirmed that their house had burned down one time or the other. Out of men 48% and out of women 36% confirmed that they had experienced losses due to wildfires encroaching into their land.

In poor countries the use of fire is mainly about the lack of economic choice and alternatives. There is no choice but to keep using fire in agricultural activities despite having no resources to handle a large fire outbreak resulting from their use of fire in livelihood activities. The implication for fire management of women handling most of the fire activity is strong. In most cases they are excluded from primary decision-making processes on management of land resources – a situation that needs to be addressed in the context of CBFiM as well as other frameworks.

Forms of CBFiM

There are communities involved in fire management in a range of ways.

- In the western United States in planning and influencing land management through stakeholder fora (Everett, 2001).
- In Finland where most members of the Voluntary Fire Brigades in local communities have most of their assets invested in "forest farming" and are private forest owners who will protect their forests and
- Australia through Volunteer Fire Brigades that arise from the community and are mainly for protection of community assets and perhaps in many cases less engaged in forest and land management for subsistence or dependence on it in other ways.

With the exception of Finnish forest owners, in the key respect of "substantial involvement in the objectives and practices involved in preventing, controlling or utilising fires." these developed world "communities" do not conform to the definition above. These groups are volunteers, from the community and in a sense 'for' the community but they are focused on fire fighting in two respects - preparedness and response with a little bit of prevention if they participate in prescribe burning or other measures. They are not really "community based" in the same form that CBFiM has been identified to date in developing nations, but do form a node of the CBFiM continuum.

This emphasis on locality does not imply that only local residents should be involved in fire management. Obviously there are other stakeholders (people who can be affected by the outcomes of fire management and people who can affect the outcomes). Partnerships between local people and other stakeholders are quite consistent with CBFiM. But an approach that starts with local actors and works out to include other stakeholders involves different strategies than one that starts by identifying all stakeholders and includes local residents as just one category.

While some community fire management practices are locally initiated, others are set up by outside agencies, such as forest departments perhaps supported by donors. Typically, these externally sponsored systems recruit community members into committees or working groups to manage fires. It is possible to distinguish between externally sponsored community approaches where there is meaningful community involvement in decision-making and approaches where the community is involved in carrying out tasks determined by others (such as providing labour to build firebreaks). Some modes of management that do not allow for community input but do allow for community involvement (Figure 1 - dashed lines) are not considered CBFiM as per the definition previously given. Although there is some emphasis on whether the system is initiated internally or externally, it should be noted that the initiation is not as important as the amount of credibility given to local decision making (Figure 1 - double lines).

Any attempt to improve and support CBFiM must start with an understanding of the causes and functions of various types of fires, and with their implications to various stakeholders within and outside a community. It is necessary for external actors to know where a fire started and why, before working with a local community to manage its effects. Similarly whether various stakeholders see a fire as beneficial or damaging is important before deciding what management is appropriate or possible. The technical and organisational capacities of communities should also be considered.

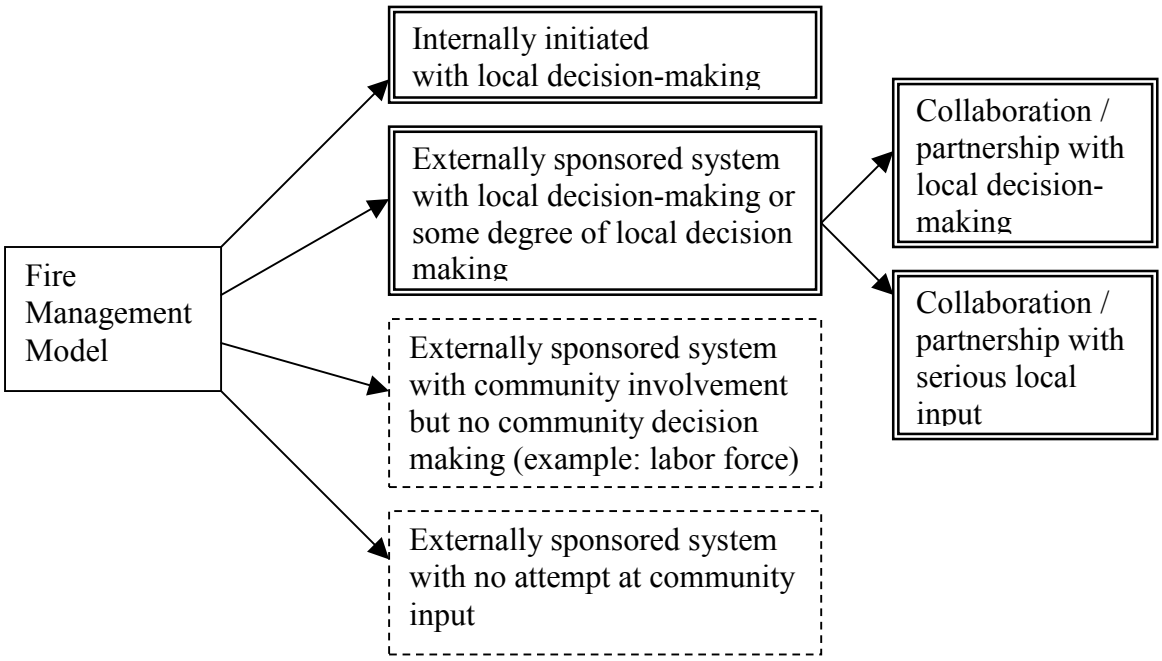

Figure 1. Modes of Community Input in Decision Making in Fire Management

Legislation, Policy and CBFiM

In most developing nations, specifically South East Asia, fire is not well dealt with in legislation (Abdullah, 2002). The tenure covered is usually restricted to public lands and the responsibility for fires starting and the management of fires is not allocated. Generally fires are treated as negative; the use of fire for livelihoods purposes is mainly not accepted, with exceptions in a few countries. The lighting of fires is in many cases an offence punishable under the laws. In very few cases are fires permitted for any purpose. Malaysian legislation is an exception where deliberate fire is allowed under permit for local and small-scale activities that are specified in the law. Commercial scale fire use is banned in Malaysia.

Specific Legislation most often criminalises local farmers using fire as illustrated by an example from Mozambique (Article 40, Forest burning crime; Forest Act of Mozambique, 1999):

> *"Anyone who, voluntarily, sets fire and thus partially or totally destroys crops, forests, woods or a grove of trees, shall be condemned to an imprisonment sentence of up to one year and to the corresponding fine".*

More than a million local families are daily practicing shifting cultivation in Mozambique. Applying this law to the essential livelihood practices in local communities is problematic. The only solution is to involve these communities in; fire awareness, mitigation and education activities (CBFiM) so that their traditional knowledge and inherent skills are applied to the issue of unwanted damaging fires. Increasing awareness of the damaging effects of fires can have a strong effect on communities that may not have recognised the impacts, on them as well as others and the landscape, of escaped fires (Wright & Byring 2003).

With the meager resources usually allocated to fire management the Government cannot supervise this new Act in Mozambique; and the tightening of legislation will not have any impact on wildfire occurrence.
In Namibia a similar situation was approached by developing National Guidelines on Fire Management wherein directives were laid out on the responsibilities of various stakeholders in CBFiM, including Principles for Community Participation in Forest Protection in Namibia (Jurvélius 2001):

> *Besides the national government, traditional authorities, commercial farmers and local communities are also responsible for the implementation of forest protection policies to maintain and manage the environment, to prevent and overcome damages, reduce air pollution, wind and water erosion as well as to sustain natural resources.*
> *When it comes to Declared National Parks; then the principles of Community Involvement in Park Management should be applied to any fire situation in or around the Park. The local communities involved in forest fire management should be paid out of the Game Product Trust Fund.*

Activities set out under the guidelines included:

- To inform and educate the rural population, commercial farm communities and the general public in the role of forests and its contribution to the national economy. Numerous are still the people who see the forest as merely a source of income for timber and non-wood forest products. This short-term exploitation goal has led to drastic damage and denudation of forests to the point that the existence and quality of forest resources have declined greatly.
- To inform and educate the public about adverse environmental and economic effects of bush encroachment on commercial farming communities.
- Encourage the formation of Fire Protection Associations in commercial farming areas and Fire Committees in communal areas.
- Encourage NGO's, CBO's and private initiatives regarding forest extension and law abiding activities.
- Encourage civic organizations, religious organizations, women's groups, listener-reader-viewer groups, conservation groups, handicraft producers, local artists and environmental organizations to upgrade their understanding and appreciation of forests through their participation in regular activities and exchange of information.
- Enhance the role of civic organizations in motivating community participation in forest protection activities including fire prevention and suppression.

The focus in this case is on forests but the direction and focus of the principles and activities could equally apply, once adjusted, to other parts of the human and natural landscape.

A further consideration is the clarity of tenure under laws and regulation. In CBFiM efforts the formal or informal rights of access and use of lands was identified as a key aspect of communities taking an active role in fire management. The allocation of rights, access and operational efforts to clarify tenure are in many case not well formed in many nations. This is not necessarily restricted to developing nations as an issue, Greece has a poor cadastral base which contributes to the ongoing difficulties with fire in that country.

There are many important components involved in fire management at the policy and field level but a recurring theme is the fundamental question of who should control the use of fire and manage it appropriately? The rural landscape in developing nations remains home to millions of people, both indigenous inhabitants as well as voluntary and forced migrants. Rural communities inevitably compete with internal and external factors for access to natural resources and the right to use fire as a management tool. Increased competition for land, water and forest resources may be an important factor driving the need for more clearly defined roles and responsibilities in fire management.

Context for CBFiM

Fire is a disturbance that has played, and will continue to play, a major role in both fire sensitive and fire adapted ecosystems throughout the world. In almost all of these ecosystems, humans have altered the natural fire regimes by changing the frequency and intensity of fires. In many parts of the world, local communities are often blamed for what are considered harmful fires. This view often encourages fire and forest management institutions to perceive local communities as part of the problem, and certainly not the solution. Evidently because local people usually have most at stake in the event of a harmful fire, they should clearly be involved in mitigating unwanted fires. Community Based Fire Management (CBFiM) is an option for blending participatory community development strategies and fire management to reduce unwanted fires and their impacts.

Agricultural Burning

Agricultural fires are used for a wide range of purposes including:

- Management and maintenance of rangelands
- Beekeeping
- Hunting
- Wildlife Management
- Native People/Indigenous fires

The management of these fires generally lies with agricultural authorities and agencies. Worldwide most forest fires come from uncontrolled agricultural activities. Escaped agricultural fires represented 91% of fires in Italy (Corpo Forestale 2002) and 95% of fires in Portugal in 2002 (Forest Fires- Myths and Realities 2003).

The extent of agricultural burning is enormous. The figures of the European Commission Global Burned Area Assessment for the year 2000 showed over 230,000 fire scars in grasslands and croplands with a total burned area of over 200,000,000 hectares.

These figures suggest that fires deliberately started deliberately by people for agricultural purpose are significant in both numbers and area. The proportion of forest fires arising from escaped agricultural fires indicate that strengthening or encouraging of community based fire management is likely to be a significant means of improving the impacts of unwanted and damaging fires. The impact of this approach might be enormous.

Worldwide fires are overwhelmingly human, caused approximately 90% of all fires. Of these the majority are agricultural or livelihood fires deliberately lit to meet specific objectives. Intention will include hunting and wildlife management as well as land preparation and management of residues. Consequently community fire use must be recognised as potentially the largest source of information, expertise and experience available.

The focus for CBFiM needs, therefore, to be on building on existing knowledge, leading to efforts that improve the safe use of fire and minimising escaped damaging fires. Fire should also not be completely excluded from the daily lives of people and the landscapes they inhabit. Case studies illustrate the ways communities use smaller wanted fire to cultivate crops and non-timber forest products, hunt, create forage and manage pests and disease need to be distinguished from uncontrolled fires (FAO 2003).

The Current State of CBFiM

To varying degrees, governments have begun to adopt collaborative or community-based forest management strategies. The term "community-based" in the context of fire covers a wide spectrum of situations; from potentially forced engagement in an activity (coercion), to free and willing participation in actions developed by local actors themselves (empowerment). The emphasis on "community-based" is not only the community involvement, but also where community capacity has been recognized and supported by external agencies (governments, non-government organizations, projects and others). This may include support to an existing indigenous system through formalizing, modifying, or otherwise elaborating on it, or instituting new systems. Many of these systems and approaches are considered more effective in tempering uncontrolled fires, more beneficial to local ecosystems, and more cost-efficient over the long term.

More common are instances where CBFiM has resulted from the formation of community institutions and mechanisms that support more efficient fire management entities (such as the two cases documented by FAO from Çal and Bergama in Turkey – FAO 2003). Here, the lead institutional transformations occur at the local level, with government and non-government agencies accordingly reshaping their own functions away from direct management functions towards more technical and advisory roles. The nature of institutional change varies from place to place.

In some countries, the driving force behind CBFiM approaches is indigenous land and/or use rights, including the right to use fire as a management tool. The securing of these rights may ultimately help maintain the beneficial uses of managed fires for such objectives as controlling weeds, reducing the impact of pests and disease, and generating income from non-timber forest products. A case study from Orissa, India (Darlong, 2002), documents the importance of the traditional uses of fire for cultivating Kendu and Mahua flowers. The dearth of documentation of these and other practices threatens to erode the stores of cultural knowledge. There are elements of CBFiM and other community-based strategies that represent a revival and formalization of traditional natural resource management regimes but there should be caution against the over-emphasis of this aspect or when re-introducing a traditional fire regime.

A similar caution is urged in respect to over-emphasizing the role and capacity of local communities to fight fires historically larger and of higher intensity than those of the regimes of the past. Given the fire regimes in many parts of the world, communities and their members can be an important, perhaps pivotal, component, but should not shoulder the entire burden for fighting fires. Several of the CBFiM approaches documented in various sources occur in remote locations where the government's fire control/suppression approaches are severely hindered by access and response time. In such remote locations, communities are present and have a significant role to play in the prevention and suppression of harmful fires that have a detrimental impact on their lives but the government must not relinquish all accountability.

The community should not bear the sole responsibility for extinguishing larger, more intense fires that require resources beyond local capacity.

Ultimately, CBFiM is concerned with how villagers manage fire for local daily subsistence needs, including as an aspect, ensuring local peoples' access to, and management of, land and forest resources. By placing tighter local controls on how fire is used, and reaching clearer consensus on resource use and territorial rights agreements with their neighbours and government agencies, local people can minimize the destructive effects of fire and maximize its benefits.

External Intervention

Since external actors have generated most of the documentation and assessment there is an emphasis on the means and modes of intervention. Though from an outside perspective there ideas and approaches have much to offer in developing CBFiM and supporting progress towards matching its potential and integrating CBFiM into fire management.

To lead to *sustainable CBFiM* the aim should be to build on existing knowledge. Communities must own the fire management activity and design their community participation approach fitting their locality. They should call/arrange their own meetings and invite experts that they think will be of use for their focus. This will only happen if fire management is integrated with their production/livelihood systems.

A synthesis of insights and ideas generated to date by external actors is presented below.

Conclusion

CBFiM is anchored in community level influence, if not control, of fire management decision-making. The active, intentional use of fire is an important factor in many, perhaps most, communities especially in developing nations. The initial focus for CBFiM should be on improving skills in the use of deliberate fires, incorporating key aspects of gender, community institutions and appropriate training. There are significant efforts still needed for CBFiM to take its place in the balanced and sustainable management of landscapes and ecosystems. These include improved fire data collection and analysis; strengthened recognition in law, policy and practice of the potential and roles communities can undertake.

The current efforts by a range of stakeholders and actors are welcome and positive. With continued emphasis and consistent focus the rapid increased appreciate of CBFiM can be reinforced and integrated into land and fire management.

Though they are preliminary the CBFiM nodes provide a means for identifying options and characteristics of community and local scale involvement in fire management for both emerging and developed countries.

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Appendix 1: Towards CBFiM: Steps to Support Fire Management for Communities

While CBFiM is considered to be driven and managed mainly by rural communities themselves, much input and support is needed from government agencies, NGOs, and other institutions to establish CBFiM through a particularly designed development programme. In the past, many programmes and activities aimed at improving the livelihood of rural communities were only successful as long as the support from "outside" was maintained, often having only limited impact on communities in terms of sustainable development and welfare.

One reason for limited success was that local communities were regarded as "targets" rather than as co-operation "partners" meaning such programmes did not necessarily match with the needs and interests of local communities. Consequences include low participation of villagers, no sustainable effects of activities carried out and generally no "sense of self-interest" developed by these communities.

The process of developing or strengthening CBFiM has been a focus of the GTZ Integrated Forest Fire Management (IFFM) Project in East Kalimantan, Indonesia. They have documented the process and the steps of it (Figure 2). One key facet that their experience has identified, supported by understanding and insight from elsewhere, is the essential nature of the benefits for the community from practicing CBFiM. This can be either improved circumstances or a reduction of unwanted impacts. To rephrase the definition in part – involvement in land and fire management decision-making and activities improves community livelihood, health and security. CBFiM is unlikely to be of interest to the community or sustainable if initiated if it does not meet this need.

<u>CBFiM Processes and Activities/Products by External Actors</u>

Based on experiences especially in Sub-Saharan Africa and South East Asia, the following processes and activities are proposed for planning and implementing sound fire programmes, which give due consideration to both technical issues and stakeholder involvement.

A critical facet of the processes for supporting CBFiM is a needs assessment at village level. Together with forestry and/or agricultural extension workers and the village leaders organize community workshops to discuss the fire history of the village, fire use, wildfire causes, wildfire impacts, past fire management efforts (perhaps by the use of a Participatory Sketch Mapping tool).

Process	Step	Modules	Tools / Products
Preparation	0	**Selection of Villages**	❖ Guidelines on village selection
Social Marketing	1	**Need Assessment**	❖ Guidelines on key questions (fire history, fire causes, fire impacts, resources, etc.); ❖ Fire risk sketch mapping; ❖ Organizational aspects;
	2	**Village Prevention Campaign; Village Extension Meetings; Road Show**	❖ Manual / guidelines on village prevention campaigns and extension meetings; ❖ Toolbox;
	3	**Capacity Building**	
Mobilisation	a.)	**Establishment of Village Fire Crews**	❖ Guidelines for facilitators;
Facilitation & Guidance	b.)	**Basic Fire Management Training (Fire Prevention, Suppression, Information)**	❖ Training manual; ❖ Tool box; ❖ Handout for participants;
	c.)	**Provision of Fire Fighting Equipment (Hand Tools)**	❖ Handout on equipment use and maintenance;
	d.)	**Institutional Strengthening of Village Fire Management (SOP, Job Descriptions, etc.)**	❖ Workshop / Training guidelines for facilitators; ❖ Handout for participants; ❖ Fire information and communication; ❖ Co-operation and networking;
	e.)	**Village Workshop on Drafting of Village Fire Regulation**	❖ Process documentation; ❖ Documentation of laws and regulations related to fire;
Self-reliance Self-help	f.)	**Yearly Planning for Fire Management at Village Level**	❖ Guidelines and process documentation (includes budget planning);
Monitoring	g.)	**Facilitation, Monitoring, and Evaluation of CBFiM Development**	❖ Guidelines / Manual for Extension Workers

Figure 2. Steps and Process for CBFiM Development or Strengthening[15].

[15] From H. Abberger and E. Marbyanto, GTZ IFFM Project, East Kalimantan, Indonesia (unpub.)

Social Marketing through Prevention Campaigns and Extension Work[16]

In most circumstances there seems to be a strong need for awareness rising. This is a fundamental process in enabling local people to become involved in managing their fires. A key issue is to define the fire management responsibilities between government agencies, communities and NGOs. Awareness raising and an increased participation of rural communities in wildfire prevention and fire management is the main goal of campaigns and extension work carried out in selected priority villages. Based on experience drawn from many prevention campaigns carried out around the world, the following aspects should be included into village campaigns in one or the other way:

- Functions and importance of landscapes
- The ecological, economic, social and cultural benefits of fire
- The role of fire in the landscape
- The implications of removing fire from its ecological, traditional or economic function in the landscape
- Possible wildfire risks
- Negative impacts of wildfires
- Introduction to laws and regulations related to fire
- Prescribed burning in shifting cultivation and agriculture
- Possibilities for the participation of rural communities in fire management

The active participation of communities in village campaigns is very important and facilitators should understand local culture. The programme should allow as much contribution and inputs as possible from the participants. Good visualization and easy-to-understand contents are crucial in presentations given by facilitators.

Role-playing and presentations by participants add to a lively and attractive event and provide good conditions to articulate local concerns not only in regards to fire. A way to make village campaigns even more interesting is to include entertainment events such as movie shows, theatre shows, etc. Generally, village campaigns should raise the interest and motivation of rural communities to participate in the development of CBFiM in their respective villages.

Fire prevention campaigns in villages should involve government officers at local or at district level. They need to co-operate and co-ordinate efforts with all other government and non-government agencies with extension work capacities agencies. They also closely co-operate with the provincial fire officials, which should be responsible mainly for the development of concepts, campaign material, and the training of facilitators. Furthermore, village fire crews need to be actively involved in campaigns in their own and possibly also in neighbouring villages.

Means and ways that have been successfully used to implement the education, training, information-dissemination and other extension activities on fires, fire management and fire awareness include:

- Personal contacts (often pivotal and critical)
- Interview/discussions with target groups; government agencies, traditional leaders, farmers, fishermen, cattle raisers, women's groups, conservation cadres, environmentalists, tourists, hunters, honey hunters, arsonists, school children, teachers, handicraft makers and others.
- Developing and establishing a National Fire Logo, e.g. Si Pongi in Indonesia (GTZ IFFM), Twiga in Tanzania and "Fire Ostrich" in Namibia (NFFP).
- Use of printed and electronic media
- Theatre drama, plays and national radio to rely fire message to rural communities with low literacy rates
- Targeting primary and secondary schools and other training institutions
- Involving local artists in the production of educational materials, text writing, song writing and video production
- Participation in literary programs for adult learners (the majority of whom are women)
- Participating in national/local exhibitions, cultural festivals, parades, school competitions
- Participation in National Arbour or Environmental Day, Food Day
- Organising national fire campaigns on radio/TV (with national fire logo displayed)
- Producing logo; badges, key rings etc.

[16] From Abberger and Marbyanto (unpub.)

- Creating and preparing fire stories or fire cartoons for mass distribution in national and local languages for example NFFP (1999)
- Producing and placing fire billboards along strategic roads in national as well as in local languages.

Most of these approaches to campaigns are more suited to literate societies. Altered emphasis and methods may be needed for societies with oral traditions or low literacy.

Development of Community Fire Institutions

Village fire management has to be institutionalized at an early stage of any programme. This must be based in existing institutional arrangements. Responsibilities and tasks have to be assigned to community members who will, on a voluntary basis, make up a village fire crew. It has to be carefully elaborated, how fire management can be integrated into the organizational village structure in order to gain full acknowledgement and support by the community. In villages with well-organised and functioning farmer groups, the integration of fire management into their portfolio should be considered.

Confirming the safe use of fire and effective fire management practice is a key aspect of institutional development.

One task of village fire crews is to prevent and suppress unwanted fires in the village area. Importantly, they have to promote safe burning practices in agriculture in coordination and co-operation with village and district authorities. In order to fulfil these tasks, village fire crews require a regular budget from the village administration.

Additional budget sources can be government agencies, NGOs, or private enterprises. Village fire crews might also provide paid services in fire prevention and suppression to other villages.

Training

The sections above have dealt with the steps to take to achieve sustainable participatory approaches in fire management. These steps need to be complemented by training. The basic information (baseline study) on fire, including gender segregated data, will provide the basis for planning training activities – who should be trained (notably women as identified for Southern Africa) in what and to what level.

The training plan should include the following:

The 5W + 1H = (or answer the questions; Why, What, Who, Where, When and How)

Approaches in response to fires from external actors, including donors, have generally (and still do) emphasised fire suppression. Implicit in this is the assumption that the fire "problem" results from a lack of awareness about fire damage and unwanted impacts and a shortage of skills and perhaps organisation. The experience of many observers and case studies suggest strongly neither assumption is supportable. In point of fact lack of awareness and shortage of skills and poor institutional arrangements on the part of regular fire users in a community is unlikely.

By analyses of the 5W + 1H, the training may be directed to the right target group as well as contain the right curricula to meet the local needs.

Prescribed Burning Training

The use of fire for subsistence and livelihoods is much more common than community institutions set up to only fight fires. CBFiM mainly exists where fire is used in some way that generates benefit for the local people. Active fire use generates skills, understanding and awareness and strengthens community institutions that deal with fire and related aspects.

Training in prescribed burning can have a range of benefits for the local people but importantly also for other actors and stakeholders that influence or are affected by managed fires. The training can ensure that skills and capacities are maintained and improved. Maintaining the understanding of fire at the local level is becoming an increasingly important need. As various social and economic changes take place under the influence of rural –

urban migration, spontaneous and forced transmigration and land use changes, many of the skills of deliberate fire use are being lost or weakened.

Prescribed fire is also one of the activities that combine together all the elements and stakeholders in the fire management system. Training for it also does this and provides an opportunity to improve shared understanding of prescribed fire and CBFiM.

Components of fire training

Issues related to training in fire management are complex; there is a need to cover both fire inclusion and fire exclusion in curricula and training programmes. Frequently, there is a generalized need to train staff in Government agencies, NGOs and local populations, in various aspects of fire management. This will include providing information on efficient methods of prescribed burning as well as information on situations in which fire should be excluded.

Staff responsible for fire management and local people alike, need to appreciate and understand the role and relationship between the basic components of fire (fuel, heat, oxygen), as well as the principles of fire behaviour. In addition, they need to master, at least in principle the skills of prescribed burning.

Such knowledge will form the basis of a more common understanding of local fire ecology, including the role of trees and forests and the requirements of fire for regeneration of forests and trees.

The generalized view that local people will not understand complex biological and ecological issues has been proven wrong in many instances. Tens of thousands of local people and government staff were trained in forest fire management and related activities in Burkina Faso, Namibia and in Mozambique in the 1990s and early 2000. Only very few of those who received training were not able to relate the environmental information to their own community or home area. Local people, being dependent on the environment for survival and well-being, are often keen observers and knowledgeable about nature surrounding them. Discussion on the relation between everyday village life and forest fires will help them better to understand both immediate and longer-term impacts of forest fires and of the use of fire.

Training curricula and materials have continuously been improved through regular evaluation of training events together with participants. Fire management training should provide a balanced mix of theory and field-practice, which incorporates local conditions and knowledge and experience of the participants. The training concept should give sufficient time for discussions, work groups sessions, role-plays, and other participatory methods. The curriculum includes fire prevention activities, environmental education, institutional issues, the role, functions, and responsibilities of fire crews, the use and maintenance of simple equipment, and also fire fighting strategies and techniques.

This Position Paper # 5 will however neither be dealing with how to develop appropriate working methods and techniques in combating fires nor with questions of how to develop suitable handtools for community fire fighting, where emphasis should be on local manufacturing.

Often assumptions, which can be gross over estimations, are made of peoples' capabilities to fight fires by using tree branches, palm leaves etc. Barefooted people without any protection against radiant heat, smoke inhalation and flames are next to useless in combating fires, unless equipped with tools, clothing and as appropriate water to contain the fire. Well made rake-hoes, fire swatters and backpack sprayers are required for community fire fighting (Jurvélius 1980). A comprehensive training manual together with useful materials is currently being prepared for publication.

<u>A taxonomy of learning objectives</u>

An objective is defined as: "intent communicated by a statement describing a proposed change in a learner". When looking at the overall aim of CBFiM one may generalise it by saying that the aim is to change the behaviour of people using fire (Curzon 1991).

Ensuring the appropriate level of information exchange, enhanced understanding and capacity building is balanced to the role to be filled by those undergoing training is critical. In order to be comfortable and confident that training is meeting the objectives set for it a theoretical framework is useful. The taxonomies of learning

objectives have been mainly developed in industrialised countries where all levels of an organisation (fire chiefs to fire fighters) have their own defined training levels and learning objectives.

The aim of using learning objectives is to describe what people should be able to do after they completed their training. However, as in all learning, the person gradually develops more in-depth understanding of a topic and thus the educator needs some kind of yardstick to measure this progress.

"Jurvélius' Taxonomy" (Figure 3) describes the full range of skills, levels and capacities that might be required in CBFiM activities (Based on Bloom and Sullivan's taxonomies of learning objectives). These Taxonomies were specifically identified for the training of CBFiM Instructors and extension officers; they were tested for thousands of students and farmers in Africa and Asia.

Information on the learning/teaching process is required before people are able to market/sell the CBFiM to local decision makers, to politicians and to Traditional leaders. This aspect is crucial when looking at the sustainability of any CBFiM projects or activities once the phase of intervention is over. Jurvélius' Taxonomies of Learning Objectives can be used to conceptualize what an Instructor/Extension Officers in CBFiM should know; and be able to do after completion of their training. Level 4 may be considered the minimum target of attainment for CBFiM Instructors who has to be able to conceptualise the full spectrum of fire management
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Figure 3: Jurvélius' Taxonomy of Learning Objectives for CBFiM [17]

DOMAIN/ STAGES	**COGNITIVE (Knowledge or Information)**	**AFFECTIVE (Feelings, Attitudes, Values)**	**PSYCHOMOTOR (Motor skills, doing something with hands, feet, body)**
Level 1	KNOWLEDGE	RECEIVING	IDENTIFYING
Level 2	COMPREHENSION	RESPONDING	NAMING
Level 3	APPLICATION	VALUING	DESCRIBING
Level 4	ANALYSIS	ORGANIZING CONCEPTUALIZING	CONSTRUCTING
Level 5	SYNTHESIS	CHARACTERIZING	DESIGNING
Level 6	EVALUATION	INTEGRATION LEADING TO CHANGES IN BEHAVIOUR	MODIFICATION & ADAPTATION DEMONSTRATING

Yearly Planning for Fire Management at Village Level

Fire management Planning should be integrated into the overall village planning. Generally, such planning barely exists in many communities. Fire management is part of forest management and agriculture in communities. The necessary planning tool should therefore integrate fire management into the general land management planning of a community.

[17] Prepared by Mike Jurvélius

PART VI

Strategic Paper
A Strategy for Future Development of International Cooperation in Wildland Fire Management [18]

Introduction

The attendees of the Sydney Summit are searching for pragmatic and sustainable responses to the human health, environmental, and economic damage caused by unwanted wildland fires. Each country has valuable experience that will provide a contribution to developing synergistic solutions. Many countries and international agencies, especially those with well-developed wildland fire management systems or with resources to share, are in a position to assist others.

Theme

The theme of the summit is: *Fire Management and Sustainable Development: Strengthening international cooperation to reduce the negative impacts of wildland fires on humanity and the global environment*.

Objectives

The Summit participants will review, discuss, and recommend strategies to improve communication and coordination between agencies and organizations to build a coherent response in reducing the negative impacts of wildland fires on humanity and the global environment. The objectives of the Summit are:

1. Based on the international conventions, the state-of-the-art knowledge generated by the international science community and the recommendations of prior conferences on wildland fires as well as the outcomes of the World Summit for Sustainable Development (WSSD), participants will develop strategies and organize resources to support and enhance the networks and information sharing between agencies and organizations.

2. Agree to develop and support implementation of appropriate mechanisms to improve global and regional communication and knowledge sharing on wildland fire management issues and solutions.

3. Agree to work regionally to implement key Summit outputs intended to facilitate the interagency cooperation and implementation of ecologically sound, community based wildland fire management programs.

Intended Outputs

The Summit participants will discuss, recommend, and adopt as appropriate a series of strategies that will build on the work of many groups, conferences and regional summits and produce a series of actions building towards enhanced international cooperation in wildland fire management. These processes will pave the way towards a Global Wildland Fire Summit and the 4th International Wildland Fire Conference.

The proposed Summit outputs are position papers. The papers will be discussed and finalized during the Summit with participants agreeing either in principle or in substance to the paper and to implementation within their agencies. The level of agreement will depend on the participants' ability to commit their agencies to policy. An agreement in principle will mean that the participants agree that the strategies have merit and will begin to discuss and implement the strategies either within their agency or work with local partners to implement the strategy in the region.

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[18] Strategy Paper No. 4 has been prepared on behalf of the ILC by Denny Truesdale (Assistant to the Deputy Chief, USDA Forest Service, USA) and Johann G. Goldammer (The Global Fire Monitoring Center [GFMC], Fire Ecology Research Group, Max Planck Institute for Chemistry, Germany).

1. An agreement on the ***principles*** that would apply to international wildland fire management projects and exchanges. The principles would be used and applied to projects with participation or funding from international or interagency partners.

   Specific actions for Summit participants:

   - Agreement in principle with the concept of adopting wildland fire management principles;
   - Agreement to work individually and collectively to adapt and apply the principles to local and regional activities.

2. An agreement on an ***international agreement template*** that can be used by agencies wishing to form a cooperative or mutual aid arrangement with one or more other countries for mutual assistance and technology exchange on wildfire management. The template will build on the FAO report of May 2002, *Legal Framework for Forest Fire Management International Agreements and National Legislation*.

   Specific actions for Summit participants:

   - Agreement on the concept that a common template for international wildland fire agreements is useful;
   - Agreement to adapt the template to specific local and regional conditions when instituting new agreements.

3. An statement of support from Summit participants to adopt an ***Incident Command System (ICS)*** as the international standard for wildfire incident management for all agencies participating in international or interagency agreements and exchanges. The statement will include examples of agencies currently using ICS, and sources of technology, training, and technical assistance.

   Specific actions for Summit participants:

   - Statement of support for adopting ICS as the international standard;
   - Agreement to introduce ICS to their agencies and organizations and begin discussions with cooperating agencies for implementation.

4. An agreement to a ***strategy for future development*** of the issues and international responses to wildland fires, including commitments to a series of regional conferences, an international wildland fire congress, and the 4th International Wildland Fire Conference in 2007.

   Specific actions for Summit participants:

   1. Agreement with the concept that a series of regional conferences, summits, or roundtables will lead to a Global Wildland Fire Summit (date to be determined);
   2. Agreement that the International Liaison Committee (ILC) of the 3rd International Wildland Fire Conference work with a local steering committee to prepare the 4th International Wildland Fire Conference by active support through regional meetings and conferences;
   3. Agreement to work individually and collectively to secure resources and funding for hosting the regional sessions and implementing other Summit outputs.

Operational Procedures

Global Wildland Fire Network

The Regional Wildland Fire Networks will be consolidated, developed and promoted through active networking in information sharing, capacity building, preparation of bilateral and multilateral agreements, etc. This process will be facilitated through regional Wildland Fire Conferences and Summits in cooperation with the International Liaison Committee and the UN-ISDR Working Group on Wildland Fire.

International Liaison Committee
The ILC will meet annually in 2004 and 2005 and biannually in 2006 and 2007. A portion of the agenda for each meeting will include preparation for the 4th Conference. In order to encourage the regional fire networks to actively work towards solutions to regional problems related to the Sydney Summit outcomes, the ILC will offer to hold meetings in the regions and devote a portion of the agenda to a Regional Summit with invited political, agency, and organizational representatives to discuss development of protocols and establishing networks for exchanging technical, scientific, and other information.

The regional summits will be hosted and supported financially by local agencies or organizations. The agenda and themes will be developed locally. The meetings can be held in conjunction with established conferences and meetings.

Background Information

Background information for the Summit is provided on the website of the GFMC / Global Wildland Fire Network at:

http://www.fire.uni-freiburg.de/GlobalNetworks/RationaleandIntroduction.html

and

http://www.fire.uni-freiburg.de/summit-2003/introduction.htm

Annex

The outcomes of the Conference and Summit and the work of the ILC are built on a series of actions and the sustained work of many groups, both formally and informally to promote and advance fire management activities throughout the world. Without an appreciation of the work that has gone on prior to this effort, the wildland fire community runs the risk of expending energy on redundant activities, or worse, missing opportunities to build and leverage the valuable work of others.

One of the actions envisioned for the Summit participants is an agreement to develop an ***organizational structure*** for international liaison in wildland fire issues. This Conference follows the 1st and 2nd conferences sponsored by the North American Forestry Commission (NAFC) – Fire Management Working Group (FMWG). NAFC is one of several forestry commissions established over 35 years ago by FAO. The work of the FMWG is a good example of how established organizations combined with the individual, or ad hoc, efforts have resulted in international agreements, bi-lateral programs among the member agencies, and, most notably, the three international conferences. With the success of the 3rd Conference and Summit as a benchmark, the ILC and the conference organizers envision an organizational structure that builds on the strengths of both the established organizations, and the creative energy of the ILC.

Examples of the established mechanisms include the United Nations programs and conventions, non-UN international organizations and programmes, the civil society, and the Global Fire Monitoring Centre (GFMC). Examples of individual or ad hoc efforts are the work of the ILC at international and regional levels and some of the individual and collective fire networks being established by the ISDR Global Wildland Fire Network.

Below is a summary of some of the major programs and activities that can be the building blocks for future activities within the wildland fire community. It is suggested that Summit participants become familiar with the work of these groups and use them to leverage ongoing and future activities.

- The Global Wildland Fire Network under the auspices of the UN-International Strategy for Disaster Reduction, Inter-Agency Task Force, and the GFMC;

- The UN Office for the Coordination of Humanitarian Affairs (OCHA), through the Emergency Services Branch, Environmental Emergencies Section (EES), in coordination of international assistance in case of wildland fire disasters;

- The Type II Partnership "Integrated Approach to Prevention for and Response to Environmental Emergencies in Support of Sustainable Development" coordinated by UN-OCHA;

- The Global Forest Fire Assessment 2005 within the frame of the FAO Global Forest Resources Assessment (FRA) 2005 supported by the FAO, the GFMC, and the Global Observation of Forest Cover/Global Observation of Landcover Dynamics (GOFC/GOLD) - a project of the Global Terrestrial Observing System [GTOS] programme, sponsored by the Integrated Global Observing Strategy [IGOS].

The ILC envisions several future activities that will lead up to the 4th International Wildland Fire Conference and Summit in 2007. These activities will build on the actions of the established groups and programs and will continue the work of the ILC, the FMWG, and the Australasian Fire Authorities Council (AFAC) the organizers of the 3rd Conference and Summit in Sydney. The ILC, and its partners, will work to gain widespread support and involvement to build global support and participation in the 4th Conference. Some key activities include:

- A post-Summit activity to prepare an input paper to the UN General Assembly that seeks the support of countries to strengthen international cooperation in response to wildland fire disasters and post fire mitigation;

- Additional support for the ILC organizational structure from individual agencies and international organizations and programs;

- Participation with FAO, GFMC and GOFC-GOLD in support of the Global Forest Fire Assessment 2005;

- Recruit additional agencies and international organizations and programs to fund and staff the Global Wildland Fire Network and the ILC;

- Preparation for the follow-up Global Wildland Fire Summit.

PART VII

Background Paper: An Overview of Vegetation Fires Globally [19]

Executive Summary

The increasing incidence, extent and severity of uncontrolled burning globally, together with its many adverse consequences, has brought fire into the international environmental policy arena, with growing calls for international action leading to greater control of burning, especially in tropical countries. Despite this concern, there is a paucity of accurate and timely information on the numbers of fires, area burned and phytomass consumed annually at national, regional and global scales, and on the social, economic and environmental costs. Given that fire is also an important natural process in many ecosystems, and that people have traditionally used fire for millennia as a land-management tool, the challenge is to develop informed policy that recognizes both the beneficial and traditional roles of fire, while reducing the incidence and extent of uncontrolled burning and its adverse impacts.

As suggested by the Working Group on Wildland Fire of the United Nations International Strategy for Disaster Reduction (UN-ISDR), Inter-Agency Task Force for Disaster Reduction, and in the process of coordinating the preparation of the 3rd International Wildland Fire Conference, the outcomes of the World Summit for Sustainable Development (WSSD) (Johannesburg 2002) provide a mandate for action to reduce the negative effects of wildland fire on environment and humanity.

While the 3rd International Wildland Fire Conference will provide the opportunity to exchange ideas and disseminate new information about wildland fire management, it needs a Summit to provide the forum where commitments to action can be sought and attained. It was against this background that the organisers of the Conference, the International Liaison Committee, decided to convene this inaugural International Wildland Fire Summit.

The International Wildland Fire Summit will be held immediately following the 3rd International Wildland Fire Conference on 8 October 2003 under the theme "Fire Management and Sustainable Development: Strengthening International Cooperation to Reduce the Negative Impacts of Fire on Humanity and the Global Environment".

The Summit theme had been selected to underscore the need to address the increasing vulnerability of ecosystems and human populations to uncontrolled wildland fires as well as the inappropriate or excessive application of fire in modifying vegetation cover. Consequently a high priority has been given to find immediate, practical and pragmatic solutions that will enhance international cooperation in wildland fire management.

This background paper provides information on the status and main trends of wildland fire problems at global level.

1. Introduction

Fire is a prominent disturbance factor in most vegetation zones throughout the world. In many ecosystems fire is a natural, essential, and ecologically significant force, organizing physical and biological attributes, shaping landscape diversity, and influencing energy flows and biogeochemical cycles, particularly the global carbon cycle. In some ecosystems, however, fire is an uncommon or even unnatural process that severely damages vegetation and can lead to long-term degradation. Such ecosystems, particularly in the tropics, are becoming increasingly vulnerable to fire due to growing population, economic and land-use pressures. Some recent well-known examples include widespread wildfire occurrence in evergreen rainforests in the Amazon Basin of Brazil, Indonesia, and Central America. Moreover, the use of fire as a land-management tool is deeply embedded in the culture and traditions of many societies, particularly in the developing world. Given the rapidly changing social, economic and environmental conditions occurring in developing countries, marked changes in fire regimes can be expected, with uncertain local, regional, and global consequences. Even in regions where fire is natural (e.g., the boreal zone), more frequent severe fire weather conditions have created recurrent major

[19] Prepared by the Working Group on Wildland Fire, United Nations International Strategy for Disaster Reduction (ISDR), and the Global Fire Monitoring Center (GFMC)

fire problems in recent years. The incidence of extreme wildfire events is also increasing elsewhere the world, with adverse impacts on economies, livelihoods, and human health and safety that are comparable to those associated with other natural disasters such as earthquakes, floods, droughts and volcanic eruptions. Despite the prominence of these events, current estimates of the extent and impact of vegetation fires globally are far from complete. Several hundred million hectares of forest and other vegetation types are estimated to burn annually throughout the world, consuming several billion tons of dry matter and releasing emission compounds that affect the composition and functioning of the global atmosphere and human health. However, the vast majority of these fires are not monitored or documented. Informed policy and decision-making clearly requires timely quantification of fire activity and its impacts nationally, regionally and globally. Such information is currently largely unavailable.

The primary concerns of policy makers focus on questions regarding the regional and global impacts of excessive and uncontrolled burning, broad-scale trends over time, and the options for instituting protocols that will lead to greater control. Other key questions involve determining under what circumstances fires poses a sufficiently serious problem to require action, what factors govern the incidence and impacts of fires in such cases, and what might be the relative costs and benefits of different options for reducing adverse impacts?

2. The Current Extent and Impact of Wildland Fire Globally

2.1 Global Wildland Fire Assessments

The most recent inventory of global fire activity was carried out under the framework of Forest Resources Assessment 2000, conducted by the Food and Agriculture Organization of the United Nations (FAO) for the 1990-2000 period. This report, the *Global Forest Fire Assessment 1990-2000* (FAO 2001), prepared in cooperation with the Global Fire Monitoring Center (GFMC) is the most complete to date, including, for the first time, information on fires in non-forest vegetation types (e.g., savanna fires and agricultural burning).

However, the wildland fire statistics collected are not complete for all countries, in several cases the accuracy of the estimates are unknown and the format is not consistent. Further, statistical datasets providing number of fires and area burned do not begin to meet the level of information required to assess the environmental and economic consequences of wildland fires. For example, current formats for fire statistics collection do not include parameters that would permit conclusions on economic damages or impacts of emissions on the atmosphere or human health. Considering the complexity of pathways of vegetation succession following fire, including the cumulative impacts of anthropogenic and environmental stresses, it is not possible at this time to conclude from existing statistical data whether long-term changes can be expected in terms of site degradation and reduction of carrying capacity of fire-affected sites. Thus, a new system for fire data collection that would meet the requirements of a growing number of different users is urgently needed.

The recently published Global Burned Area Product 2000 derived from a spaceborne sensing system (SPOT Vegetation) is the first important step towards obtaining prototype baseline data on the extent of global wildland fires for the year 2000 (JRC 2002). The accuracy of the satellite-derived data set has also yet to be determined. However initial analysis indicates that approximately 351 million hectares globally were affected by fire in the year 2000. For individual countries the number of fires and area burned differ considerably from the data provided by responsible national agencies. This is likely partially due to the fact that statistical datasets of national agencies in many countries primarily include fire incidences in managed forests; with only a few countries providing fire statistics that cover non-forest ecosystems. Furthermore most countries do not have in place appropriate means to survey wildland fire occurrence impacts. On the other hand the area burned, as derived from the spaceborne instrument, also does not provide information on the environmental, economic or humanitarian impacts of fire. An appropriate interpretation of satellite-generated fire information requires additional information layers, particularly on ecosystem vulnerability and recovery potential; that are not yet available at a global level.

Major conclusions of the 1990-2000 Global Forest Fire Assessment can be summarized as follows:

- Drought years in the 1990s caused widespread burning in tropical rainforests with significant impacts on natural resources, public health, transportation, navigation and air quality.
- While many countries, and regions, have a well-developed system for documenting, reporting and evaluating wildfire statistics in a systematic manner, but lack information on the effects of these fires,

many other countries do not yet have such a system, largely because of more pressing social issues. Satellite systems have been used effectively to map active fires and burned areas, especially in remote areas where other damage assessment capabilities are not available.

- Even those countries supporting highly financed fire management organizations are not exempt from the ravages of wildfires in drought years. When wildland fuels have accumulated to high levels, no amount of firefighting resources can make much of a difference until the weather moderates (as observed in the United States in the 2000 fire season).
- Uncontrolled use of fire for forest conversion, agricultural and pastoral purposes continues to cause a serious loss of forest resources, especially in tropical areas.
- Some countries are beginning to realize that inter-sectoral coordination of land use policies and practices is an essential element in reducing wildfire losses. There were numerous examples in the 1990s of unprecedented levels of inter-sectoral and international cooperation in helping to lessen the impact of wildfires on people, property and natural resources.
- Examples exist where sustainable land use practices and the participation of local communities in integrated forest fire management systems are being employed to reduce resource losses from wildfires.
- In some countries, volunteer rural fire brigades are successful in responding quickly and efficiently to wildfires within their home range; and residents are taking more responsibility to ensure that homes will survive wildfires.
- Although prescribed burning is being used in many countries to reduce wildfire hazards and achieve resource benefits, other countries have prohibitions against the use of prescribed fire.
- Fire ecology principles and fire regime classification systems are being used effectively as an integral part of resource management and fire management planning.
- Fire research scientists have been conducting cooperative research projects on a global scale to improve understanding of fire behaviour, fire effects, fire emissions, climate change and public health.
- Institutions like the Global Fire Monitoring Center have been instrumental in bringing the world's fire situation to the attention of a global audience via the Internet.

In reviewing the global fire situation, it is apparent that a continued emphasis on the emergency response side of the wildfire problem will not address current needs and will only result in a continuation of the current trend towards large and damaging fires in the future. The solution to the emergency response dilemma is to couple emergency preparedness and response programmes with more sustainable land use policies and practices. Only when sustainable land use practices and emergency preparedness measures complement each other will long-term natural resource benefits for society be realized.

2.2 Global Observation and Monitoring of Wildland Fires

From the changing role of fire in the different vegetation zones described above it can be concluded that fire management is becoming increasingly important with respect to global issues of resource management, disaster reduction and global change. With this increasing importance comes the need for a concerted effort to put in place the international global observation and monitoring systems needed to give early warning and identify disastrous fire events, inform policy making and to support sustainable resource management and global change research (Justice 2001). The observation systems will need to include both ground based and space based monitoring components. Advances in information technology now make it easier to collect and share data necessary for emergency response and environmental management. Current satellite assets are under-utilized for operational monitoring and fire monitoring falls largely in the research domain. Increasing attention needs to be given to data availability, data continuity, data access and how the data are being used to provide useful information.

There is no standard *in-situ* measurement/reporting system and national reporting is too variable and inadequate to provide a regional or global assessment. It is also often hard to relate the satellite and *in-situ* data reporting. Reliable information is needed to inform policy and decision making, and management policies should be developed based in part on a scientific understanding of their likely impacts. Fora are needed for exchange of information on monitoring methods, use of appropriate technology, policy and management options and solutions. A continued and informed evaluation of existing monitoring systems, and a clear articulation of monitoring requirements and operational prototyping of improved methods, is also required.

The Global Observation of Forest Cover / Global Observation of Land Dynamics (GOFC/GOLD) program, a part of the Global Terrestrial Observing System (GTOS), is designed to provide such a forum. The GTOS, which is sponsored by the International Global Observing System Partners, has its Secretariat at the FAO in Rome. GOFC/GOLD has its Secretariat in the Canadian Forest Service. The GOFC/GOLD Program is an international coordination mechanism to enhance the use of earth-observation information for policy, natural resource management and research. It is intended to link data producers to data users, to identify gaps and overlaps in observational programs, and recommend solutions. The program will provide validated information products, promote common standards and methods for data generation and product validation and stimulate advances in the management and distribution of large volume datasets. Overall it is intended to advance our ability to obtain and use environmental information on fires and secure the long-term observation and monitoring systems.

GOFC/GOLD has three implementation teams: fire, land cover and biophysical characterization. The principal role of GOFC/GOLD is to act as a coordinating mechanism for national and regional activities (Justice et al. 2003). To achieve its goals GOFC/GOLD has developed a number of regional networks of fire data providers, data brokers and data users. These networks of resource managers and scientists provide the key to sustained capability for improving the observing systems and ensuring that the data are being used effectively. GOFC/GOLD regional networks are being implemented through a series of regional workshops. These regional network workshops are used to engage the user community to address regional concerns and issues, provide a strong voice for regional needs and foster lateral transfer of technology and methods within and between regions. Networks are currently being developed in Central and Southern Africa, Southeast Asia, Russia and the Far East and Central and South America.

The GOLD-Fire program has a number of stated goals:

- To increase user awareness by providing an improved understanding of the utility of satellite fire products for resource management and policy within the United Nations and at regional national and local levels.
- To encourage the development and testing of standard methods for fire danger rating suited to different ecosystems and to enhance current fire early warning systems.
- To establish an operational network of fire validation sites and protocols, providing accuracy assessment for operational products and a test bed for new or enhanced products, leading to standard products of known accuracy.
- To enhance fire product use and access for example by developing operational multi-source fire and GIS data and making these available over the Internet.
- To develop an operational global geostationary fire network providing observations of active fires in near real time.
- To establish operational polar orbiters with fire monitoring capability. Providing a) operational moderate resolution long-term global fire products to meet user requirements and distributed ground stations providing enhanced regional products. These products should include fire danger, fuel moisture content, active fire, burned area and fire emissions. b) operational high resolution data acquisition allowing fire monitoring and post-fire assessments.
- To create emissions product suites, developed and implemented providing annual and near real-time emissions estimates with available input data.

It is particularly important to improve the quality, scope, and utility of GOFC-Fire inputs to the various user communities through:

- gaining a better understanding of the range of users of fire data, their needs for information, how they might use such information if it was available, and with what other data sets such information might be linked;
- increasing the awareness of users with respect to the potential utility of satellite products for global change research, fire policy, planning and management; and
- based on ongoing interaction with representatives of the various user communities developing enhanced products.

2.3 Vegetation Fire Emissions: Atmosphere, Climate and Human Health

Research efforts under the Biomass Burning Experiment (BIBEX) of the International Geosphere-Biosphere Programme (IGBP), International Global Atmospheric Chemistry (IGAC) Project, and a large number of other projects in the 1990s were successful in the sampling and quantification of fire emissions, and the determination of emission factors for various fuel types. However, global and regional emission estimates are still problematic, mostly because of uncertainties regarding amounts burned. Most recent estimates indicate that the amount of vegetative biomass burned annually is in the magnitude of 9.2 billion tons (Andreae and Merlet 2001, Andreae 2002).

Vegetation fires produce a range of emissions that influence the composition and functioning of the atmosphere. The fate of carbon contained in fire-emitted carbon dioxide (CO_2) and other radiatively active trace gases is climatically relevant only when there is no regrowth of vegetation - e.g., deforestation or degradation of sites. Alternatively, NO_x, CO, CH_4, and other hydrocarbons are ingredients of smog chemistry, contribute to tropospheric ozone formation and act as "greenhouse gases", while halogenated hydrocarbons (e.g. CH_3Br) have considerable impact on stratospheric ozone chemistry and contribute to ozone depletion.

Fire-emitted aerosols influence climate directly and indirectly. Direct effects include (a) backscattering of sunlight into space, resulting in increased albedo and a cooling effect, and (b) absorption of sunlight which leads to cooling of the Earth's surface and atmospheric warming. As a consequence convection and cloudiness are reduced as well as evaporation from ocean and downwind rainfall. The key parameter in these effects is the black carbon content of the aerosol and its mixing state.

Indirect effects of pyrogenic aerosols are associated with cloud formation. Fire-emitted aerosols lead to an increase of Cloud Condensation Nuclei (CCN) that are functioning as seeds for droplet formation. Given a limited amount of cloud water content this results in an increase of the number of small droplets. As a first consequence clouds become whiter, reflect more sunlight, thus leading to a cooling effect. As a second indirect effect of "overseeding" the overabundance of CCN coupled with limited amount of cloud water will reduce the formation of droplets that are big enough (radius ~14 µm) to produce rain; consequently rainfall is suppressed. In conclusion it can be stated that

- The fire and atmospheric science community has made considerable progress in determining emission factors from vegetation fires
- Global and regional emission estimates are still problematic, mostly because of uncertainties regarding amounts of area and vegetative matter burned
- Fire is a significant driver of climate change (as well as a human health risk)
- Fire, climate, and human actions are highly interactive
- Some of these interactions may be very costly both economically and ecologically

Smoke from burning of vegetative matter contains a large and diverse number of chemicals, many of which have been associated with adverse health impacts (Goh et al. 1999). Nearly 200 distinct organic compounds have been identified in wood smoke aerosol, including volatile organic compounds and polycyclic aromatic hydrocarbons. Available data indicate high concentrations of inhalable particulate matter in the smoke of vegetation fires. Since particulate matter produced by incomplete combustion of biomass are mainly less than 1 micrometers in aerodynamic diameter, both PM_{10} and $PM_{2.5}$ (particles smaller than 2.5 micrometers in aerodynamic diameter) concentrations increase during air pollution episodes caused by vegetation fires. Carbon monoxide and free radicals may well play a decisive role in health effects of people who live and/or work close to the fires.

Inhalable and thoracic-suspended particles move further down into the lower respiratory airways, and can remain there for a longer period of time, leaving deposits. The potential for health impacts in an exposed population depends on individual factors such as age and the pre-existence of respiratory and cardiovascular diseases and infections, and on particle size. Gaseous compounds adsorbed or absorbed by particles can play a role in long-term health effects (cancer) but short-term health effects are essentially determined through particle size. Quantitative assessment of health impacts of air pollution associated with vegetation fires in developing countries is often limited by the availability of baseline morbidity and mortality information. Air pollutant data are of relatively higher availability and quality but sometimes even these data are not available or reliable.

Vegetation fire smoke sometimes overlies urban air pollution, and exposure levels are intermediate between ambient air pollution and indoor air pollution from domestic cooking and heating. Because the effects of fire

events are nation- and region-wide, a "natural" disaster can evolve into a more complex emergency, both through population movement and through its effects on the economy and security of the affected countries. The fire and smog episodes in South East Asia during the El Niño of 1997-98, in the Far East of the Russian Federation in 1998, and again in Moscow Region in 2002, are striking examples.

The World Health Organization (WHO), in collaboration with the United Nations Environmental Programme (UNEP) and the World Meteorological Organization (WMO), has issued comprehensive guidelines for Governments and responsible authorities on actions to be taken when their population is exposed to smoke from fires (Schwela et al. 1999). The Guidelines give insights into acute and chronic health effects of air pollution due to biomass burning, advice on effective public communications and mitigation measures, and guidance for assessing the health impacts of vegetation fires. They also provide measures on how to reduce the burden of mortality and preventable disability suffered particularly by the poor, and on the development and implementation of an early air pollution warning system.

3. Changing Fire Regimes

The following sections provide a review on changing fires regimes in some of the most important global vegetation zones, the northern boreal forest, temperate forests, tropical rainforest and tropical / subtropical savanna regions.

3.1 The Fire Situation in Boreal Forests

The global boreal forest zone, covering approximately 12 million square kilometers, stretches in two broad transcontinental bands across Eurasia and North America, with two-thirds in Russia and Scandinavia and the remainder in Canada and Alaska. With extensive tracts of coniferous forest that have adapted to, and become dependent upon, periodic fire for their physiognomy and sustainable existence, and that provide a vital natural and economic resource for northern circumpolar countries, boreal forests are estimated to contain ~37% of the world's terrestrial carbon. These forests have become increasingly accessible to human activities, including natural resource exploitation and recreation, over the past century, with the export value of forest products from global boreal forests accounting for 47% of the world total.

The largest boreal forest fires are extremely high-intensity events, with very fast spread rates and high levels of fuel consumption, particularly in the deep organic forest floor layer. High intensity levels are often sustained over long burning periods, creating towering convection columns that can reach the upper troposphere and lower stratosphere, making long range smoke transport common. In addition, the area burned annually by boreal fires is highly episodic, often varying by an order of magnitude between years.

For many reasons boreal forests and boreal fires have increased in significance in a wide range of global change science issues in recent years. Climate change is foremost among these issues, and the impacts of climate change are expected to be most significant at northern latitudes. Forest fires can be expected to increase sharply in both incidence and severity if climate change projections for the boreal zone prove accurate, acting as a catalyst to a wide range of processes controlling boreal forest carbon storage, causing shifting vegetation, altering the age class structure towards younger stands, and resulting in a direct loss of terrestrial carbon to the atmosphere.

Over the past two decades forest fires in boreal North America (Canada and Alaska) have burned an average of 3 million hectares annually. While sophisticated and well-funded fire management programs in North America suppress the vast majority of fires while small, the 3% of the fires that grow larger than 200 hectares in size account for 97% of the total area burned. There is little likelihood of improving suppression effectiveness since the law of diminishing returns applies here – the 3% of fires that grow larger do so because they occur under extreme fire danger conditions and/or in such numbers that suppression resources are overwhelmed, and applying more funding would have no effect. In addition, Canada and Alaska have vast northern areas which are largely unpopulated and with no merchantable timber, and where fires are monitored but suppression is unwarranted and not practiced, allowing natural fire where possible. Combining the current high levels of fire activity across the North American boreal zone, with restricted suppression effectiveness and a recognition of the need for natural fire, it is all but certain that climate change will greatly exacerbate the situation, and the only option will be adaptation to increasing fire regimes (e.g. Kasischke and Stocks 2000).

The fire problem in Eurasia's boreal forests – primarily in Russia - is similar in some ways to the North American situation, but there are significant differences (Goldammer and Furyaev 1996; Goldammer and

Stocks 2000; Shvidenko and Goldammer 2001). The Russian boreal zone is close to twice as large as its North American counterpart, stretching across eleven time zones, with a wide diversity of forest types, growing conditions, structure and productivity, and anthropogenic impacts that define different types of fires and their impacts. For example, surface fires are much more common in the Russian boreal zone than in North America where stand-replacing crown fires dominate the area burned, and many Russian tree species have adapted to low-intensity fires. While Canada has a strong continental climate in the boreal region of west-central Canada, where most large fire activity occurs, Eurasia has much stronger continentality over a much larger land base. The climate of the major land area of the Russian Federation is characterized by low precipitation and/or frequent droughts during the fire season, and more extreme fire danger conditions over a much larger area. In addition, large areas of the Russian boreal zone are not protected or monitored, so fire activity is not recorded for these regions.

Official Russian fire statistics for the past five decades typically report annual areas burned between 0.5 and 1.5 million hectares, with very little inter-annual variability. In fact, as Russian fire managers agree, these numbers are a gross underestimation of the actual extent of boreal fire in Russia. There are two reasons for this: a lack of monitoring/documentation of fires occurring in vast unprotected regions of Siberia, and the fact that the Russian reporting structure emphasized under-reporting of actual area burned to reward the fire suppression organization. In recent years, with the advent of international satellite coverage of Russian fires in collaboration with Russian fire scientists, more realistic area burned estimates are being generated. For example, during the 2002 fire season satellite imagery revealed that about 12 million hectares of forest and non-forest land had been affected by fire in Russia, while official sources report only 1.2 million hectares of forests and 0.5 million hectares of non-forest land burned in the protected area of 690 million hectares (Goldammer 2003; Davidenko and Eritsov 2003; Sukhinin et al. 2003). During the early summer of 2003 remote sensing data indicate a total vegetated area affected by fire in Russia exceeding 22 million hectares (GFMC 2003). Based on recent remote sensing data, it appears that the annual area burned in Russia can vary between 2 and 15 million hectares/year.

In recent years there has been an increase in the occurrence of wildfires under extreme drought conditions (e.g. the Trans-Baikal Region in 1987 and the Far East in 1998), and the severity of these fires will greatly disturb natural recovery cycles. There is growing concern that fires on permafrost sites will lead to the degradation or disappearance of eastern Siberian larch forests. Russia has close to 65% of the global boreal forest, an economically and ecologically important area that represents the largest undeveloped forested area of the globe. With the vast quantities of carbon stored in these forests, Russian forests play a critical role in the global climate system and global carbon cycling. Projected increases in the severity of the continental climate in Russia suggest longer fire seasons and much higher levels of fire danger. The inevitable result will be an increase in the number, size, and severity of boreal fires, with huge impacts on the global carbon cycle and the Russian economy.

At the same time, recent political and economic changes in Russia have led to an extreme reduction in their fire suppression capability, with the State Forest Service showing a huge debt, and the outlook for future funding increases bleak. As a result, *Avialesookhrana*, the aerial fire protection division of the Forest Service, has been forced to reduce aerial fire detection and suppression levels, with operational aircraft flying hours and firefighter numbers now less than 50% of 1980s levels. Consequently, the occurrence of larger fires is increasing, and the areas being burned annually are unprecedented in recent memory.

Increasing fire risks in the boreal forests of Russia are a major threat to the global carbon budget, and this requires significant national and international attention (Kajii et al. 2003). Management and protection of these vital resources should not be given solely to the private sector or delegated to regional levels. The establishment and strengthening of a central institution to protect forests must be a priority supported by Russia and the international community.

Recent Intergovernmental Panel on Climate Change (IPCC) reports have emphasized the fact that climate change is a current reality, and that significant impacts can be expected, particularly at northern latitudes, for many decades ahead. Model projections of future climate, at both broad and regional scales, are consistent in this regard. An increase in boreal forest fire numbers and severity, as a result of a warming climate with increased convective activity, is expected to be an early and significant consequence of climate change. Increased lightning and lightning fire occurrence is expected under a warming climate. Fire seasons are expected to be longer, with an increase in the severity and extent of the extreme fire danger conditions that drive major forest fire events. Increased forest fire activity and severity will result in shorter fire return intervals, a shift in forest age class distribution towards younger stands, and a resultant decrease in terrestrial carbon storage in the boreal zone. Increased fire activity will also likely produce a positive feedback to climate change, and

will drive vegetation shifting at northern latitudes. The boreal zone is estimated to contain 35-40% of global terrestrial carbon, and any increase in the frequency and severity of boreal fires will release carbon to the atmosphere at a faster rate than it can be re-sequestered. This would have global implications, and must be considered in post-Kyoto climate change negotiations.

Increased protection of boreal forests from fire is not a valid option at this time. Fire management agencies are currently operating a maximum efficiency, controlling unwanted fires quite effectively. There is a law of diminishing effects at work here though, as increasing efficiency would require huge increases in infrastructure and resources. While it is physically and economically impossible to further reduce the area burned by boreal fires, it is also not ecologically desirable, as fire plays a major and vital role in boreal ecosystem structure and maintenance. Given these facts, it would appear that, if the climate changes as expected over the next century, northern forest managers will have to constantly adapt to increasing fire activity. The likely result would be a change in protection policies to protect more valuable resources, while permitting more natural fire at a landscape scale (Stocks et al. 2001; Stocks 2001).

3.2 The Fire Situation in Temperate Forests

In recent years fires have been increasing in number and severity across the temperate zone, with significant fire events becoming more common in the United States, the Mediterranean Basin, and Mongolia for example.

Temperate North America: The United States

Over most of the past century the United States has made a huge investment in wildland fire management, developing a sophisticated fire suppression capability. As the 1900s progressed, the United States became increasingly effective in excluding fire from much of the landscape. Despite numerous human-caused and lightning fires the area burned was greatly reduced from the early 1990s. However, the price for successful fire exclusion has proven to be twofold. The most obvious price was the huge cost of developing and maintaining fire management organizations that were increasingly requiring higher budgets to keep fire losses at an acceptable level. The second cost, hidden for decades, is now apparent, as the policy emphasis on fire exclusion has led to the build-up of unnatural accumulations of fuels within fire-dependent ecosystems, with the result that recent fires burn with greater intensity and have proven much more difficult to control. Despite extensive cooperation from other countries, and huge budget expenditures, intense droughts in 2000 and 2002 contributed to widespread wildfires in the western United States that burned between 2.5 and 3 million hectares in each year. Losses from these fires now include substantial destruction of homes, as the trend towards living in fire-prone environments grows, and the wildland urban interface is expanding.

The Mediterranean Basin and the Balkans

Within the Mediterranean Basin fire is the most important natural threat to forests and wooded areas. Mediterranean countries have a relatively long dry season, lasting between one and three months on the French and Italian coasts in the north of the Mediterranean, and more than seven months on the Libyan and Egyptian coasts to the south. Currently, approximately 50,000 fires burn throughout the Mediterranean Basin, and burn over an annual average of 600,000 hectares; both statistics are at a level twice that of the 1970s. In countries where data is continuous since the 1950s, fire occurrence and area burned levels have shown large increases since the 1970s in Spain, Italy, and Greece. Human-caused fires dominate in the Mediterranean Basin, with only 1-5% of fires caused by lightning. Arson fires are also quite prevalent.

Paradoxically, the fundamental cause of the increasing vulnerability of vegetation of the Southern European countries bordering the Mediterranean Basin is linked to increased standards of living among the local populations (Alexandrian et al. 2000). Far-reaching social and economic changes in Western Europe have led to a transfer of population from the countryside to the cities, a considerable deceleration of demographic growth, an abandonment of arable lands, and a disinterest in the forest resource as a source of energy. This has resulted in the expansion of wooded areas, erosion of the financial value of wooded lands, a loss of inhabitants with a sense of responsibility for the forest, and a resultant increase in the amount of available fuel.

The demographic, socio-economic and political changes in many countries of Southeast Europe and the neighbouring nations of the Balkans have resulted in an increase of wildfire occurrence, destabilization of fire management capabilities and increased vulnerability of ecosystems and human populations. The main reasons for this development include the transition from centrally-planned to market economies, national to regional conflicts, creation of new nations involving political tensions and war, land-use changes, and regional climate

change towards an increase in the frequency of extreme droughts. New solutions are required to address the increasing fire threat on the Balkans. Regional cooperation in the Mediterranean Region and the Balkans must address the underlying causes of changing fire regimes and a more economic trans-national use of fire management resources (Goldammer 2001b).

Temperate Steppes to Boreal Forests: Mongolia

With an area of 1,565,000 square kilometers and a population of 2.3 million, Mongolia is one of the least populated countries in the world, yet significant fire problems exist there. With an extremely continental climate, poor soil fertility and a lack of surface water, wildfires in Mongolia have become a major factor in determining the spatial and temporal dynamics of forest ecosystems. Of a total of 17 million hectares of forests, 4 million hectares are estimated to be disturbed, primarily by fire (95%) and logging (5%). Forests are declining in Mongolia as continual degradation by wildfire turns former forests into steppe vegetation. The highest fire hazard occurs in the submontane coniferous forests of eastern Mongolia, where highly flammable fuels, long droughts, and economic activity are most common. In recent years fire activity in Mongolia has increased significantly, due to economic activity on lands once highly controlled or restricted. In Mongolia, only 50-60 forest fires and 80-100 steppe fires occur annually on average. The major underlying cause of increasing wildfires is the fact that urban people are now seeking a livelihood in forests due to the collapse of the industrial sector. During the 1996 to 1998 period, when winter and spring seasons were particularly dry, Mongolia experienced large-scale forest and steppe fires that burned over 26.3 million hectares of forest and steppe vegetation, including pasture lands, causing significant losses of life, property and infrastructure. The loss of forest land in Mongolia is increasing, with severe economic consequences, and a growing realization that a precious ecological resource which contains virtually all rivers, protects soils and rangelands, and provides essential wildlife habitat is at risk.

Australia: New Vulnerabilities

Australia's fire problems are currently a growing focus of fire managers and policy makers in the Australasian region. The continent is facing a dilemma: On the one hand Australia's wildlands have evolved with fire and thus are extremely well adapted to fire. In the late 1990s more than 345,000 wildfires burned an average of ca. 50 million hectares of different vegetation types every year. In many of Australia's wildlands frequent fires of moderate intensity and severity are important to maintain properties and functioning of ecosystems and to reduce the accumulation of highly flammable fuels. Thus, it is generally accepted that fire protection (fire exclusion) in Australia's wildlands will lead to fuel accumulation and, inevitably, to uncontrollable wildfires of extreme behaviour, intensity and severity. These ecosystems need to be burned by natural sources or by prescribed fire.

On the other hand there is a trend towards the building of homes and infrastructure in the wildlands around Australian cities. This exurban settlement trend has created new vulnerabilities and conflicts concerning the use of fire as a management tool. The extended wildfires occurring in the Southeast of Australia (New South Wales, A.C.T., Victoria) in 2002 and 2003 had limited impacts on native vegetation but had a significant impact on values at risk at the wildland-residential interface as well as on plantation forests.

3.3 Tropical Rainforests

Fires in tropical evergreen forests, until recently, were considered either impossible or inconsequential. In recent decades, due to population growth and economic necessity, rainforest conversion to non-sustainable rangeland and agricultural systems has proliferated throughout the tropics (Mueller-Dombois and Goldammer 1990; UNEP 2002). The slash-and-burn practices involve cutting rainforests to harvest valuable timber, and burning the remaining biomass repeatedly to permanently convert landscapes into grasslands that flourish for a while due to ash fertilization, but eventually are abandoned as non-sustainable, or to convert rainforest to valuable plantations. Beyond this intentional deforestation there is a further, more recent problem, as wildfires are growing in frequency and severity across the tropics. Fires now continually erode fragmented rainforest edges and have become an ecological disturbance leading to degradation of vast regions of standing forest, with huge ecological, environmental, and economic consequences. It is clear that, in tropical rainforest environments, selective logging leads to an increased susceptibility of forests to fire, and that the problem is most severe in recently logged forests. Small clearings associated with selective logging permit rapid desiccation of vegetation and soils increase this susceptibility to fire. Droughts triggered by the El-Niño-Southern Oscillation (ENSO) have exacerbated this problem, and were largely responsible for significant wildfire disasters in tropical rainforests during the 1980s and 1990s.

Tropical rainforests cover ~45% of Latin America and the Caribbean. Between 1980 and 1990, when the first reliable estimates were made, the region lost close to 61 million hectares of forest, 6% of the total forested area. During the 1990-1995 period a further 30 million hectares were lost. The highest rates of deforestation occurred in Central America (2.1% per year) but Bolivia, Ecuador, Paraguay and Venezuela also had deforestation rates above 1% per year, while Brazil lost 15 million hectares of forest between 1988 and 1997.

Landscape fragmentation and land cover change associated with this massive deforestation combine to expose more forest to the risk of wildfire, and fires are increasing in severity and frequency, resulting in widespread forest degradation. This change in tropical fire regimes will likely result in the replacement of rainforests with less diverse and more fire-tolerant vegetation types. Although quantitative area burned estimates are sporadic at best, it is estimated that the 1997-1998 El Niño-driven wildfires burned more than 20 million hectares in Latin America and Southeast Asia The widespread tropical rainforest wildfires of 1998 have changed the landscape of Latin America's tropical evergreen forests by damaging vast forested areas adjacent to fire-maintained ecosystems, such that fires will likely become more severe in the near future, a fact not yet appreciated by resident populations, fire managers, and policy makers. The Latin American and Indonesian problems have much in common, and indicate the problems in tropical rainforests worldwide.

Smoke pollution from tropical rainforest fires, as is the case in many other fire regions of the world, greatly affects the health of humans regionally, with countless short- and long-term respiratory and cardiovascular problems resulting from the lingering smoke and smog episodes associated with massive wildfires.

The environmental impacts from tropical forest fires range from local to global. Local/regional impacts include soil degradation, with increased risks of flooding and drought, along with a reduced abundance of wildlife and plants, and an increased risk of recurrent fires. Global impacts include the release of large amounts of greenhouse gases, a net loss of carbon to the atmosphere, and meteorological effects including reduced precipitation and increased lightning. A loss of biodiversity and extinction of species is also a major concern.

The economic costs of tropical forest fires are unknown, largely due to a lack of data, but also attributable to the complications of cause and effect: negative political implications definitely discourage full disclosure. These can include medical costs, transportation disruption, and timber and erosion losses. They can also, in the post-Kyoto era, include lost carbon costs which, in the case of the 1998 fires in Latin America, can be crudely estimated at $10-15 billion.

The driving force behind the devastating Indonesian fires of 1982-1983 and 1997-1998 was droughts associated with ENSO, in combination with the exposure of rainforest areas to drought as a result of selective logging. It has been estimated that the overall land area affected by the 1982-1983 fires, in Borneo alone, was in excess of 5 million hectares. In non-ENSO years fires cover 15,000-25,000 hectares. The 1997-1998 fire episode that exceeded the size and impact of the 1982-1983 fires. During 1997 large fires occurred in Sumatra, West and Central Kalimantan, and Irian Jaya/Papua. In 1998 the greatest fire activity occurred in East Kalimantan. In total, the 1997-1998 fires covered an estimated area in excess of 9.5 million hectares, with 6.5 million hectares burning in Kalimantan alone. These widespread fires, all caused by humans involved in land speculation and large-scale forest conversion, caused dense haze across Southeast Asia for an extended period. Severe respiratory health problems resulted, along with widespread transport disruption, and overall costs were estimated at US$9.3 billion. Carbon losses were particularly severe due to high levels of fuel consumption, particularly in peatlands.

3.4 Southern African Savannas/Grasslands

Fire is a widespread seasonal phenomena in Africa (van Wilgen et al. 1997). South of the equator, approximately 168 million hectares burn annually, nearly 17% of a total land base of 1014 million hectares, accounting for 37% of the dry matter burned globally. Savanna burning accounts for 50% of this total, with the remainder caused by the burning of fuelwood, agricultural residues, and slash from land clearing. Fires are started both by lightning and humans, but the relative share of fires caused by human intervention is rapidly increasing. Pastoralists use fire to stimulate grass growth for livestock, while subsistence agriculturalists use fire to remove unwanted biomass while clearing agricultural lands, and to eliminate unused agricultural resides after harvest. In addition, fires fuel by wood, charcoal or agricultural residues are the main source of domestic energy for cooking and heating.

In most African ecosystems fire is a natural and beneficial disturbance of vegetation structure and composition, and in nutrient recycling and distribution. Nevertheless, substantial unwarranted and uncontrolled burning does occur across Africa, and effective actions to limit this are necessary to protect life, property, and fire-sensitive natural resources, and to reduce the current burden of emissions on the atmosphere with subsequent adverse effects on the global climate system and human health. Major problems arise at the interface between fire savannas, residential areas, agricultural systems, and those forests which are not adapted to fire. Although estimates of the total economic damage of African fires are not available, Ecologically and economically important resources are being increasingly destroyed by fires crossing borders from a fire-adapted to a fire-sensitive environment. Fire is also contributing to widespread deforestation in many southern African countries.

Most southern African countries have regulations governing the use and control of fire, although these are seldom enforced because of difficulties in punishing those responsible. Some forestry and wildlife management agencies within the region have the basic infrastructure to detect, prevent and suppress fires, but this capability is rapidly breaking down and becoming obsolete. Traditional controls on burning in customary lands are now largely ineffective. Fire control is also greatly complicated by the fact that fires in Africa occur as hundreds of thousands of widely dispersed small events. With continuing population growth and a lack of economic development and alternative employment opportunities to subsistence agriculture, human pressure on the land is increasing, and widespread land transformation is occurring. Outside densely settled farming areas, the clearance of woodlands for timber, fuelwood and charcoal production is resulting in increased grass production, which in turn encourages intense dry season fires that suppress tree regeneration and increase tree mortality. In short, the trend is toward more fires.

Budgetary constraints on governments have basically eliminated their capacity to regulate from the centre, so there is a trend towards decentralization. However, the shortage of resources forcing decentralization means there is little capacity for governments to support local resource management initiatives. The result is little or no effective management and this problem is compounded by excessive sectoralism in many governments, leading to uncoordinated policy development, conflicting policies, and a duplication of effort and resources. As a result of these failures, community-based natural resource management is now being increasingly widely implemented in Africa, with the recognition that local management is the appropriate scale at which to address the widespread fire problems in Africa. The major challenge is to create an enabling rather than a regulatory framework for effective fire management in Africa, but this is not currently in place. Community-based natural resource management programs, with provisions for fire management through proper infrastructure development, must be encouraged. More effective planning could also be achieved through the use of currently available remotely sensed satellite products.

These needs must also be considered within the context of a myriad of problems facing governments and communities in Africa, including exploding populations and health (e.g. the AIDS epidemic). While unwarranted and uncontrolled burning may greatly affect at the local scale, it may not yet be sufficiently important to warrant the concern of policy makers, and that perception must be challenged as a first step towards more deliberate, controlled and responsible use of fire in Africa.

3.5 Global Peatlands

The world's peatlands play a significant role in biodiversity patterns, socio-economic development and livelihood, water storage and supply, flood control, and climate regulation. Peatlands are fragile ecosystems vulnerable to fire, and impacted heavily by uncontrolled drainage (Parish et al. 2002). The increased conversion of forests on tropical peat lands to agricultural cultivations and the presence of large areas of drained peatlands in the boreal zone of is a growing concern for fire managers. Peat soils can reach a depth of 10 metres or more and thus contain burnable volumes in excess of 100,000 cubic metres of biomass per hectare.

Recent fire episodes in the tropical and boreal peat-swamp biomes have revealed that the combination of extreme droughts, especially in conjunction with the El Niño phenomenon or extended summer droughts in boreal Eurasia, lead to severe and often irreversible damages of wetland ecosystems, transfer of terrestrial carbon to the atmosphere and to severe smoke pollution affecting human health and security.

Projected regional climate changes, coupled with continuing trends of land-use changes, indicate that the vulnerability of peatlands will increase and the loss of peatlands by excessive, uncontrolled fire will accelerate.

However, there are options to proactively protect and maintain peatlands. To avoid major fire disasters in peatlands, there is a need to educate land managers in these areas about best fire management practices on peat soils.

Peat is a renewable natural resource, which will regenerate if the burned area is rehabilitated and properly protected, even if the re-accumulation of peat is a fairly slow process.

4. Conclusions: Policy and Wildland Fire Science

The challenge of developing informed policy that recognizes both the beneficial and traditional roles of fire, while reducing the incidence and extent of uncontrolled burning and its adverse impacts, clearly has major technical, social, economic and political elements. In developing countries better forest and land management techniques are required to minimize the risk of uncontrolled fires, and appropriate management strategies for preventing and controlling fires must be implemented if measurable progress is to be achieved. In addition, enhanced early warning systems for assessing fire hazard and estimating risk are necessary, along with the improvements in regional capacity and infrastructure to use satellite data. This must be coupled with technologies and programs that permit rapid detection and response to fires.

A better understanding by both policy-makers and the general population of the ecological, environmental, socio-cultural, land-use and public-health issues surrounding vegetation fires is essential. The potential for greater international and regional co-operation in sharing information and resources to promote more effective fire management also needs to be explored. The recent efforts of many UN programmes and organizations are a positive step in this direction, but much remains to be accomplished. In the spirit and fulfilment of the 1997 Kyoto Protocol to United Nations Framework Convention on Climate Change, the 2002 World Summit for Sustainable Development (WSSD) and the UN International Strategy for Disaster Reduction (ISDR), there is an obvious need for more reliable data on fire occurrence and impacts. Remote sensing must and should play a major role in meeting this requirement. In addition to the obvious need for improved spaceborne fire-observation systems and more effective operational systems capable of using information from remote sensing and other spaceborne technologies, the remote sensing community needs to focus its efforts more on the production of useful and meaningful products.

Finally, it must be underscored that the traditional approach in dealing with wildland fires exclusively under the traditional forestry schemes must be replaced in future by an inter-sectoral and interdisciplinary approach. The devastating effects of many wildfires are an expression of demographic growth, land-use and land-use changes, the socio-cultural implications of globalisation, and climate variability. Thus, integrated strategies and programmes must be developed to address the fire problem at its roots, while at the same time creating an enabling environment and develop appropriate tools for policy and decision makers to proactively act and respond to fire.

What are the implications of these conclusions on fire science? Back in the early 1990s the first major inter-disciplinary and international research programmes, including inter-continental fire-atmosphere research campaigns such as the Southern Tropical Atlantic Regional Experiment (STARE) with the Southern Africa Fire-Atmosphere Research Initiative (SAFARI) in the early 1990s (JGR 1996), clearly paved the way to develop visions and models for a comprehensive science of the biosphere. At the beginning of the 3rd millennium it is recognized that progress has been achieved in clarifying the fundamental mechanisms of fire in the global environment, including the reconstruction of the prehistoric and historic role of fire in the genesis of planet Earth and in the co-evolution of the human race and nature.

However, at this stage we have to examine the utility of the knowledge that has been generated by a dedicated science community. We have to ask this at a time when it is becoming obvious that fire plays a major role in the degradation of the global environment. It follows from the statement of Pyne (2001) "*Fire has the capacity to make or break sustainable environments. Today some places suffer from too much fire, some from too little or the wrong kind, but everywhere fire disasters appear to be increasing in both severity and damages*" that we must ask whether wildland fire is becoming a major threat at the global level? Does wildland fire at a global scale contribute to an increase of exposure and vulnerability of ecosystems to secondary / associated degradation and even catastrophes?

The regional analyses provided in this paper reveal that environmental destabilization by fire is obviously accelerating. This trend goes along with an increasing vulnerability of human populations. Conversely, humans

are not only affected by fire but are the main causal agent of destructive fires, through both accidental, unwanted wildfires, and the use of fire as a tool for conversion of vegetation and reshaping whole landscapes.

This trend, however, is not inevitable. There are opportunities to do something about global fire because – unlike the majority of the geological and hydro-meteorological hazards – wildland fires represent a natural hazard which is primarily human-made, can be predicted, controlled and, in many cases, prevented.

Here is the key for the way forward. Wildland fire science has to decide its future direction by answering a number of basic questions: What is the future role of fundamental fire science, and the added value of additional investments? What can be done to close the gap between the wealth of knowledge, methods and technologies for sustainable fire management and the inability of humans to exercise control?

From the perspective of the authors the added value of continuing fundamental fire science is marginal. Instead, instruments and agreed procedures need to be identified to bring existing technologies to application. Costs and impacts of fire have to be quantified systematically to illustrate the significance of wildland fire management for sustainable development.

Fire science must also assist to understand which institutional arrangement would work best for fire management in the many new nations that have been created over the past dozen years, e.g. the nations built after the collapse of the former Soviet Union or Yugoslavia, or countries that democratised of former dictatorships, a few by simple independence or dramatic regime changes. The questions to be addressed include:

- What kind of fire policies and fire institutions should such nations adopt?
- What research programs are suitable?
- What kind of training yields the biggest results?
- What kind of fire management systems are appropriate for what contexts?
- What kind of international aid programs achieve the best outcomes?
- How should such countries reform in a way that advances the safety of their rural populations and the sustainability of their land and resources?

So far no such study – no such field of inquiry, the political ecology of fire – exists. Yet there are ample examples available from history, especially Europe's colonial era, and many experiments over the past 40 years. There is the record of policy and institutional reforms for the major fire nations such as the United States, Russia, Canada, and Australia. There are scores of FAO-sponsored projects. What is needed is a systematic collection and analysis of these experiences and data. This is something that can be achieved with a modest investment of scholarship and money.

Similarly, a compelling need exists to understand better the impact of industrialization which involves the burning of fossil biomass. Both developed and undeveloped countries are struggling to understand the consequences of fossil fuel use for fire management, of this transformation. How, precisely, does burning fossil biomass change the patterns of fire on the land, for good or ill? We understand something about the relationships and cumulative effects between biomass burning and fossil-fuel burning in the atmosphere; we do not understand the mechanics of their competition on the Earth's vegetated surfaces. Modern transportation systems can open forests to markets, and lead to extreme fires. Equally, chemical fertilizers, pesticides, and mechanized ploughs can remove fire from agricultural fields. The replacement of biofuels for cooking and heating in some regions by fossil fuels have led to a vast accumulation of hazardous fuels in wildlands. In other regions the availability of fossil or solar energy has eased the pressure of vegetation depletion. Yet both fire's introduction and its removal have ecological consequences. These are linked problems for which there are no models or theory.

Most of the current fire research is sponsored by governments, and that because those governments have responsibility for large tracts of public land. These landscapes matter because their fires can (and do) threaten communities, because the mismanagement of fire can undermine the ecological health of the protected biota, and because they influence carbon cycling and global warming. But most of the world's fires reside in the developing world and are embedded within agricultural systems or systems subject to rapid logging for export or conversion to plantations. These are the scenes of many of the worst fires and most damaging fire and smoke episodes. Traditional research into fire fundamentals has scant value in such conditions, which are the result of social and political factors. Yet these are circumstances in which even a small amount of research could produce large and immediate dividends.

This implies that scientific focus has to be shifted. The fire domain for a long time has been governed by inter-disciplinary natural sciences research. Engineering research has contributed to a high level of development in the industrial countries. What is needed in future is a research focus at the interface between the human dimension of fire and the changing global environment. The new fire science in the third millennium must be application-oriented and understood by policy makers, a science that bridges institutions, politics, and ecology. Continued research in fire fundamentals, fascinating as it is, cannot address these matters.

This recommendation is reflected by the establishment of a dedicated Working Group on Wildland Fire of the United Nations. The Working Group operates in support of the Inter-Agency Task Force for Disaster Reduction of the United Nations International Strategy for Disaster Reduction (ISDR) and brings together an international consortium of UN agencies and programmes, representatives from natural sciences, humanities, fire management agencies and non-government organizations (ISDR 2001). The terms of reference of this group is, among others, to advise policy makers at national to international levels in the reduction of the negative effects of fire in the environment, in support of sustainable management of the Earth system. The activities include a major global networking activity – the Global Wildland Fire Network – facilitated through the Global Fire Monitoring Center (GFMC 2002) and supported by the science community.

The UN Working Group also intends to develop a proposal for internationally acceptable criteria, with common procedures and guidelines, for the collection of data on fires in a consistent manner, with the intention of compiling accurate estimates of wildland fire globally that can be used by various user communities locally, nationally, regionally and globally.

The contribution of global wildland fire science to the way forward must lead towards the formulation of national and international public policies that will be harmonized with the objectives of international conventions, protocols and other agreements, e.g., the Convention on Biological Diversity (CBD), the Convention to Combat Desertification (UNCCD), United Nations Framework Convention on Climate Change (UNFCCC) and the UN Forum of Forests (UNFF). The wildland fire community must also search for efficient, internationally-agreed-upon solutions to respond to wildland fire disasters through international cooperative efforts. The formulation of initiatives at the International Wildland Fire Summit, supported by the United Nations, for efficient and timely interaction of the international community is urgently required.

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UNITED NATIONS		NATIONS UNIES

Wildland Fires – a Growing Environmental, Economic, and Humanitarian Problem
International Wildland Fire Summit, Sydney, 3-6 October 2003
Opening Address by Jan Egeland,
UN Under-Secretary-General for Humanitarian Affairs [20]

Ladies and Gentlemen:

I would have very much wished to be with you today as the subject is of crucial importance to our work. Unfortunately, previous commitments have prevented me from being here in person.

We need few reminders of the terrible damage that outbreaks of vegetation fires can cause. In the Australian summer of 2002-3, one of the worst fires in the country's history occurred in Canberra, causing widespread destruction to literally hundreds of homes. This year fires of equal scale and ferocity also broke out across the European and North American continents in the course of a northern hemisphere summer heatwave.

The incidence of extreme wildfire events is increasing throughout the world, with adverse impacts on economies, livelihoods, and human health and safety that are comparable to those associated with other natural disasters such as earthquakes, floods, droughts and volcanic eruptions. Many fires are the result of communities' increasing vulnerability due to growing populations, economic and land-use pressures.

Fortunately, the international community has made great strides over the past decade and has shown itself both willing and able to engage international cooperation to reduce the negative impacts of wildland fires. To cite a few of our achievements to date:

Wildland fire science and new technologies, particularly space-borne remote sensing systems, have contributed significantly to a better understanding of the impact of wildland fire on humanity, ecosystems and the functioning of the planetary system.

Many countries have signed bilateral agreements signalling their willingness to cooperate on wildland fire management along common borders and to provide mutual assistance in the large fire emergencies that occur. Similarly, we have seen a significant increase of technical and scientific cooperation projects.

The capacity of developing countries to handle the sustainable management of vegetation resources, including fire management is being strengthened, and rural populations in countries are increasingly involved in community-based fire management projects.

Many of you will already know that the International Strategy for Disaster Reduction (ISDR) has a Working Group on Wildland Fire, which reports to the Inter-Agency Task Force for Disaster Reduction. One of the principal functions of this Working Group is to advise the UN system on all matters related to the reduction of the negative impacts of wildland fire on human societies and the global environment, as well as foster inter-sectoral cooperation within and among the UN, international partners and civil society.

Ladies and Gentlemen:

In the course of your discussions at this Summit you will have occasion to touch on the issue of *reducing risk and vulnerability* to wildland fires, and seek to identify appropriate mechanisms to improve global communication and knowledge sharing on wildland fire management. You will also be called on to commit yourselves, in principle, to take all necessary steps to manage wildland fuels and fires and to adhere to a five-year global plan of action which we hope will result in positive outcomes in the reduction of the damage caused by wildland fires.

[20] Delivered by Juan Carlos Brandt, Director UNIC Sydney

Your discussions will contribute to the current review of the Yokohama Strategy and Plan of Action for a Safer World that was adopted in 1994 at the First World Conference on Disaster Reduction. At the Conference, concrete actions on disaster preparedness, mitigation and prevention were outlined at the international, regional, national and local scale. The ISDR Secretariat has since been requested by the UN General Assembly to review the implementation of Yokohama Strategy, identifying good practices, remaining gaps, emerging issues, and calling for global action in the 21st Century.

Governments, practitioners, civil society, UN and international organisations are invited to participate in the review process through their involvement in meetings such as this Summit. An opportunity to increase political and financial commitment for disaster risk reduction will take place at the Second World Conference on Disaster Reduction – to be tentatively held in Kobe and hosted by the Hyogo Prefecture in January 2005 – where the results of the review and a Programme for Action for the period 2005-2015 will be presented, and endorsed.

Lastly, as today is the 8th of October, the day we celebrate the UN International Day for Disaster Reduction, let me quote from UN Secretary-General's Kofi Annan's message to commemorate the Day:

"Natural hazards are a part of life. But hazards only become disasters when people's lives and livelihoods are swept away. The vulnerability of communities is growing due to human activities that lead to increased poverty, greater urban density, environmental degradation and climate change."

"On the International Day for Disaster Reduction, let us remind ourselves that we can and must reduce the number and impact of disasters by building sustainable communities that have the long-term capacity to live with risk."

Ladies and gentlemen, with these words, I wish you every success in your deliberations.

Thank you.

CBD

CONVENTION ON
BIOLOGICAL DIVERSITY

Statement by Hamdallah Zedan
Executive Secretary, Convention on Biological Diversity
to the International Wildland Fire Summit, Sydney, Australia, 8 October 2003

On behalf of the Convention on Biological Diversity (CBD), I wish to commend and thank the organizers of the International Wildland Fire Summit for selecting the vitally important theme of *Fire Management and Sustainable Development: Strengthening international cooperation to reduce the negative impacts of wildfires on humanity and the global environment.*

The marked rise in the number and extent of uncontrolled fires, with their accompanying destruction and distress is a world-wide phenomenon. To a large extent, this has been the result of too many unwanted fires and too few desirable fires. This year, one of the worst in recorded history, has witnessed an alarming increase in the number and extent of uncontrolled fires, starting with the devastation wreaked by the Canberra wildfire in January. Portugal, France, the Russian Federation, Canada and the United States have all suffered immense losses from wildfires in terms of timber and non-timber resources, wildlife habitat, forest biodiversity, and infrastructure.

While many ecosystems are adapted to fires and, in fact, require some fires to regenerate, fires are increasingly damaging important ecosystems such as forests – a situation of great concern in light of their role as important repositories of the earth's terrestrial biodiversity. As the effects of uncontrolled fires are likely to transcend political boundaries, international and regional cooperation in sharing information to promote more effective fire management that explicitly integrates institutional, policy, and scientific aspects is needed. To this end, the International Wildland Fire Summit represents a timely initiative.

The Convention on Biological Diversity can contribute in many ways with respect to the formulation of a strategy for future development of the issues and international responses to uncontrolled fires; in particular, with respect to forests. First, the role of the Convention as the focal point for forest biological diversity within the Collaborative Partnership on Forests enables it to make valuable contributions. Second, the expanded programme of work on forest biological diversity under the Convention, which mirrors the concerns of this Summit, includes activities that are relevant to fire prevention, management, and mitigation, on issues ranging from atmospheric pollution, climate change and ecological restoration, to protected areas, development of community-management systems, cross-sectoral integration and public education. The World Summit on Sustainable Development called upon countries to implement the programme. Third, the guidelines for the integration of biological diversity in impact assessment procedures being developed under the Convention on Biological Diversity can also be useful in assessing fire impacts. Fourth, the Conference of the Parties to the Convention on Biological Diversity has adopted a Strategic Plan with the target of achieving, by 2010, a significant reduction in the rate of loss of biodiversity. This target was endorsed by the World Summit on Sustainable Development. The expanded programme of work on forest biological diversity serves as one mechanism to achieve the target.

This year, the Secretariat of the Convention was appointed as a member of the Working Group on Wildland Fire of the United Nations International Strategy for Disaster Reduction. It is our profound hope that the contribution of the Convention on Biological Diversity to the Group will help strengthen international cooperation in order to make uncontrolled fires a rarity. We are confident that the International Wildland Fire Summit will lead the way to achieving this goal, and look forward to contributing to the implementation of the outcomes of the Summit.

I wish the organizers and participants in the International Wildland Fire Summit a very successful meeting.

International Cooperation in Wildland Fire Management Special

This special IFFN issue on international cooperation in wildland fire management provides an opportunity to publish the texts of the agreements on the sharing of wildland fire suppression resources between the United States of America and Australia and New Zealand.

J.G. Goldammer, Editor, IFFN

International Arrangements on the Sharing of Wildland Fire Suppression Resources between the United States of America and Australia and New Zealand

Background

The wildland fire season in the United States during 2000 was the worst fire season in more than 50 years. Almost 100,000 fires consumed more than 2.8 million hectares of forest and range lands. This was approximately twice the U.S. ten-year average. The season was long and difficult and firefighters faced dangerous burning conditions throughout the western U.S.

At the height of the fire season in late August, the U.S. interagency wildland fire community, which consists of federal, state, and local resources, had mobilized more than 20,000 civilian fire fighters, approximately 4,000 soldiers and marines and thousands of other support personnel in dispatch centers, warehousing facilities, and administrative centers throughout the country.

Faced with this unprecedented situation, and with a forecast for a continuing hot and dry weather pattern, fire managers realized they would need to reach beyond U.S. borders for assistance. During the remainder of the 2000 fire season, the U.S. received assistance from more than 1200 Canadian firefighters, 96 fire specialists from Australia and New Zealand and 20 Mexican firefighters. These additional resources performed important roles in the U.S. fire fighting efforts. Some international fire fighters provided much needed support to fire crews on the fireline while others performed as middle managers on incident management teams. International agreements with Canada and Mexico were in place prior to the 2000 fire season but none existed with Australia and New Zealand.

Why Did the U.S. go to Australia and New Zealand?

U.S. fire managers have had informal *study group* exchanges with Australia and New Zealand for more than 20 years. These exchanges provided opportunities to share information about each other's programs and experiences. Based on that exchange relationship and the knowledge of the Australian and New Zealand firefighting systems, when the U.S. fire situation reached a critical level in 2000, the U.S. approached Australia and New Zealand and asked for their help. The 96 fire experts that came to the U.S. were integrated into the U.S. fire fighting organization where they served in middle management positions on fires, freeing up U.S. fire managers to take on more critical tasks.

The Relationship in 2000

The justification for seeking the assistance of Australia and New Zealand in 2000 was based on an *assumption* that a U.S. Public Law called the "Wildfire Suppression Assistance Act," gave the authority to the U.S. Secretaries of the Interior and Agriculture to enter into assistance agreements, especially because of the critical situation facing fire managers on the fire lines. U.S. fire managers, who coordinated this activity during 2000, did not understand the clearance and vetting processes required by the U.S. Department of State prior to putting Australia and New Zealand fire fighters in harms way on the fire lines. Fortunately, no serious incidents occurred, and all of the Australian and New Zealand firefighters returned home safely and from all accounts, they performed ably and were a credit to their countries.

When the 2000 fire season was over, U.S. fire managers understood that the assumed authority used to bring Australia and New Zealand fire fighters over would not be viable in the future. And the biggest issue that arose was a concern about tort claim liability. Solicitors and risk managers from Australia and New Zealand, upon review of U.S. law did not feel that their firefighters were provided sufficient legal coverage by the U.S., if an Australian or New Zealand firefighter, even properly performing his duties, was involved in unforeseen fire line incident which caused injury or damage to other parties. New arrangements needed to be developed and signed by all parties before the U.S. could once again request and receive help from Australia and New Zealand.

The 2001 Christmas Fires in Southeastern Australia

The devastating fires around Sydney and other areas of southeast Australia in 2001, like the U.S. fires in 2000, drew worldwide attention. The U.S., trying to return the favor of help that it received in 2000, offered to provide some assistance. Thanks to a break in the weather, the professionalism of the their fire fighters, and to the incorporation of some lessons learned from their experiences in the U.S. in 2000, Australian fire managers were able to control their fires. However, had U.S. help been needed, the ability and timeliness of the U.S. to provide assistance would have been greatly hampered by the lack of signed arrangements and operating plans. This once again highlighted the need for the completion of more formal arrangements and protocols between the countries which would meet the concerns of all parties.

The 2002 U.S. Fire Season

After a quiet wildland fire season in 2001 in the U.S., the 2002 wildland fire season was just as challenging to fire managers as 2000. As conditions in the forests and rangelands of the Western U.S. worsened and record setting hectares burned in several states, the U.S. again prepared to call for international assistance. However, Canada which provided valuable and lengthy support to the U.S. in 2000 faced its own fire problems stretching from Quebec to British Columbia. And there were still unresolved issues with arrangements and protocols with Australia and New Zealand.

Throughout 2001 and up to August of 2002 U.S., Australian, and New Zealand fire managers, risk managers and solicitors had been proposing and reviewing potential options to solve the liability concerns raised after the 2000 fire season. One alternative that was explored was purchasing sufficient liability insurance to meet risk managers requirements, but the cost was prohibitive, and the policies would have been too complex. The best possible solution was to change U.S. law that would give *any* international firefighter brought to the U.S. under the "Wildfire Suppression Assistance Act," tort liability coverage equivalent to that provided to U.S. Government fire fighters. In early August the bill was passed and signed by the President of the U.S. The language in the bill provided the assurance required by Australian and New Zealand and U.S. fire managers were once again allowed to request international assistance from Down Under. Signatures of the Secretaries of Agriculture and the Interior were quickly inked on the official Arrangement papers and posted overnight to Australia and New Zealand. The Australian States of Victoria, New South Wales, Tasmania, Western Australia, and South Australia and New Zealand signed the Arrangements. Within a week of the passage of the legislation, 50 Australian and New Zealand fires specialists were on U.S. fire lines filling, as they did in 2000, critical mid-level management fire positions in operations and aviation.

The 2002-2003 Bush Fire Season in Australia

The 2002-2003 bush fire season in Australia saw some of the worst fires in over 50 years. The hardest hit states were Victoria and New South Wales. In later January of 2003, the State of Victoria requested U.S. assistance. Thirty six U.S. fire fighters went to Australia for a month. A twenty person hand crew worked shoulder to shoulder with Australian fire fighters on the fire line. An infrared scanning aircraft with crew and infrared photo interpreters was also sent. And two small incident management teams took on management responsibilities for portions of a massive fire in the Alpine Region of Victoria. The U.S. fire fighters shared their knowledge and experience with their Australian counterparts and also gained a great deal of respect for the challenges facing Australian fire fighters in the management and suppression of bush fires.

This request for U.S. assistance tested and solidified the two-way nature of the Arrangements signed in 2002.

The 2003 U.S. Wildland Fire Season

The 2003 wildland fire season initially did not appear that it would reach the proportions of needs that were required in 2000 and 2002. However, by mid-July the affects of a multi-year drought, record high temperatures and low humidity and the right weather conditions caused numerous large fires to rage out of control in the Northern Rockies. For the third time in four years U.S. fire managers were facing the need for more international assistance, and Canada, as in much of 2002, was busy suppressing devastating fires of its own in several provinces. And once again, based on the 2002 Arrangements, 40 Australian and New Zealand fire fighters came to the aid of the U.S.

The 2003 request reaffirmed the true value of being able to call upon Australian and New Zealand firefighters during extreme wildland seasons. It also began to seem routine.

Other Values of the Arrangements

Instituting these Arrangements not only provided for a clear mechanism to share fire fighting resources during critical times, it also established formal procedures for cooperative exchanges outside of critical fire season time periods. Knowledge of each other's capabilities and systems before the fires start can pay important dividends in the heat of battle. These cooperative exchanges have the following objectives:

- To share information on training, qualification, and certification systems and requirements;
- To share knowledge about operational procedures and systems including ground and air operations;
- To observe and participate in each others prescribed fire programs;
- To study how each country uses fire fighting equipment and apparatus;
- To observe how each country uses relationships at national, state and local levels to coordinate and access firefighting resources such as volunteers;
- To share information on fire prevention and education.

The Future

Through four mobilizations of firefighters (three to the U.S. and one to Australia) and numerous exchange activities, these Arrangements have repeatedly proven the value of having effective, flexible, cooperative and formal relationships. These Arrangements are not static but must be periodically reviewed, adjusted, and re-approved by the signatories. The U.S. will continue to work with its partners in Australia and New Zealand to improve and expand on these valuable relationships in order to cooperatively address the common global challenges of wildland fire management.

Wildfire Arrangement Between the Department of the Interior and the Department of Agriculture of the United States of America and the Australian Participating Agencies

The Department of the Interior and the Department of Agriculture of the United States of America, on the one hand, and the Australian Participating Agencies, on the other hand (hereinafter referred to as the "Participants");

CONSIDERING that through an ongoing informal relationship, the Participants have had exchanges on firefighting issues since 1964;

CONSIDERING the authorities given to the United States Secretary of the Interior and Secretary of Agriculture to enter into such arrangements by the Emergency Wildfire Suppression Act as Amended, U.S. Public Law 100-428, 42 USC, Section 1856m;

CONSIDERING that in the summer of 2000, firefighters from Australia provided able assistance to the U.S. during its worst fire season in over 50 years**,** and;

RECOGNIZING that it is desirable and in the public interest to formalise the provision of mutual assistance in fighting fires and to share information about suppression and management of fires**;**

The Participants Have Reached the Following Understandings:

I
Purpose

The purpose of this Arrangement is to provide a framework for one Participant to request and receive Wildfire Suppression Resources from the other Participant and to encourage cooperation on other fire management activities.

II
Definitions

For the purposes of this Arrangement:

1. **"Australian Participating Agencies"** means the State Governments, Statutory Corporations and other corporate entities of Australia who have signed this Arrangement.

2. **"Receiving Participant"** means the Participant receiving Wildfire Suppression Resources.

3. **"Sending Participant"** means the Participant furnishing Wildfire Suppression Resources.

4. **"Wildfire"** means any forest, range or bush fire.

5. **"Wildfire Suppression Resources"** means personnel, supplies, equipment, and other resources required for pre-suppression and suppression activities.

III
Understanding

1. A Participant should immediately consider the request of the other Participant for Wildfire Suppression Resources, and, to the fullest extent practicable, promptly approve such request.

2. The Requesting Participant should reimburse the Sending Participant in accordance with Part IV.

3. A Participant may obtain, as appropriate, the participation of its state, regional, local, private or tribal/aboriginal fire organisations in the implementation of this Arrangement, subject to its national or state laws and regulations.

4. The Receiving Participant may organise, task, and direct the Sending Participant's Wildfire Suppression Resources as necessary to meet the Receiving Participant's fire suppression objectives effectively and efficiently.

5. Activities contemplated under this Arrangement are subject to the availability of funds.

6. The Sending Participant should have the right to withdraw some or all of its Wildfire Suppression Resources as necessary at the Sending Participant's discretion. Notice of intent in this respect should be communicated to the Receiving Participant.

7. The Sending Participant should provide all the safety equipment required to meet its regulations. Should additional equipment be required by the Receiving Participant, the Receiving Participant should supply it at the Receiving Participant's expense.

IV
Reimbursement

1. Except for the costs set forth in Part V of this Arrangement, the Sending Participant should be reimbursed by the Receiving Participant for the costs incurred by the Sending Participant in furnishing Wildfire Suppression Resources for, or on behalf of the Receiving Participant. The costs may include the cost of premiums to purchase death and personal injury insurance for the employees of the Sending Participant, as more fully described in the Annual Operating Plan provided for in Part VII of this Arrangement. The specific costs and procedures for reimbursement should be set forth in the Annual Operating Plan, which should be a binding contract.

V
Cross-Waiver of Claims and Assumption of Liability

1. In the Annual Operating Plan, the Receiving and Sending Participants should include provisions by which each Participant and each component of that Participant intends to waive its claims against the other Participant and each component of that Participant for compensation for loss, damage, personal injury, or death occurring as a consequence of the performance of activities undertaken pursuant to the Annual Operating Plan.

3. The Annual Operating Plan should contain provisions whereby the Receiving Participant agrees to assume all liability for the tortious acts or omissions of the Sending Participant's personnel sent to provide wildfire assistance to the Receiving Participant.

VI
Entry of Personnel and Equipment

1. The Participants intend to work together, with the involved agencies of their respective governments, to process appropriate legal documentation, within the applicable laws and regulations of both countries, and to otherwise facilitate entry to and exit from its territory of all personnel engaged in wildfire suppression pursuant to this Arrangement.

2. Each Participant should undertake all reasonable steps and use its best efforts, within applicable laws and regulations of both countries, to facilitate the admission and exit of all supplies, equipment, aircraft, vehicles, specialised machinery, or other equipment whether owned or contracted, that are used or intended for use in wildfire suppression or transport of wildfire suppression equipment or personnel pursuant to this Arrangement without entry fees and without payment of any duties or taxes imposed by reason of importation.

VII
Annual Operating Plan

1. An Annual Operating Plan should be concluded and executed between the Participants as a binding contract.

2. The Annual Operating Plan should:

   (a) identify designated points of contact responsible for fire suppression;
   (b) set forth specific criteria and procedures for approving requests for Wildfire Suppression Resources;
   (c) establish procedures for efficient and timely communication of relevant information between designated points of contact;
   (d) identify the necessary procedures and legal documentation that are to be completed with agencies of the governments to allow entry into each country of Wildfire Suppression Resources;
   (e) specify the conditions, costs and procedures for the reimbursement, as deemed appropriate, of the Sending Participant for the furnishing of Wildfire Suppression Resources;
   (f) include terms consistent with Part V, a cross-waiver for compensation for loss, damage, personal injury or death occurring in consequence of the performance of this Arrangement or the Annual Operating Plan;
   (g) establish equivalent standards for qualifications, including physical fitness, training and experience;
   (h) provide for withdrawal rights of the Sending Participant.
   (i) provide for the Receiving Participant to assume all liability for the tortious acts or omissions of the Sending Participant's personnel sent to provide wildfire assistance to the Receiving Participant.

3. The Participants should use their best endeavours to complete a review of the Annual Operating Plan by 15 May in each year. Until the review is completed, the last Annual Operating Plan should continue to apply.

VIII
Status of Personnel

1. Except as provided in clause 3 of this part, any service performed in furtherance of this Arrangement by an employee of a Participant should constitute service performed on behalf of that Participant.

2. Except as provided in clause 3 of this part, the performance of a service under this Arrangement by any employee, contractor, subcontractor or agent of one Participant should in no case render such person an employee, contractor, subcontractor or agent of the other Participant.

3. For the purposes of tort liability any employees, contractors, subcontractors or agents of the Sending Participant sent to fight fires in a foreign country under this Arrangement are considered to be employees of the Receiving Participant. The only remedies for acts or omissions committed while fighting fires shall be that provided under the laws of the host country and those remedies shall be exclusive remedies for any claim arising out of fighting fires in a foreign country. Neither the Sending Participant or any organisation associated with the firefighter shall be subject to any tort action pertaining to or arising out of fighting fires.

IX
Other Areas of Cooperation

1. This Arrangement constitutes a reaffirmation of the importance of engaging in cooperative fire management activities. This Arrangement is intended to encourage and strengthen other cooperative fire management activities, through the sharing among the Participants of personnel, fire management techniques, skills, and innovations. The objective of these activities is to improve the fire fighting capabilities and knowledge of each Participant, resulting in the provision of more effective fire fighting assistance to one another when necessary. Each Participant should bear all of its costs and expenses of participating in these other cooperative activities, unless otherwise mutually arranged.

X
Provisions of Mutual Aid

1. Through this Arrangement, the Participants may provide mutual aid in furnishing Wildfire Suppression Resources for lands and other properties for which the Participants normally provide Wildfire Suppression Resources.

2. This Arrangement outlines potential exchanges of wildfire suppression resources between the Participants. The specific terms of an exchange, some of which are referenced in this Arrangement, should be detailed in the Annual Operating Plan provided for in Part VII of this Arrangement.

XI
Dispute Settlement

1. Any differences that arise in the interpretation or application of the provisions of this Arrangement or any Annual Operating Plan concluded pursuant hereto should be resolved by the Participants by means of negotiations and consultations.

XII
General Provisions

1. This Arrangement supersedes any previous arrangement or understanding between the parties.

2. Activities under this Arrangement commence upon signature and continue until 15 May 2010. After that date this Arrangement continues from year to year until it is terminated.

3. This Arrangement may only be modified by mutual written consent of the Participants.

4. A Participant or Participating Agency may withdraw from this Arrangement at any time, providing reasonable written notice to the other Participant~~s~~. Withdrawal from this Arrangement should not affect the implementation by the withdrawing Participant or Participating Agency of any fire suppression initiated prior to the provision of notice of that Participant's or Participating Agency's withdrawal. Withdrawal of a Participant does not terminate this Arrangement as to the remaining Participants.

5. This Arrangement may be terminated with reasonable written notice to the other participants:
   a) upon the withdrawal from this Arrangement of both the Department of the Interior and the Department of Agriculture of the United States of America; or
   b) upon the withdrawal of all of the Australian Participating Agencies, or
   c) with the mutual consent of all the Participants.

6. The termination of this Arrangement should not affect the implementation of any fire suppression initiated prior to such termination.

Signed in Australia and Washington, D.C, in two originals, in the English language.

Annual Operating Plan for the Wildfire Arrangement Between the Department of the Interior and the Department of Agriculture of the United States of America and the Australian Participating Agencies

I. Purpose

This Annual Operating Plan is prepared pursuant to Part VII of the United States and Australia Arrangement signed in 2002 that provides for wildfire suppression assistance and other fire management activities between Australia and the United States.

II. Contract

This Annual Operating Plan constitutes a binding contract between the parties made in consideration of the mutual obligations set out in it. The Department of the Interior and the Department of Agriculture of the United States of America enter into this contract under the Emergency Wildfire Suppression Act as Amended, U.S. Public Law 100-428, 42 USC, Section 1856m.

III. Definitions

For the purpose of this Annual Operating Plan:

"Australian Participating Agencies" means the State Governments, Statutory Corporations and other corporate entities of Australia who have signed this Annual Operating Plan.
"Plan" means this Annual Operating Plan.

"United States" means those agencies of the U.S. Department of Agriculture and the U.S. Department of Interior involved in wildfire suppression activities and responsible for receiving Australian Participating Agencies Wildfire Suppression Resources or sending U.S. Wildfire Suppression Resources to Australia.

"Receiving Participant" means the Participant receiving Wildfire Suppression Resources.

. **"Sending Participant"** means the Participant furnishing Wildfire Suppression Resources.

"Wildfire" means any forest, range or bush fire.

"Wildfire Suppression Resources" means personnel, supplies, equipment, and other resources required for pre-suppression and suppression activities.

IV. General Procedures

A. Requests for Wildfire Assistance

1. Requests for wildfire assistance from the United States will be made by the Chairman of the Forest Fire Management Group (FFMG) to the Manager, National Interagency Coordination Center, (NICC) at the National Interagency Fire Center (NIFC) in Boise, Idaho, USA.

2. Requests for wildfire assistance from the Participating Agencies of Australia will be made by the Manager, at NICC, to the Chairman of the FFMG. Such requests will only occur when all U.S. civilian capabilities for the type of Wildfire Suppression Resources requested have been exhausted.

3. For billing and reimbursement, or other correspondence, the designated official for the United States will be the Manager, NICC, and for Australia, the designated official will be the Chairman of FFMG or his/her delegate.

4. To minimise delays at points of entry for Customs and Immigration clearances, NICC or FFMG will, 24 hours prior to mobilisation, supply to customs at the Point of Entry (PoE) all transport and arrival information, in the forms specified, containing but not limited to the following details:

   Personnel: The full name, country of citizenship, date and country of birth, personal identification number (eg. Social Security Number), passport number, home base and departure point.

   Equipment: The item, quantity and serial numbers, carrier and bill of lading number, country of manufacture.

5. Customs Declaration forms will be completed for presentation to customs at the PoE.

B. Personnel

1. Reimbursement for personnel expenditures incurred while performing services under the Plan will be on the following basis:

   (a) The United States sending wildfire suppression resources to Australia:

   (1) All United States salary costs to include overtime and relevant allowances submitted for payment will be reimbursed by the Australian Participating Agency in accordance with salary schedules in existence within the United States.

   (2) The costs of travel, lodging, meals and other expenses normally approved by the United States, will be reimbursed by the Australian Participating Agency when not provided by the Australian Participating Agency.

   (3) Travel costs (airline tickets, and local transportation) may be billed separately to the Australian Participating Agency.

   (4) Upon the production of receipts the cost of travel, lodging, meals, vehicle rentals, communication equipment, and other approved expenditures shall be reimbursed when the Australian Participating Agency cannot provide these services through their procurement methods. Lodging and meals will be reimbursed at the rate provided for in the United States travel regulations.

   (5) Australian Participating Agencies will pay for all immediate medical treatment and any associated costs resulting from an injury incurred in the course of firefighting duties whilst on assignment.

   (b) Australian Participating Agencies sending wildfire suppression resources to the United States:

   (1) All Australian Participating Agency salary costs including overtime and any other relevant allowances submitted for payment by the Australian Participating Agencies will be reimbursed by the United States in accordance with salary schedules and/or union contracts in existence within the Australian Participating Agencies.

   (2) At the time of the request for assistance, the Australian Participating Agencies may be reimbursed at a daily flat rate agreed to by the Australian Participating Agencies and the United States that is established and documented prior to the mobilisation of wildfire suppression

personnel by the Australian Participating Agencies. The daily rate is in lieu of itemised salary costs, overtime and relevant allowances for wildfire suppression personnel of Australian Participating Agencies.

(3) The costs of travel, lodging, meals and other expenses normally covered by the Australian Participating Agencies, will be reimbursed by the United States when not provided by the United States.

(4) Travel costs (airline tickets, and local transportation) may be billed separately to the United States.

(5) Upon the production of receipts the cost of travel, lodging, meals, vehicle rentals, communication equipment, and other approved expenditures shall be reimbursed when the United States cannot provide these services through their procurement methods. Lodging and meals will be reimbursed at the rate provided for in the Sending Participants travel regulations.

(6) The United States pay for all immediate medical treatment and any associated costs resulting from an injury incurred in the course of firefighting duties whilst on assignment.

2. The Receiving Participant will detail any specialised expertise required for fire suppression or fire management assignments.

3. Prior to mobilisation, the Participating Agencies either sending or receiving wildfire suppression resources will agree to equivalent standards, training, fitness levels, and experience required for each position included in a request.

4. The United States National Wildfire Coordinating Group (NWCG) Qualifications Handbook (310-1) will be used as the basis for establishing equivalent qualifications. For any request for a position not included in the NWCG 310-1, the Receiving Participant will send documentation outlining the major requirements of the position requested. **NOTE:** Because of limitations of delegating authorities within the U.S. Government, the positions of Incident and Deputy Incident Commander, Area and Deputy Area Commander will not be filled by Australian Participating Agencies personnel under this Annual Operating Plan.

5. All Participating Agencies under the Plan assigning wildfire suppression personnel to resource requests will certify that the personnel assigned will meet the requirements of the position ordered.

6. Sending Participant personnel will receive an adequate orientation session from their Participating Agency prior to deployment and another briefing from the Receiving Participant upon arrival. The latter will include a summary of the Receiving Participants operating guidelines. Prior to demobilisation, the Receiving Participant will debrief Sending Participant personnel.

7. The Sending Participant will provide all of the safety equipment required to meet its regulations. Should additional equipment be required by the Receiving Participant the equipment will be supplied at the expense of the Receiving Participant.

8. The Sending Participant and the Receiving Participant will provide for adequate liaison for the duration of the assistance. In making a request for wildfire suppression resources, the Receiving Participant will allow for the inclusion of a Team Leader, which the Sending Participant shall provide for the full duration of the period of assistance. The Team Leader supplied by the Sending Participant shall be responsible for:
   (a) Operational liaison and coordination functions as required by the Receiving Participant;

(b) Health, safety, welfare and commissary needs of Sending Participant's personnel during non-operational periods of the deployment and
(c) Liaison and public relations coordination functions for the Sending Participant

9. Length of deployment, rest and rotation for personnel shall be identified prior to the commencement of the deployment to the Sending Participant. The Sending Participant shall adhere to rest, rotation, and length of deployment policies of the Receiving Participant (providing they do not conflict with the Sending Participant's policies and procedures in which case the Sending Participant's policies and procedures shall prevail).

10. All Sending Participant personnel shall carry with them two examples of identification (at least one of which must be photographic identification).

11. Any criminal conviction may prohibit mobilisation to the Receiving Participant's country. If an individual has been convicted of minor criminal offences, the individual may, at the discretion of the Receiving Participant, be required to undergo an interview process with the Receiving Participant's immigration office to determine whether the individual may be mobilised. All costs associated with the process will be borne by the individual or the Sending Participant. The Receiving Participant retains the right to refuse entry to any individual from the Sending Participant whom the Receiving Participant deems undesirable.
Nothing in this clause derogates from any powers of the U.S. or Australian customs and immigration authorities to refuse entry by any person to either country under relevant legislation.

12. Prescription drugs must remain in their original labelled container or be accompanied by a prescription.

13. Personal cargo weight for incident deployment shall be a total of 65 lbs. (29.5 kg), which includes a personal or deployment pack of 45 lbs. (20.4 kg) and a line pack of 20 lbs. (9.1 kg). Additional cargo must be identified and approved by the Sending Participant and the Receiving Participant.

C. Equipment and Supplies

1. Equipment provided to the Sending Participant by the Receiving Participant remains the property of the Receiving Participant.

2. Where considered necessary by the Sending Participant, specialised equipment may be accompanied by trained technicians and/or operators to ensure safe and efficient set up and operation of the equipment. All salary costs including overtime, and any other relevant allowances submitted for payment by the Sending Participant will be reimbursed by the Receiving Participant in accordance with salary schedules and/or union contracts in existence within the Sending Participant Agencies.

3. It is recommended that all equipment be registered with the respective Sending Participant's customs authority prior to mobilisation.

4. The cost of equipment refurbishing to the Sending Participant's specification is reimbursable by the Receiving Participant unless the Sending Participant agrees that the Receiving Participant will perform the work.

5. All transportation costs of equipment belonging to the Sending Participant will be reimbursed by the Receiving Participant.

D. Recall

The recall of resources from the Receiving Participant shall be made with a minimum of 24 hours notice. Recall will be in accordance with the procedures for requesting resources.

E. Personal Injury, Death, Damage to or Loss of Property, and Insurance Coverage

1. (a) All employees, contractors, sub-contractors or agents of the Sending Participant sent to provide wildfire assistance to the Receiving Participant pursuant to the Plan are, for the purposes of tort liability only, considered to be employees and agents of the Receiving Participant. The only remedies for acts or omissions committed while fighting fires shall be those provided under the laws of the jurisdiction in which assistance is provided to the Receiving Participant and those remedies shall be exclusive remedies for any claim in tort arising out of fighting fires in a foreign country. Neither the Sending Participant nor any personnel sent by it to provide wildfire assistance to the Receiving Participant or any organisation associated with such personnel shall be subject to any action in tort pertaining to or arising out of fighting fires.

   (b) The Receiving Participant agrees to assume any and all liability for the tortious acts or omissions of personnel sent to provide wildfire assistance to the Receiving Participant pursuant to the Plan including liability for all loss and damage suffered by any person as a result of such acts or omissions. Without limiting the generality of the foregoing, the Receiving Participant's assumption of such liability extends to the payment of any damages or other amounts awarded, whether by a court or other person or body, to any person who has suffered or claims to have suffered loss and damage as a result of such acts or omissions, any amount paid or payable to such claimant in settlement of the claim, and all costs incurred in relation to the claim.

   (c) In the event that the Sending Participant or any personnel sent by it to provide wildfire assistance to the Receiving Participant are the subject of any claim by any person arising out of tortious acts or omissions committed or alleged to have been committed by them in the course of providing such assistance, the Receiving Participant will undertake at its cost the defence of such claim on behalf of the Sending Participant or its personnel, provided always that the Receiving Participant retains the right to compromise or settle any such claim on behalf of the Sending Participant or its personnel as in its sole discretion the Receiving Participant sees fit.

2. Subject to clause 1 of this Part, each Participant waives any claims against the other Participant and of each component of that Participant for compensation for loss, damage, personal injury, or death occurring as a consequence of the performance of activities undertaken pursuant to the Plan.

3. (a) The U.S. Departments of Interior and Agriculture, self-insure employees of the United States Government while on official work assignments and on official travel status. Therefore, employees of the U.S. Government will not require additional insurance coverage under the Plan for activities conducted on behalf of an Australian Participating Agency.

   (b) Prior to personnel of any Australian Participating Agency being deployed to the United States, Australian Participating Agencies will ensure that appropriate personal injury and death insurance coverage is in place for each of their personnel deployed in response to United States wildfire suppression resources requests. Additional personal injury and death insurance costs necessarily incurred by Australian Participating Agencies by reason of their deployment will be reimbursed by the United States.

F. Billing and payment

Billing procedures for emergency fire suppression assignments are as follows:

1. The billing and payment requests should be submitted directly to the designated official of the Receiving Participant as identified in IV.A.3.

2. Invoices for goods and services will be paid in the Receiving Participant’s currency.

3. All interest charges will be forgiven for over-due accounts on Government-to-Government invoices provided payment is made within 6 months of the last date of the billing document being received by the Receiving Participant.

4. Billing will include the following:
   (a) Cover letter with reference to specific resource request information;
   (b) An original itemised invoice.

5. The Sending Participant will include backup documentation summarising listing of salary, supplies, travel, and equipment with dates, hours, and crew, equipment, or aircraft type. This will not be required for flat rate billing as provided in IV.B.1 (b)(2), except for all travel, supplies and equipment expenses incurred by the Sending Participant.

G. Situation Reporting

The NICC Manager and the FFMG Chairman or his delegate will exchange daily situation reports throughout the period of the deployment of Australian or U.S. Participating Agency personnel. The report should include information on activities undertaken by deployed personnel, fire situations, problems encountered, and achievements. Monitoring and evaluating the changing conditions associated with the emergency will be the responsibility of the Receiving Participant.

H. Review, Amendment and Termination

1. The Plan shall be reviewed annually on or before 15 May by the Participating Agencies and updated and renewed as may be agreed between the Participating Agencies.
2. Any Participating Agency may terminate its participation in the Plan upon the expiration of reasonable notice in writing given to each other Participating Agency, such notice to be not less than three months.

I. Governing Law and Jurisdiction

1. Subject to clause 2 of this part, the Plan shall be governed by the laws of the United States of America.
2. Where wildfire suppression assistance is provided to a Receiving Participant pursuant to the Plan, all matters concerning the interpretation or enforcement of the Plan, and all questions, disputes or claims of whatever nature, arising out of or in relation to the provision of such assistance will be governed by the laws of the jurisdiction in which the Receiving Participant receives such assistance. Each Participant submits to the non-exclusive jurisdiction of courts exercising jurisdiction in that place and waives any right it might have to claim that those courts are an inconvenient forum.

J. Counterparts

The Plan may consist of a number of counterparts each of which when executed shall be an original and all counterparts together shall constitute one and the same instrument.

COUNTRY NOTES

ISRAEL

Integrated Forest Fire Management in Israel
A 15 Year Review (1987-2002)

1. Introduction

The dramatic growth in afforested areas in Israel since the 1950's and associated accumulated fuels in mature forests sharply increased the likelihood of high-intensity fires with the potential to cause heavy damage to forests and adjacent neighbourhoods. Wildland fires and forest fires in particular, now threaten residential areas on a daily basis during the fire season, and pose new challenges to the development and evolution of fire management strategies.

Over the past 15 years, Israel's landscape has undergone a dramatic demographic transformation. Massive building and development projects proceeded at the expense of the nation's open space resources, with numerous residential quarters bordering upon forests, pasturelands and native woodlands. One result of this rapid growth process is a complex urban/wildland interface found throughout the country's most populous regions.

One such consequence of this high level of interaction and conflict on the land were a series of large forest fires. During the 1980s and 1990s, several devastating fires occurred on the Mount Carmel Forest Reserve (near Haifa) and the forests along the Tel Aviv - Jerusalem highway. As a result, increased public awareness brought about the establishment of a public inquiry committee (Ministry of the Interior 1995), a consultative program with the US Forest Service, and the allocation of special funds for rehabilitating and researching burnt forests.

The integration of fire pre-suppression operations, fuel management, other silvicultural treatments, and data management is a central aspect of forest management and its implementation takes place by various means. This paper reviews changes to the Keren Kayemeth Leisrael's Forest Department's fire management strategy during the past 15 years, and describes the integrative process of forest fire management it underwent.

2. Literature Review

Mediterranean forestry and forest management is recognized as a separate field of world forestry and received international attention since 1948 in the form of the FAO Sub-Commission on Mediterranean Forest Problems (Morandini 1999). Recently, MEDPINE1 and MEDPINE2 conferences focused in depth on the ecology, biogeography, management, conservation, fire ecology, restoration and regeneration of Mediterranean pine species (Ne'eman et al. 2000b, Thanos 2002). Forest fires and forest fire management receive a particularly large amount of attention, due to their central role as natural and anthropogenically induced events in Mediterranean ecosystems and forests (Alexandrian et al. 1999, Calabri 1983, FAO 1977, Leone et al. 2000, MIO 2002, Naveh 1975, Pausus et al. 1999, Velez 1990a, 2001).

Derman et al. (1986), Kliot (1996), Kutiel (1992a) and Naveh (1973, 1974, 1977) document the ecological role of fire in Israel's ecosystems and forests. Fire and fuel management techniques employed in Israel are described by Bonneh (1996), Brandel et al. (1988), Eshet (1988), Ne'eman et al. (2000a) and Woodcock (1996). Research on the behavior, techniques and ecological effects of prescribed burning are documented by Kutiel (1989), and Zohar et al. (1988, 1990a, 1990b, 1994, 1996). A 1992 issue of *Horizons in Geography* is devoted to research conducted on forest fires and their effects in Israel (Kutiel 1992b). The 1996 issue of *Ecology and Environment* is entirely devoted to research conducted on the post-fire effects of a devastating 1989 wildfire on Mt. Carmel. It contains 18 papers detailing the physical, botanical, zoological, managerial and social effects of the fire (Perevolostky et al. 1996).

3. Background

Israel is located at a junction of three continents where climatic and geobotanical zones coincide. In the northern Mediterranean geobotanical zone – an area covering half of the country (10,500 km^2) - native evergreen and deciduous forests, as well as planted conifer and mixed forests, exist. At present, 150,000 hectares (ha.) of both planted (90,000 ha.) and native forest (60,000 ha.) cover 7% of Israel's total area, or 15% of the Mediterranean region of Israel. Most of these forestlands grow in an area that receives annual precipitation levels of 300 to 900 mm (Orni and Efrat 1980).

Also located in this precipitation belt are all of Israel's major metropolitan centers: Haifa, Tel Aviv, and Jerusalem, with a very large number of associated suburban and rural communities. Therefore, urban growth, development and expansion occur concurrently and frequently threaten the nation's forests resources. The population of Israel grew from 500,000 at the beginning of the 20th century to over 6,700,000 today. According to an interim report (KKL 1994), the population within this belt of afforestation, precipitation and urbanization is amongst the densest in the world (638 inhabitants/km^2). A complex and dynamic matrix of forest/urban area interactions characterizes the present Israeli landscape.

Climate: The climate of Israel's geographic areas with afforested landscapes is typically Mediterranean in nature: cool, wet winters and hot, dry summers (UNESCO 1963). Mean annual temperature ranges between 19-21°C. On average, January is the coldest month (8-10°C) and August the hottest (26-28°C) (Survey of Israel 1985). Relative humidity averages 55-60% with the lowest levels in May-June and the highest levels in December-February. (Orni and Efrat 1980). The main rainy season extends from October to May, with 75% of the rain falling from December to February (Gottfried 1982). In Israel, there are two distinct wind regimes during the dry season. Most days are characterized by a regime of a constantly blowing, onshore, moist breeze, from the west (Mediterranean Sea) to the east. A few critical days are marked by extremely hot, dry winds (sharav) originating in the eastern deserts. These conditions encourage the spread of large fires and impose a great threat to forest and property alike (Horowitz et al. 2002, H. Kutiel 1992).

Topography: Israel has three longitudinal topographic belts: the coastal plain, the central and Galilean mountain regions and the Jordan Valley (Zohary 1962). Main population centers are primarily located on the coastal plain while rural settlements, agricultural lands and open space (forests, rangelands, and nature reserves) typify interior sections. Mountain ranges are characterized by rolling hills, terraced mountainsides and steep, rocky slopes dissected by numerous intermittent watercourses. Situated in the foothills and mountainous regions of Israel are the majority of Israel's natural and planted forests.

Geobotany of Natural and Planted Forests: Plant communities typically associated with the Mediterranean region of Israel are low woodlands comprised of mixed evergreen, sclerophyllous tree and shrub species and deciduous tree species of the Class Quercetea calliprini [Braun-Blanquet method](Zohary 1962). The four most prominent and important associations of forest trees found within this afforestation zone are the: 1) Aleppo Pine Forest (*Pinus halepensis, Quercus* spp., *Pistacia spp., Arbutus andrachne);* 2) Evergreen Oak Forest and Maquis (*Quercus calliprinos* and *Pistacia palaestina*); 3) Deciduous Tabor Oak Forest (*Quercus ithaburensis, Styrax officinalis* and *Pistacia atlantica*); and 4) Evergreen Carob – Lentisk Maquis (*Ceratonia siliqua* and *Pistacia lentiscus*).

Associated secondary tree species include hawthorn (*Crataegus* spp.), laural (*Laurus nobilis*), redbud (*Cercis siliquastrum*), phillyrea (*Phillyrea media*), buckthorn (*Rhamnus palaestinus*), Syrian pear (*Pyrus syriaca*), almond (*Amygdalus communis*), strawberry tree (*Arbutus andrachne*) and storax (*Styrax officinalis*) (Waisel et al 1980). Evergreen scrub and low shrub communities, termed "garrigue" and "batha" respectively, are also present. Species typically associated with them are thorny burnet (*Sarcopoterium spinosa*), *Calycotome villosa*, *Cistus* spp., sages (*Salvia* spp.) and, annual and perennial legumes and grasses.

The Keren Kayemeth Leisrael (KKL) is responsible for one hundred years of afforestation activity in Israel. [The KKL is Israel's largest and oldest NGO, responsible for afforestation, land reclamation and water resource development works.] Its efforts created approximately 90,000 hectares of planted forests in Israel's Mediterranean region. Pines (*Pinus halepensis, P. brutia, P. pinea*), eucalypts (*Eucalyptus camaldulensis, E. gomphocephala*), cypress (*Cupressus sempervirons*) are the principal species found, selected for their adaptability to a wide range of site conditions throughout the country (Bonneh 2000). National Master Plan No. 22: Forest and Forestry, approved by the government, guarantees their statutory position as forestlands (KKL et al 1995).Currently, Israel's forest resources provide a large and varied number of social goods and services to the citizenry (Ginsberg 2000).

Forest Fuels: Both natural and planted forests contain tree species with high oil, wax and terpene contents, making them highly flammable and predisposed to fire. The majority of them matured into dense and often untreated forests with very heavy fuel loads. The quick growth rates of conifers and eucalypts, in particular, contributes to a rapid rate of fuel accumulation in the forest – live, green fuels on the trees, dry fuels (needle and leaf litter) on the forest floor, and dead branches on the trees. Zohar et al. (1990b) measured fuel loading on 15 planted pine sites in northern and central Israel, as detailed in Table 1.

Table 1. Average fuel biomass characteristics of 15 planted pine sites aged 24-31 years in the Ben Shemen, Baram and Mt. Carmel forests (Zohar et al. 1990b).

Fuel Component	Ave. Fresh Weight (kg/ha)	Percentage of Total Biomass
Small branches (diameter < 1 cm)	2,100	15.3 %
Large branches (diameter > 1 cm)	3,150	22.9 %
Needle litterfall	4,140	30.2 %
Cones	4,340	31.6 %
TOTAL BIOMASS	13,730	100.0 %
RANGE OF TOTAL BIOMASS	10,000 – 30,000	

Bark thickness of Aleppo and Brutia pines vary and affect their relative susceptibility to scorching and heat damage. The former is more sensitive, with an average thickness ranging between 0.2-1.1 cm, and the latter is more resistant, with an average thickness ranging between 1.4-2.1 cm (Zohar et al. 1992). Measurements were made at 1.0 m trunk height.

In combination with topographic and climatic factors associated with forestry, and the relative closeness of these forests to residential areas, it is clear that fuel and forest fire management are urgent and pressing challenges.

4. Fire Statistics

The data presented here represent a summary of fire occurrence over a fifteen-year period from 1987 to 2002. For purpose of this analysis, the fire data was divided by type of forested area into the two categories mentioned in the "Background" section above: 1) planted forest and 2) natural forests and woodlands. The definitions of these two types confirm to those of the FAO's (2000) FRA Project for "forest" and "natural forest".

In Figure 1, the number of forest fires in Israel ranges from about 500 to 1100 per year, with the majority occurring in planted forests. When normalized to take into account the relative cover of these two categories (see above), there are still some four times more fires per year in planted forests (4-10 per thousand hectares) relative to natural forests (1-3 per thousand hectares).

The total area burned by forest fires (Figure 2) has greater variability than the number of fires, reflecting a dependence on seasonal fuel and climatic conditions. In addition, despite the far greater number of fires in planted forests noted above, the relative yearly area burned for the two forest types shows no clear distinction. There are years where the area burned in natural forest exceeds that in planted forest, and vice versa. The average yearly area burned (960 ha for planted and 819 ha for natural forest) in the two forest types is in fact not significantly different.

As the yearly data on number and burned area indicate, fires in natural forests tend to be larger in Israel than those in planted forests. The difference in average fire size is more than four-fold: 1.6 ha for planted forest versus 7.0 ha for natural forest.

A somewhat deeper look at the result of this size difference is seen in Figure 3, which compares the average number of fires each year in four different size categories differing by orders of magnitude. In Figure 3 the number of fires occurring each year is plotted on a log scale by the four size categories. This graph indicates very clearly how forest fire history in planted forests is dominated by smaller fires (< 10 ha) in contrast to natural forests which have much less of their yearly burned area contributed by small fires.

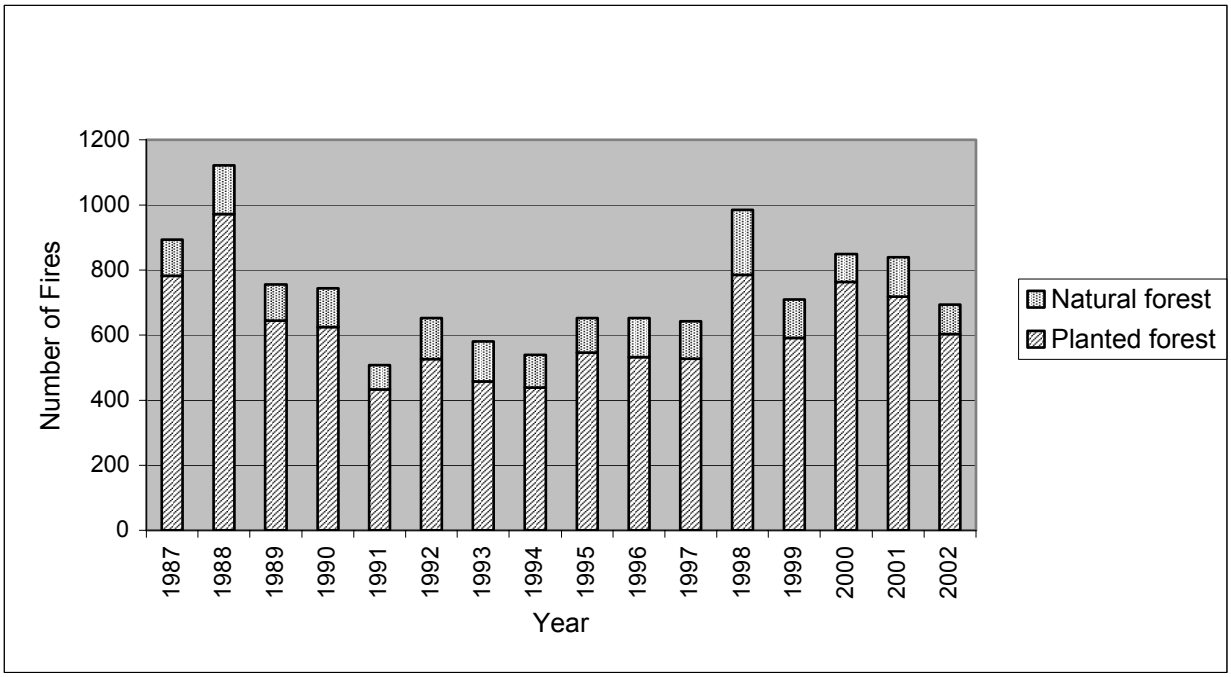

Figure 1. Fifteen years forest fire history in Israel (1987-2002)

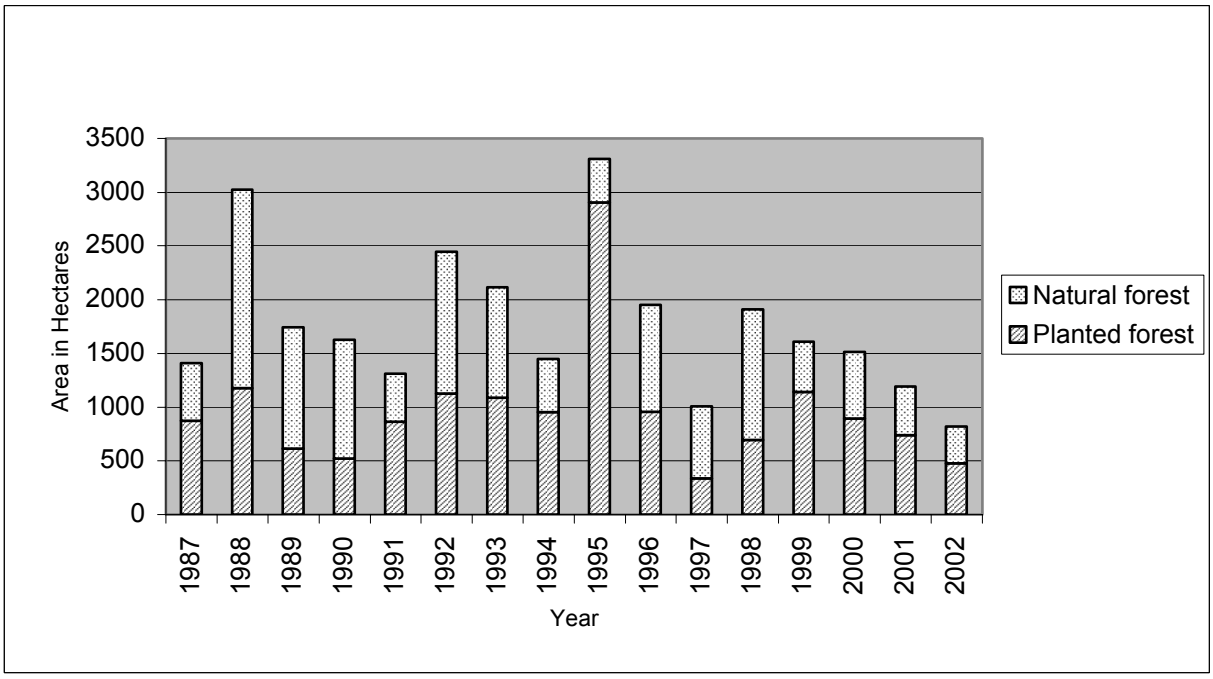

Figure 2. Total area burned in planted and natural forests of Israel (1987-2002)

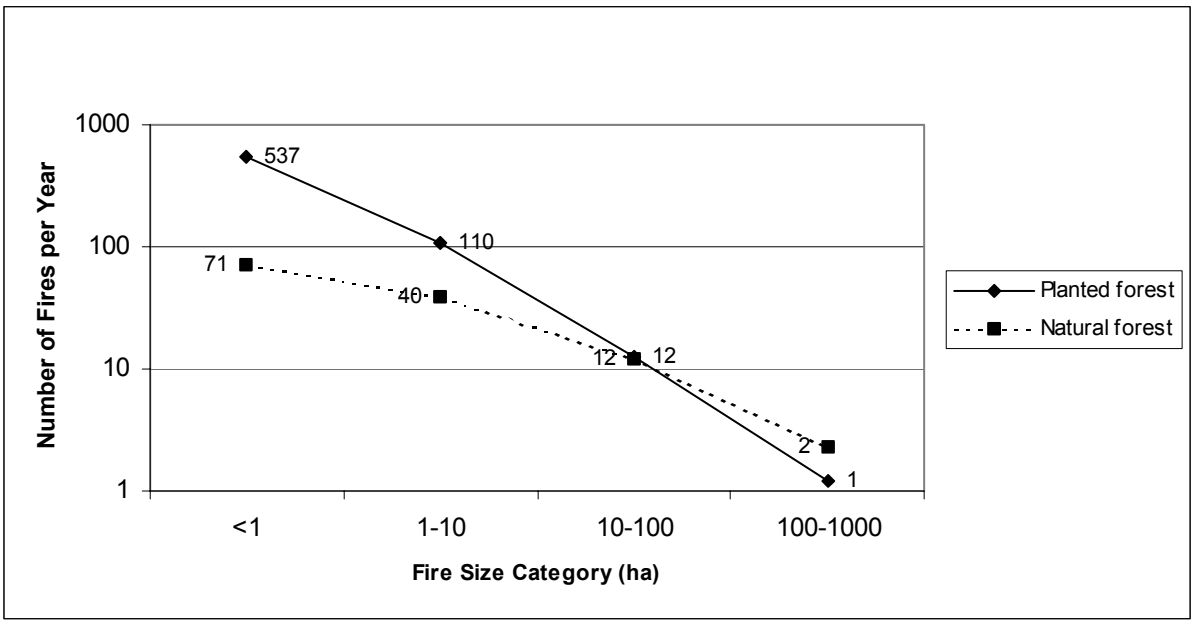

Figure 3. Average yearly number of fires by size category (1987-2002)

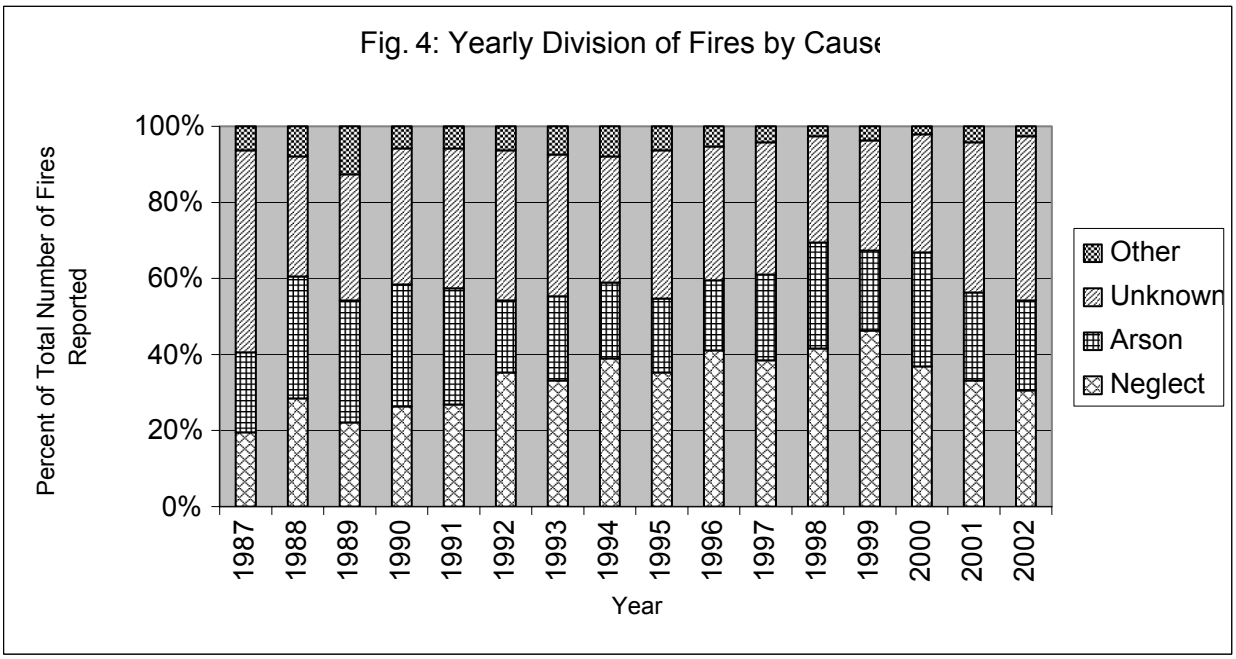

Figure 4. Distribution of fire causes in Israel by year (1987-2002)

It may be hypothesized that both the greater number and smaller size of fires in planted forests arises from a higher level of management intensity practiced on them relative to natural forests. Fuel management practices and road network densities characterize this well (discussed below).

The final characteristic of forest fires discussed here is the causes of fires. Fire cause data was divided into four groups, as a simplification of the data allows easy comparison with other countries. Naturally-caused fires are conspicuous in their absence here, since all lightning storms occur in the winter and are associated with heavy rain. The four groups are: 1) *Arson*: all fires proven or suspected to be intentionally lit; 2) *Negligence*:

unintentional fires caused by campers, hikers, military training and garbage dumps; 3) *Unknown*: cause undetermined or unreported; and 4) *Other*.

Figure 4 illustrates the constancy of the fraction of the total number of fires associated with each cause: negligence 30-40%, arson 20-30%, unknown 30-40% and other causes 10% or less. Two exceptions stick out. In 1987, over 50% of the fires reported were of unknown cause. Also, between 1988 and 1991 the fraction of fires attributed to arson rose to over 30%. The latter may be explained by an increase in politically motivated arson associated with the Israeli-Palestinian conflict.

5. Pre-Suppression Operations and Fuel Management

"Protective silviculture", as termed by Velez (1990b), shapes and manages Mediterranean forests by giving it the capacity to protect itself from catastrophic fires. The author suggests an integrated strategy to hamper the spread of forest fires "by creating discontinuities, avoiding very extensive, monospecific surface areas and creating patchworks of different inflammability levels that "disturb" the fire." These actions "should aim to create mosaics of species, by integrating other activities that give rise to discontinuity, such as roads, electricity line fuelbreaks, cultivations and recreational areas." Below is a review of how Israel adapted this strategy.

5.1 Alteration of Surface Fuels

Grazing: Up until the establishment of the State of Israel in 1948, goat grazing on public lands was intense and relatively unregulated. A degraded landscape of overgrazed Mediterranean maquis was a common sight. The “black goat law”, imposed by the government in 1950, caused a gradual reduction in the number of goats and grazing pressure. A further reduction occurred in the 1980’s for socio-economic reasons. In some forest areas, grazing pressure even decreased much below the desirable level for effective elimination of dry herbaceous vegetation and regenerating evergreen shrubs and trees. This changeover from goat to cattle grazing encouraged the expansion and invasion of thorny shrubs formerly eaten by goats (*Sarcopoterium spinosa*, *Calycotome villosa)* into the forest’s understory and open patches, thus resulting in dangerous levels of accumulated forest fuels.

At present, beef cattle occupy most of the grazed forestland, though a small percentage of sheep and goats graze as well. The JNF Forest Department encourages controlled grazing in planted and native forests (see Photo 1). The issuance of licenses according to herd size and carrying capacity of the grazing area restricts grazing to specific areas, timeframes and pressures. During the last two decades, silvopastoral management of large, planted forests developed (Etienne 2000; Tsiouvaras 2000). The Forest Department carries out infrastructure development (fencing, watering and tending compounds) for herd owners in or nearby the forest. This aims at avoiding any legal tenure of the herd owners on the forestland, which is national property. These activities are financed by the KKL, the Ministry of Agriculture and the Israel Lands Administration through a joint administrative body known as the “Pasture Authority”.

Herbicide Application: The use of herbicides for vegetation control of forest fuels is primarily utilized along forest road corridors, forest edges and the perimeters of intensive recreational zones – areas in which grazing is not possible or where total control is desired from the time of the target vegetation's emergence (early winter). Weitz (1974) reports the spraying of firebreaks commenced in the early 1960's. Now, as then, applications typically employ a combination of non-selective pre- and post-emergent compounds to eliminate unwanted annuals and perennials. Simazine, sulfometuron (Oust) and glyphosate (Roundup) are the most commonly applied materials, at rates of: Simazine - 5000 grams/hectare; sulfometuron - 20 grams/hectare; glyphosate – 2000-3000 cc/hectare.

Slash Treatment: A major source of fuel build-up in the forest is slash and wood residues from silvicultural treatments, such as pruning, thinning and clearcutting, and accumulated fuels in untreated, overstocked stands. In the past, all practices to reduce fuel loading were manually done – forest residues were removed and burned solely by forest workers. The high cost of this practice led in many cases to its discontinuation, with much slash remaining untouched in the forest. Thereafter, “whole tree” logging by contractors began in thinning and clear-cutting operations. In this practice, delimbing and bucking of logs takes place along a roadside or outside the forest, with the residues burned, chipped or removed from the site.

Prescribed Burning: In the late 1980s and early 1990s the use of broadcast prescribed burning as a tool to reduce fuel loading on the forest floor received attention. In 1987, a KKL-USDA Forest Service cooperative

exchange program came into being. Forest Service specialists made five advisory missions to Israel: 1987 (fire management team; Brandel et al. 1988), 1989 (forest fire protection), 1990 (prescribed burning), 1991 (fire weather team) and 1992 (prescribed burning), and in 1993, two specialists conducted a two-week prescribed burning seminar and workshop in the north and central regions (Carlton et al. 1993). Conversely, KKL specialists attended USFS sponsored courses on firefighting techniques (Avni et al. 1990) and technology such as fire behaviour modelling (Woodcock 1991).

Photo 1. Intensively managed grazed fuelbreak.

Photo 2. High-pruned fuelbreak surrounding an industrial site

The parameters for a successful and efficient prescribed burn under the condition of planted pine forests in Israel were determined (Kutiel 1989; Zohar et al. 1988, 1990a, 1990b, 1994, 1996). The use of this method has remained limited to sites for renewal plantings, remote sites around military firing zones and garbage dumps that occasionally burn unaided. Most of the forest areas in Israel are located close to villages and cities, therefore complaints by the public regarding smoke from prescribed burns resulted in its confinement.

5.2 Firebreaks

Isolation of forest stands from surrounding open area fuels and prevention of fire spread between stands traditionally involved the construction of a network of vertically oriented firebreaks. Firebreaks were originally established throughout forests at the time of their planting (1950s to 1960s). A dense network of vertically arranged strips were located across forest landscapes and served their purpose to slow down or halt ground fires. The use of manual hoeing and annual herbicide applications created clean, vegetation-free zones. Once the majority of these forests matured to heights of over 12 meters, firebreaks were no longer an effective means of preventing the spread of fires, particularly the spread of crown fires. In addition, their maintenance became too expensive to sustain. Therefore, KKL abandoned the continued use and construction of vertically-oriented firebreaks on an intensive scale, except on sensitive forest borders and edges.

5.3 Forest Roads

In light of the lessons learned about firebreaks, a relatively high-density forest road network was constructed (0.09 kilometer of forest road / hectare of planted forest, and 0.02 kilometer of forest road / hectare of natural forest). They function as firebreaks as well as access points for fire crews and fire engines. Motor graders and herbicides maintain peripheral roads on a yearly basis and interior roads on a rotational bi- or tri-annual basis.

5.4. Breakup of Fuel and Landscape Continuity

Pruning: The removal of live and dead branches from the bole increases height to the base of a tree's live crown and removes ladder fuels that carry a ground fire into the forest canopy. Young conifers are pruned to a height of 1/3 total height and mature trees to a height of between 2-2.5 meters. Trees along main forest roads, recreational sites and certain borderlands receive a high pruning of 4 meters (see Photo 2).

Thinnings: The manipulation of stand density and tree spacing is utilized to maximize growth and survival of forest trees, to remove dead and dying trees, to open and create discontinuous canopy gaps and to facilitate access to ground crews. It is the primary silvicultural tool employed to manipulate vertical and horizontal changes to forest structure and fuel dispersal throughout a forest. Not only are tree fuels affected but ground fuels and understory plants as well. Extensive opening of the forest canopy encourages vigorous understory growth, thus increasing hazardous fine fuel build-up, compared to dense forest stands. Zohar et al (1988) found a positive relationship between stand density levels and rate of fire spread, and a negative relation to tree age and to the percentage of tree canopy cover. This tradeoff must be balanced with the application of controlled grazing to keep understory biomass at a safe level.

Planted Fuelbreaks: Planted fuelbreaks are a strategic form of tree planting incorporated into standard forest plantings. Conceived and utilized as important landscape elements, they break up forest fuel continuity in an aesthetic and ecologically sensitive manner (see Photo 3). They replace barren fuelbreaks with living forest elements functioning as green barriers to a fire's advancing movement. Chandler et al. (1983) describe it as "a greenbelt – a strip that has been converted to a non-flammable cover-type and is maintained in that state by irrigation and mechanical treatment". Some examples include:

- Cultivated, non-irrigated groves of Mediterranean fruit trees (olives, figs, almond, dates, pomegranate, pistachio etc.) (Zeidan 2000);
- Strips of low flammability trees (*Casuarina*, *Cupressus sempervirons*) throughout the forest and alongside forest roads, separating flammable stands from each other or from recreational areas (Zohar et al 1988);
- Low-density, open, park-forest formations (oaks, carobs) interspersed throughout a forest;
- The retention of small, unplanted, herbaceous, open patches located throughout the forest.

Shaded Fuelbreaks: The establishment and maintenance of shaded fuelbreaks in Israel shows promise as an integrative solution protecting human settlements, and the forests surrounding them, from devastating forest fires (Perevolotsky et al. 1996). A shaded fuelbreak is defined by Agee et al. (2000) as “an area manipulated for

the common purpose of reducing fuels to reduce the spread of wildfires". It is "created by altering surface fuels, increasing the height to the base of the live crown, and opening the canopy by removing trees". The authors envision them as a type of managed buffer strip constructed between built structures and the forests surrounding them. Based on the integration of ecological, biological, mechanical and chemical control techniques, they embody Wagner's (1994) concept of an "integrated forest vegetation management" approach to the specifically oriented goal of fuel reduction and management.

Photo 3. Planted fuelbreak of widely-spaced olive and cypress trees

The use and construction of shaded fuelbreaks around villages, towns and settlements has received wide attention during the past five years. Weatherspoon et al. (1996) attribute the following major benefits to them: 1) reducing severity of wildfires within treated areas; 2) providing broad zones within which firefighters can conduct suppression operations more safely and more efficiently; 3) effectively breaking up the continuity of hazardous fuels across a landscape; 4) providing "anchor" lines to facilitate subsequent areawide fuel treatments; and, 5) providing various non-fire benefits.

Several rural settlements in the Galilee have shaded fuelbreaks around them (see Photo 4). They were constructed to a depth of 100 meters from the external home borders by the following stages:

- intensive thinning of planted and natural forests surrounding the settlements created an open park-forest formation of 200-300 trees/hectare (6-7 meters between individual trees);
- high pruning of conifers to 4 meters and native trees to 50% of their height;
- complete removal of unwanted stump sprouts, shrubs, vines and low trees in the understory;
- complete slash treatment and removal through fire or chipping;
- fencing of the treated area;
- high intensity grazing of beef cattle and/or goats to remove fine fuel build up and prevent closure of the understory;
- periodic spraying of systemic herbicides to control problematic perennials not sufficiently eaten or trampled by the livestock.

Photo 4. Shaded fuelbreak of low density pines surrounding a rural community

5.5 Fire Prediction and Detection

National Fire Danger Rating System (NFDRS): In 1992, the KKL and the Israel Meteorological Service established a NFDRS with assistance from the United State Forest Service (Bradshaw et al. 1978, Woodcock 1993). On a daily basis, meteorological data is gathered. Forest fires indices [IC (Ignition component) and BI (Burning index)] are calculated on a regional basis, and alert readiness levels of fire suppression teams are accordingly declared. Three forecasted fire danger levels (regular, high, and extreme) provide the basis for determining the size of stand-by initial attack crews, the number of additional personnel to recruit for patrols, the number of lookout towers to activate, and the positioning of fire trucks and other equipment.

Fire Lookout Towers: First established in 1957, a complex of early lookout towers numbered 14 by 1967 (Weitz 1974). As forest area increased, the incidence and frequency of forest fires increased along with it. At present, a network of 40 lookout towers covers most of the country's forested areas (see Photo 5). The majority are staffed everyday during the fire season, between 09:00 and 19:00, with the remainder operated on “Red Flag” days. The Nature and Park Authority operate additional lookouts within nature reserves and national parks, thus complimenting the KKL's network. On average, observers on our lookout towers discover some 43% of reported fires with another 16% called in by KKL field workers.

Photo 5. Achihud Forest fire watchtower

6. Coordination, Computerization and Finances

Coordination: In 1988, a special unit was established in the Forest Dept. to coordinate activities nationally concerning fire prevention strategy (Kaider 1986). Areas of responsibility include: developing fire-fighting management strategies, overseeing the adoption and implementation of new techniques and technologies, development of a centralized in-house training program, supervising the adoption of a integrated communications technology, establishing a unified chain of command and control, and equipment acquisition.

Data Management: Since 1987, reports of forest fires enter a computerized database. Data on fire size, timeframe, location, type, cause, vegetation type, labour and equipment usage is recorded and stored for future statistical analysis. Annual reports summarize the past year's events and present trends concerning the effectiveness of pre-suppression and suppression strategies. These reports are an important management tool for tracking a strategy's effectiveness and its implementation, helping to identify strengths and weaknesses, and areas for improvement. The data format has changed several times but sufficient consistency was maintained to allow analysis.

Since 1995, fire data is managed in a centralized database, with access at any PC on the KKL's national network. This allows direct data input and updating from any of our eight district forestry offices as well as on-line summary reports at all management levels (see Chevrou et al 1995).

Geographic Information System: In 1995, the KKL launched a national forestry GIS project. This began with the complete remapping of our forested areas beginning with aerial photography and including extensive ground checking. The GIS layers of significance to fire management created in the framework of this project include forest stands, forest roads, lookout towers, recreation sites, and fire fighting logistics sites. A special, fire management map at a 1:25,000 scale was produced and distributed within the Forest Dept. and among other organizations involved in fighting open area fires (Police, Fire Brigades, Military, Governmental agencies, Local and Regional Councils, etc.), and include hydrant locations, rural airfields and pre-designated logistical meeting points for coordinated command and control operations.

Beginning in 1991, fire reports included the "x" and "y" coordinates of the burned area's center. Thus, from this time onwards, fire occurrence (point) layers are created from this data and used for statistical analysis of fire location and frequency on a geographical basis.

Fire Suppression Finances: An analysis of fire suppression expenditures for the years 1994-2002 reveals that they comprise, on average, 9-14% of the Forest Department's total annual operating budget (Figure 5), exclusive of pre-suppression expenses (pruning, road and fuelbreak maintenance, etc).

Whereas total forestry operating budgets have decreased over the last decade, fire suppression's share has increased proportionally (Figure 6), with most of the budget allocated to manpower costs, both internal (KKL workers) and external (outsourcing from contractors; KKL's contribution to an interagency aerial attack fund). It can be concluded that fire suppression expenditures for this time period comprised a fixed expense component of the annual budgets and were relatively inflexible to change in relation to overall budget changes. The question of whether or not to maintain a minimal level of uncompromised protection to our existing forest inventory is now under consideration.

7. Fire Suppression Organization

Fire suppression strategy bases itself upon a rapid, initial attack of small fires. Chandler et al (1983) describe the principles of initial attack as: 1) "sizing up" the fire before attack; 2) determining manpower requirements; 3) attack; and, 4) mop up. Each forest management area (25 nationwide) functions as an autonomous unit. A small crew of 3-5 workers is outfitted with two-way radios and cellular phones, and equipped with a small wildland fire truck (250 gallon water tank + fire retardant system) including tools and gear (hoses, nozzles, backpack sprayers, chain saw, drip torch, fire rakes, fire swatters, hoes, drinking water, gloves, goggles, helmets, and smoke masks). There is a program to replace some of these small trucks with larger capacity ones (500-750 gallons), thus enhancing our capability to deal with medium sized fires.

Employing an "initial attack strategy" (Wenger 1984), these crews usually arrive at a fire scene within 20 minutes of receiving a call, and successfully control between 80-90% of all fires unaided (Rosenberg 1986). The combination of high accessibility to forests and short detection times of forest fires has proven to be a successful recipe for minimizing damage to our forests from fire. In addition, our initial attack strategy gives the fire boss time to rapidly assess the situation and organize enlistment of additional KKL crews and/or municipal fire brigades in the case of medium- and large- sized fires. The employment, in some cases, of helicopters and small, fixed-wing, agricultural aircraft happens when ground crews cannot reach the fire or when weather conditions demand a massive attack on the fire front.

On "Red Flag" days, additional lookouts, mobile patrols and suppression crews operate, with aircraft held in ready for rapid deployment at local airfields located throughout the country. Mobile crew deployment is flexible. They can move between different forest management areas, districts and even regions according to logistical needs. Larger blazes necessitate an "expanded attack strategy", contingent on the employment of additional small crews, local fire brigades and/or other open space management agencies, and the use of bulldozers and/or aircraft (Wenger 1984).

Exceptionally large conflagrations, which can rage over the course of several days and require simultaneous operations on several fire fronts, are treated as "project fires" (Wenger 1984). The current suppression and attack strategy for large-scale fires predicates itself upon interagency coordination and cooperation between the KKL, municipal fire brigades, Nature and Parks Authority, the Israeli Air Force, Israeli Police and emergency medical services, and the division of operations into separate sectors of responsibility. Establishment of a mobile joint command center facilitates open and clear lines of communication between all participating

agencies and gives an overall, real-time picture of fire events to managers. Common radio frequencies facilitate clear contact between ground crews and aircraft pilots.

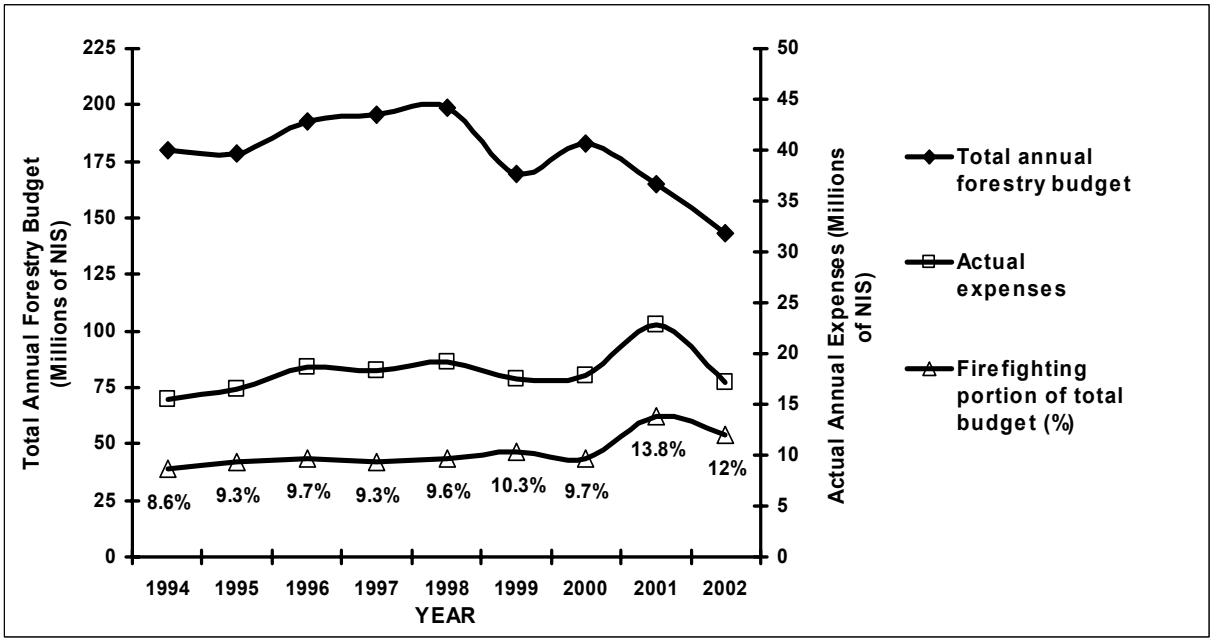

Figure 5. Fire suppression expenses as related to total annual budget (1994-2002)

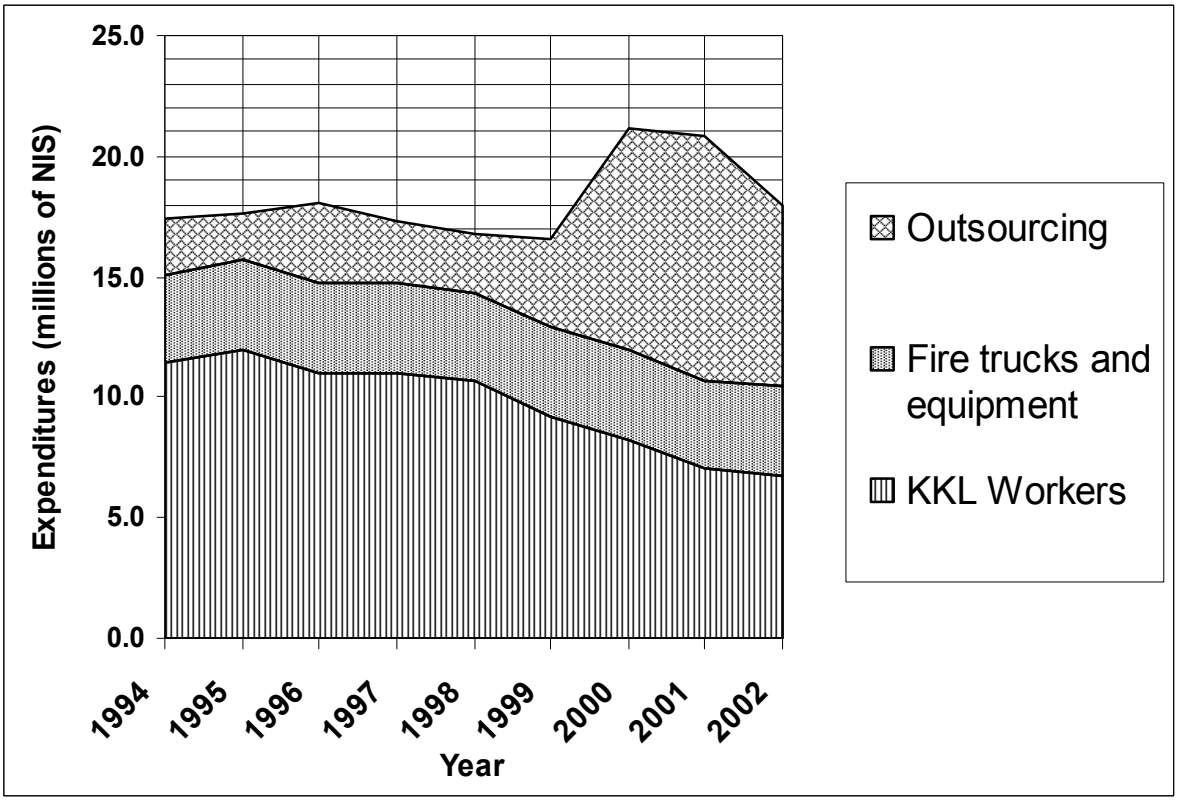

Figure 6. Allocation of annual fire suppression expenditures (1994-2002)

8. Conclusion

Dramatic and significant changes occurred to the fire fighting structure of the KKL Forest Dept. in Israel over the past fifteen years. As part of the natural growth cycle and maturation of first generation afforestation plantings and regenerating natural oak forests, catastrophic fire events became more and more predominant, and gripped the public's attention.

Today, all of Israel's forests, cities, towns and villages lie on the urban/rural interface. Demographic trends and intense land use pressures are contributing factors in a nationwide challenge to deal with forest fires along this interface. Experience has shown that the integrated application of fuel reduction methods in pine forest management can effectively reduce fuel loading in Israel's forests and the subsequent fire hazards associated with it.

Integrated management of pre-suppression measures linked to a continuously updating data and financial management system, and an updated GIS, provide very powerful tools for managing and evaluating fire fighting strategy in the short-, medium- and long terms. Managerial and silvicultural decisions are interdependent and linked to the analytical ability of the organization to self-evaluate and self-improve, based on its long term strategic goals.

Shaded fuel break construction is the most integrated form of fuel management employed, using silvicultural and ecological techniques of combined land management to create living buffer strips around rural communities threatened by wildfire.

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RUSSIAN FEDERATION

The Current Fire Situation in the Russian Federation: Implications for Enhancing International and Regional Cooperation in the UN Framework and the Global Programs on Fire Monitoring and Assessment

1. Introduction

During the last decade a number of international projects and programmes have been initiated to address the ecological role and the environmental and humanitarian impacts of wildland fires. Considering the importance of the role of Eurasia's forests in the functioning of the global system and the potential threats by wildland fire to the sustainability of vegetation cover in the region the participation of the Russian Federation in these initiatives is crucial.

This paper reflects on some basic facts on the role and magnitude of wildland fires in the Russian Federation, including the Far East of Russia. It provides a retrospective on some projects that have been conducted between Russia and its international partners. Finally the contribution of the Russian Federation to cooperative initiatives under the UN framework and the global programs on fire monitoring and assessment are described

2. The Fire Situation in Russia During the Last Decade

The worlds total boreal forests and other wooded land within the boreal zone cover 1.2 billion ha of which 920 million ha are closed forest. The latter number corresponds to ca. 29% of the worlds total forest area and to 73% of its coniferous forest area (ECE/FAO 1985). The vast majority of the boreal forest lands of Eurasia are included in the Russian Forest Fund, covering ca. 900 million ha. Depending on the criteria used to define "boreal forest", the area of closed boreal forest in the Russian Federation varies from 400 to 600 million ha. These numbers correspond to a 43-65% share of the worlds closed boreal forest.

Wildfires from natural causes (lightning) constitute a very important ecological factor in the formation and sustainability of boreal forests. In interaction with the climate and local growing conditions fire controls the age structure, species composition, landscape diversity and mosaic of vegetation, as well as energy flows and biogeochemical cycles, especially affecting the global carbon cycle. In the history of Eurasia's boreal forests fire has been used as a tool for land clearing, agriculture, hunting and pastoralism. During these historic times land-use fires often escaped control and spread as wildfires in the surrounding forest lands.

In the beginning of the 20th century the importance of fire application in the agricultural sector began to decrease. However, in spite of the reduction of traditional burning practices humans are still the most important source of wildfires; on average only 15% of fires in protected forests of Russia are caused by lightning.

Whereas in the last century a reduction of wildfires has been observed in Western Eurasia (Norway, Sweden, Finland) an increasing fire occurrence has affected the Eurasian part of Russia and other countries of the Commonwealth of Independent States (CIS).

The official statistics show that in Russia between 20,000 and 40,000 fires occur annually affecting an area of 2 to 3 million ha of forest and other lands (Davidenko et al. 2003). They are detected and controlled only in the so-called "protected forests" and on the protected pasturelands. However, the use of the space-borne sensors such as the NOAA/AVHRR Advanced Very High Resolution Radiometer) and more recently Terra/Aqua/MODIS (Moderate Resolution Imaging Spectroradiometer), ENVISAT/MERIS (Medium Resolution Imaging Spectrometer) and Terra/ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer), permitted considerable improvement in the detection of active fires along with better estimation of areas burned and impacts, at a scale that suits practical purposes.

For example, before the 1980s it was believed that, on average, fires annually burned 1.5 million ha in the boreal forests on the territory of the former Soviet Union Recent investigations based on satellite imagery revealed that the magnitude of fires had been underestimated. Surveys using remote sensing ascertained that boreal zone fires burned annually an average of 8 million ha with considerable fluctuation between years. For

example in 1987 satellite image evaluation revealed a total area burned in boreal forests and other land in the East-Asian regions of Russia of about 14 million ha (Figure 1).

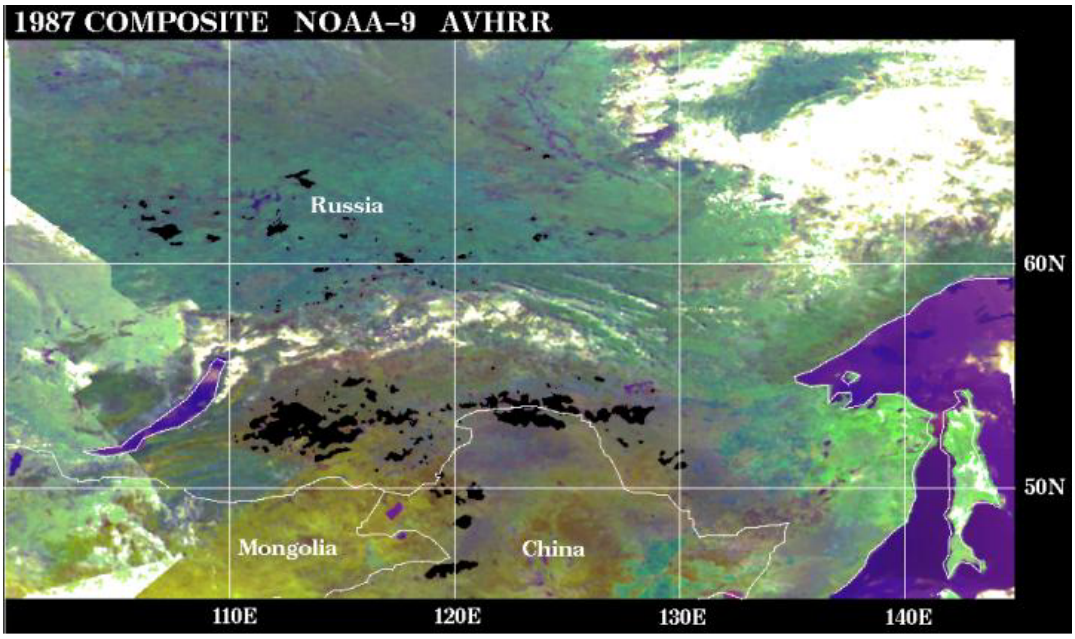


Figure 1. NOAA-AVHRR-derived burn scar map of the fire season of 1987 (Cahoon et al. 1994).

The Fire Seasons of 2002 and 2003

The fire seasons of 2002 and 2003 were extremely severe. Table 1 shows the magnitude of fires affecting the territory of the Russian Federation as reported by the government agencies and as depicted by satellite-based remote sensing.

Table 1. Comparison of wildland fire data for the Russian Federation: Agency reports vs. satellite-generated data. For details: See text.

Year	Agency Reports based on Ground and Aerial Observations			Satellite Derived Data (NOAA AVHRR) Based on Fire Counts and Derived Area Burned		
	Number of Fires Reported	Total Area Burned (ha)	Forest Area Burned (ha)	Number of Fire Events investigated	Total Area Burned (ha)	Forest Area Burned (ha)
2002	35,000	1,834,000	1,200,000	10,355	11,766,795	n.a.
2003	28,000	2,654,000	2,074,000	16,112	17,406,900	14, 474, 656

The table reveals the problems of accurate fire size and impact assessment. There are obvious discrepancies between the reported sizes of area burned by ground or aerial observations versus the data derived from satellite sensors. The area under protection and monitoring by *Avialesookhrana* covers a total of 690 million hectares of vegetated land, primarily forests. *Avialesookhrana* relies on aircraft and ground-based means to monitor ongoing fires and report fire summaries for daily updated statistics. The organization is facing severe financial and logistical constraints resulting in reduced availability of modern equipment, personnel and flight hours to adequately monitor and map fires from the air and on the ground. Thus, the reported total area affected by wildfires in 2002-2003 on the area of jurisdiction does not reflect the complete picture.

The Krasnoyarsk satellite receiving station at Sukachev Institute for Forest, now capable of downloading and processing both AVHRR and MODIS data, covers the Asian part of Russia, approximately one billion ha of

vegetated land area between the Urals in the West and Sakhalin Island in the Far East. The surveyed area includes all vegetation types (forest, tundra, steppe, etc.). In this region the active fires depicted by NOAA AVHRR and derived burned area in 2002-2003, however, bears an uncertainty and must be adjusted. According to the Fire Laboratory there is an overestimation of areas burned by small fire events due to the system-inherent low spatial resolution of the AVHRR sensor. Deducing all fire events smaller than six AVHRR pixels (equivalent to 600 ha) would reduce the overall size of area burned in 2002 in the Russian Federation and Kazakhstan by ca. 16 percent. However, the Krasnoyarsk fire laboratory is using the most conservative algorithm of fire detection, and all high-temperature events are identified as a fire with a probability of 95%.

On the other hand there are fire events that were not recorded by the satellite due to cloud cover and sensor detection limits. This may partially compensate the overestimation of burned area assessments by fire event counts. Since the total size of the area burned in Asian Russia mainly depends on large fires the total range of error is assumed to be in the magnitude of 20 percent or less. The larger number of fires reported by *Avialesookhrana* is due to many small fires that either remain undetected by AVHRR or are within single pixels and hence are not counted separately (Csiszar et al., this volume).

Intercomparison of data generated by various institutions is needed to verify the fire datasets. For instance, comparison of the 2002 fire dataset for Irkutsk Oblast with the products of the Irkutsk Institute of Solar and Terrestrial Physics reveals similar levels of fire occurrence: The Krasnoyarsk Laboratory recorded 882 fire events affecting a total of 554,665 ha, whereas the Irkutsk Laboratory recorded 1055 fires affecting a total of 625,800 ha.

Another recent study conducted by the authors of this paper investigated the fires of 2003 occurring in the region between 110.27°E to 131.00°E and 49.89°N to 55.27°N evaluating scenes of MODIS, MERIS and ASTER and compared with NOAA AVHRR. The study revealed that more than 20.2 million ha of forests and other lands had been affected by fire (Siegert et al., 2004).

Other datasets are not yet directly comparable with the Krasnoyarsk data for the Asian part of Russia. For instance, the Global Burnt Area 2000 initiative (GBA-2000) of the Global Vegetation Monitoring (GVM) Unit of the Joint Research Center (JRC), in partnership with other six institutions, has produced a dataset of vegetated areas burnt globally for the year 2000, using the medium resolution (1 km) satellite imagery provided by the SPOT-Vegetation system to derive statistics of area burned per type of vegetation cover (GBA-2000). The global dataset available for the year 2000 provides area burned by nations. The dataset reveals a total area burned in all vegetation types of Russia during the fire season 2000 of 22.38 million ha, thereof 3.11 million ha of forest, 3.31 million ha of woodland, 5.3 million ha of wooded grassland, and 10.66 million ha of other land (including 7 million ha prescribed burning of croplands). The GBA-2000 number of 6.4 million ha of forest and woodland burned must be compared with the reported area burned for the *Avialesookhrana* region of 1.64 million ha (Avialesookhrana 2002) and for the Asian region of Russia (that is covered by the Krasnoyarsk satellite receiving station) of 9.7 million ha of all vegetation types (Sukhinin 2003, pers. comm.). A similar discrepancy was found for 1998: an analysis of the fires in Siberia depicted by satellite was 13.3 million ha – an area five time higher than the official statistics for the same year (Conard et al. 2002). The analysis of fires in Russia between 1996 and 2000 by NOAA AVHRR conducted by Soja et al. (2004) also support the discrepancy between officially reported fire sizes and satellite-derived data.

Based on the discrepancies between the different satellite datasets on the one side and conventionally collected fire data on the other side the question of absolute accuracy of satellite data seems to be of minor concern. Most important is to analyse and close the extremely large gap between the datasets of the operational users and the remote sensing institutions.

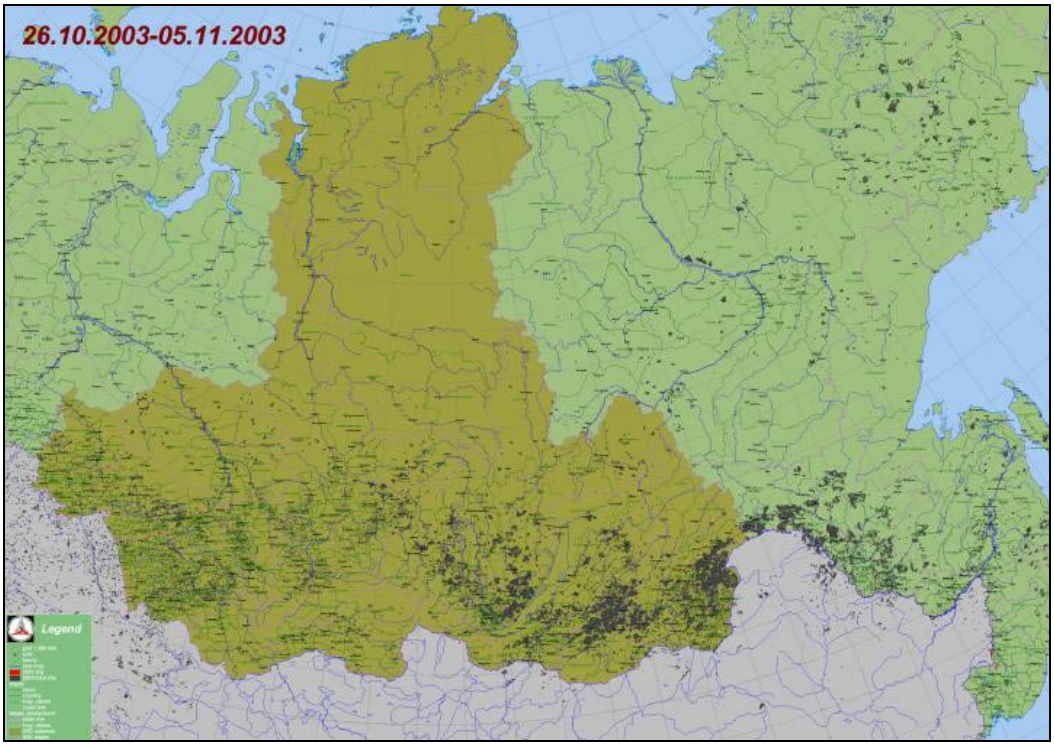


Figure 2. NOAA-AVHRR-derived burn scar map of the fire season of 2003. Source: Sukachev Institute for Forest.

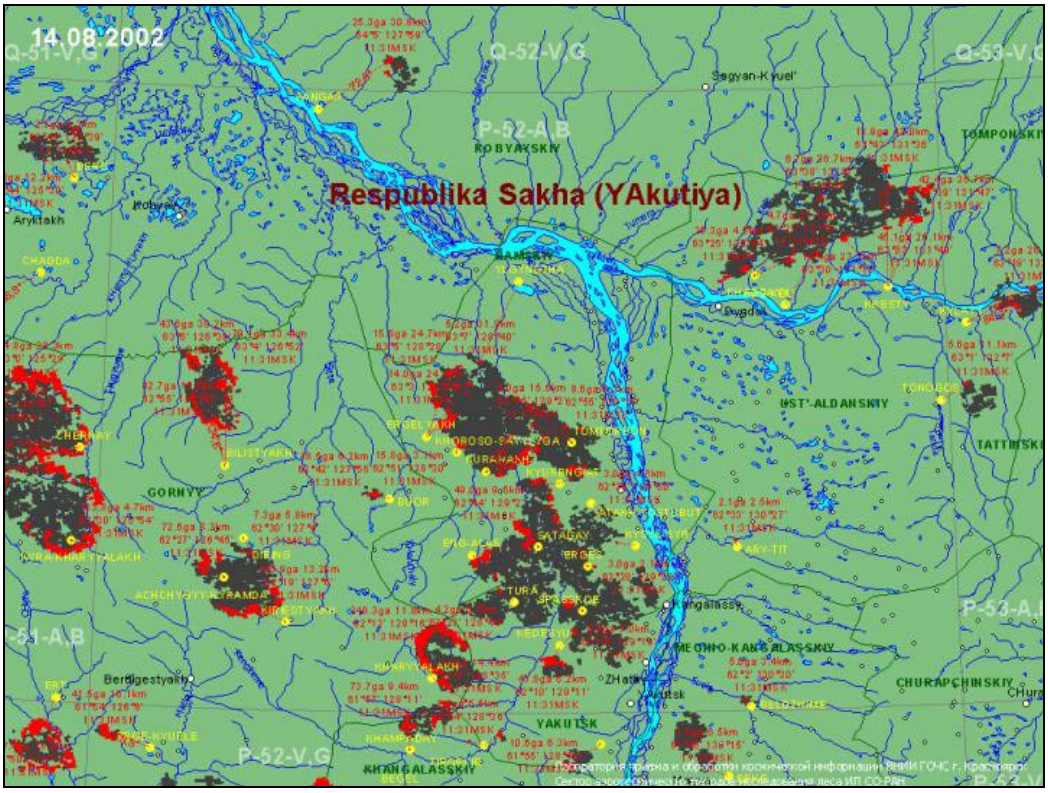


Figure 3. Example of a daily NOAA-AVHRR-derived burn scar map (Yakutia, 14 August 2002) generated by the Fire Laboratory of Sukachev Institute for Forest and displayed daily on the GFMC website.

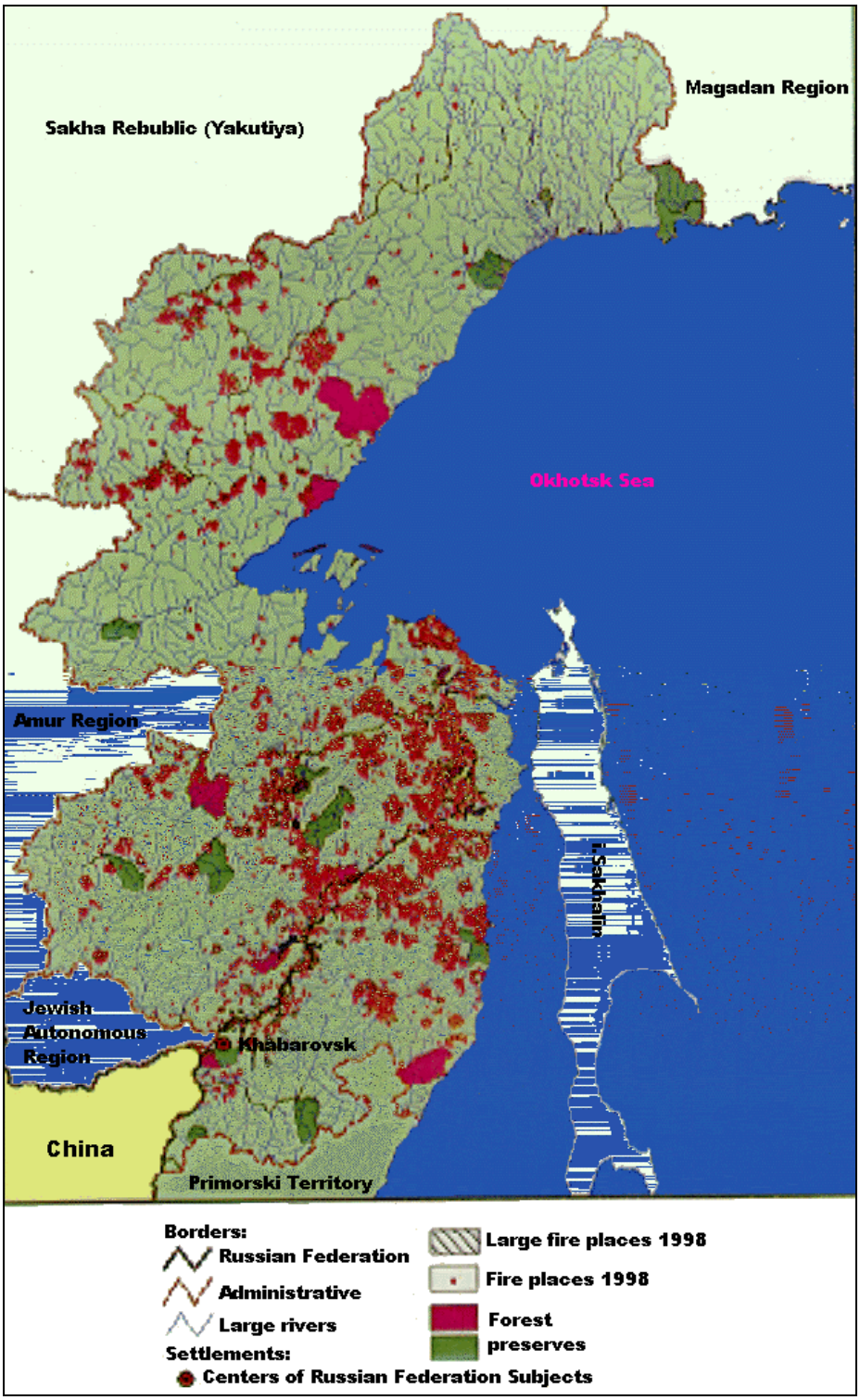


Figure 4. Forest fire map of Low Priamurya region at the end of the 1998 fire season. This fire map was digitised with the assistance of the Amur Design Office of the Russian Branch of the World Wide Fund for Nature (WWF). Source: Efremov and Sheshukov 2000.

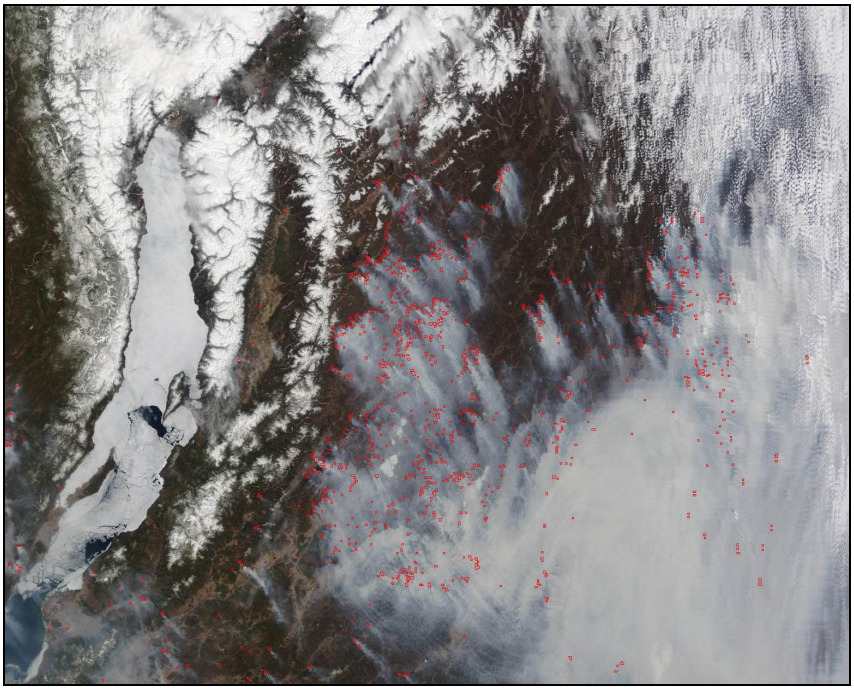


Figure 5. Fire activities on 8 May 2003 at 0400 UTC (11:00 local time) Southeast of Baikal Lake. Source: Moderate-Resolution Imaging Spectroradiometer (MODIS).

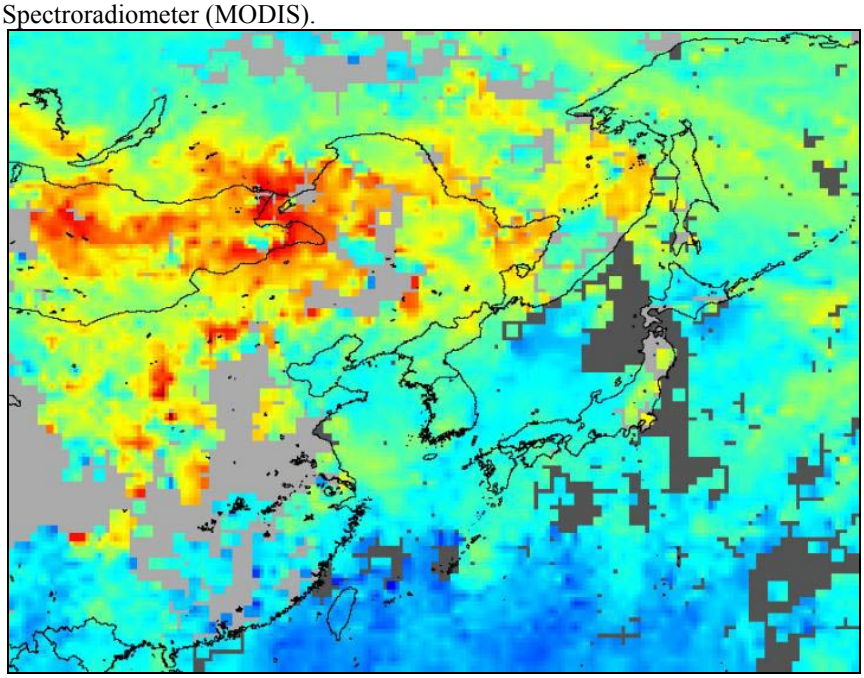
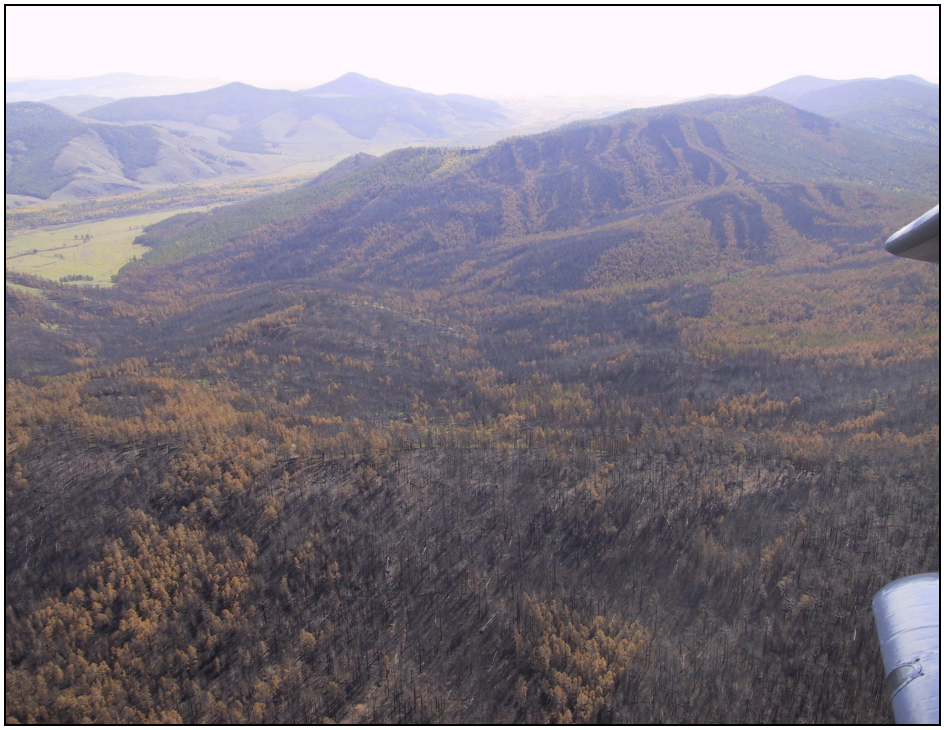


Figure 6. Accumulated carbon monoxide concentration for the period 3-8 May 2003 originated by smoke from wildland fires in the Transbaikal Region. The image shows measurements of carbon monoxide captured by the Measurements of Pollution in the Troposphere (MOPITT) sensor on the Terra satellite, with values ranging from zero (dark blue) to 360 parts per billion (red). Source: NASA Earth Observatory (http://earthobservatory.nasa.gov/)



Figures 7 and 8. Aerial view of forests in Buryatia Republic affected by wildfires in 2003 (aerial survey dated 15 September 2003). The upper photograph (5) shows the typical interface between steppe and agricultural lands and forests. The lower photograph (6) shows a significant amount of high-intensity fire scars resulting in extended destruction of forests due to the extremely dry weather conditions between mid 2002 and 2003. Photos: ©GFMC.

3. Implications of Wildland Fires in the Russian Federation on the Global Environment

3.1 Climate Change and Fire

Numerous scientific initiatives over the past years intended to clarify the role and importance of natural and anthropogenic fires in the forests and other vegetation on regional and global processes affecting the Earth system. The main issues addressed included:

- Recent changes of fire regimes due to anthropogenic and climate influences
- Carbon pools and carbon fluxes affected by changing fire regimes
- Improving of monitoring tools for assessing area burned and post-fire ecosystem development
- Role of fire on permafrost ecosystems, including release of ice-trapped paleo-trace gases by direct and indirect fire effects

Consequently several interdisciplinary research campaigns were initiated between 1993 and 2000, e.g. the Fire Research Campaign Asia-North (FIRESCAN), the IGBP Northern Eurasia Study and the project Fire Effects in the Boreal Eurasia Region (FIRE BEAR) (FIRESCAN Science Team. 1996, Goldammer and Furyaev 1996, Steffen and Shvidenko 1996, McRae et al. 2004). The most recent initiatives include the establishment of the Northern Eurasian Regional Information Network (NERIN), Siberian/Far Eastern Regional Network and the Western Russian / Fennoscandian Regional Network of the Global Observation of Forest Cover/Global Observation of Landcover Dynamics (GOFC/GOLD) programme and the Northern Eurasian Earth Science Partnership Initiative (NEESPI) (Csiszar et al., this volume).

Despite the high investments and research efforts the wildland fire science community has not yet a clear and holistic picture about the past, current and possible future role of vegetation fires at regional to global levels.

Climate-change models (Global Circulation Models - GCMs) have been used since the early 1990s to predict drought severity and consequently fire severity. One of these scenarios has been provided in the last issue of IFFN (No. 28, p. 2-14). It is based on the GCM of the Canadian Climate Center (CCC) and compares fire severity rating across Russia under the current climate conditions vs. a projected climate-change scenario for the year 2030 (Stocks et al. 1998).

3.2 Peat Fires – an Increasing Problem in Russian Eurasia

According to the Wetlands International Russia Programme peatland fires are a common phenomenon in the Russian Federation (Minaeva 2002) and may contribute to about 10% of the total area burned (Shvidenko and Nilsson 2000). In late July 2002 a severe fire episode started that mainly affected the regions Tver, Vladimir, Ryazan, Nizhnij Novgorod, and the North-West region. On 31 July 2002 ABC News reported *"Muscovites awoke on Wednesday to find their city covered in smog with the smell of burning from wildfires raging outside the Russian capital. A slight easterly wind pushed the smoke toward the city, as far as the centre, but was not strong enough to disperse it, said meteorological experts quoted by Moscow Echo radio. Moscow media said the smoke posed a health risk to residents of the city. The authorities have identified 76 separate wildfires in the Moscow region, which has been affected for several weeks by a heat wave, Moscow Echo radio reported. According to the emergencies ministry, the surface area of forest on fire around Moscow has risen sharply in the past 24 hours, reaching ca. 100 ha, ITAR-TASS reported"* (ABC News 2002). On 6 September 2002 the European Water Management News (EWMN) reported that the number of peat and forest fires had doubled in Moscow Region within 24 hours. The resulting haze reduced the visibility to less than 100 meters in the Russian capital, and the concentration of carbon monoxide exceeded the norm by more than three times (European Water Management 2002).

The smoke pollution in Moscow Region between end of July and early September 2002 reached alarming levels and did not only cause a dramatic reduction of visibility but also had detrimental impacts on the health of the Muscovite population. It is well known that smoke from vegetation fires has a number of solid and gaseous constituents that dangerous to human health, e.g., particulates smaller than micrometers in aerodynamic diameter, formaldehyde, Polycyclic Aromatic Hydrocarbons (PAHs), or carbon monoxide (CO).

Most concerning are the impacts of particulates on the respiratory / cardiovascular systems. They cause, among other, respiratory infections in adults and acute respiratory infections in children, acute and chronic changes in

pulmonary function, respiratory symptoms, asthma attacks, and cardiovascular diseases (WHO/UNEP/WMO 1999a, b). An increase of hospital admissions was noted in Moscow. At present no information is available on increased daily mortality due to peat fire smoke pollution.

Peatlands in Western Russia have been drained and used for agricultural purposes since the early 19th Century. As Minaeva (2002) stresses the fen peatlands were used as agricultural fields but are out of use now. Lands where peat was extracted were abandoned without recultivation and left to the management of local administrations of the *Rayons* which normally have no funds to properly manage and protect the former wetlands. In most cases the fires started outside the peatlands, caused by forest visitors, hunters, tourists, or by agricultural burning and burning activities along roads. Legislation is not clear, and there is no law enforcement. During the peak of peatland burning many people continued to visit the forests around Moscow, even when the fire situation was quite obvious.

Currently there are plans to restore peatlands by flooding. These plans that have been pushed by the Ministry for Emergency Situation (EMERCOM) but in many places are opposed by peat extractors or owners of *datcha* properties that have been established on former peatlands.

A recent paper by Bannikov et al. (2003) provides a in-depth case study of peat fires in Western Russia. The report reveals the problems arising from peat fires and the necessity to develop land-use plans that would avoid future fire and smoke disasters in Western Russia.

3.3 Impact of Russia's Vegetation Fire Emissions on the Global Carbon Cycle: Problems of long-term Assessments and a Case Study of 2003

3.3.1 The problem of determining the long-term atmospheric impacts and the fate of fire-released carbon

Numerous investigations in the past years have attempted to quantify the emissions from vegetation fires occurring in the Russian Federation and in other parts of the boreal zone to the atmosphere (for syntheses see Goldammer and Furyaev 1996, Kasischke and Stocks 2000). The general aim of many studies was to assess the area burned and the amount of organic matter combusted in order to calculate radiatively active trace gases and particles released to the atmosphere.

A recent example of such a study for the assessment of fire emissions in the Russian Federation is provided by Kajii et al. (2002). The authors used NOAA-AVHRR satellite data to quantify forest fires in boreal Siberia and northern Mongolia during April through October 1998, a year of extremely dry weather, in particular, in the Russian Far East. The total area burned was estimated to be 11 million ha with 350 million tons of biomass consumed and 176 million tons of carbon released into the atmosphere. The carbon released into the atmosphere was calculated to contribute 516 million tons of carbon dioxide (CO_2), 50 million tons of carbon monoxide (CO), 1.6 million tons of methane (CH_4), 1.1 million tons of non-methane hydrocarbons (NMHC), and 9.5 million tons of C particles as smoke. In addition, it was estimated that 1.8 million tons of nitrogen oxides (NO_x, as NO_2) were released.

However, calculations of emissions released by vegetation fires (= prompt release of carbon) do not allow to derive conclusions on the long-term fate of carbon – the most critical element determining the radiative characteristics of the atmosphere. Fire research has revealed the historic and cyclic nature of wildland fires in boreal ecosystems of Eurasia. Natural fire regimes are characterized by fires of various return intervals and severities. The return interval of fires in grasslands and steppe ecosystems is short, ranging between one and five years. As a result the fuel loads, fire intensities and severities in these fire ecosystems are low. Recurring fires play an important role in the dynamics of these open landscapes.

Surface fires in Siberia's fire-adapted coniferous forests also constitute a regularly occurring phenomenon which is considered important to maintain stability, productivity and carbon sequestration potential of these ecosystems.

Fires of high intensity and high severity that involve destruction of forest stands with subsequent ecosystem regeneration (stand-replacement fires) are also a typical feature of the complex ecosystem composite of boreal

Eurasia and must not necessarily lead to forest loss or reduction of carbon sequestration potential at long-term. However, ecosystem recovery after high-severity stand-replacement fires requires a much longer time span.

Replacement of coniferous stands by deciduous stands, for instance, may also not lead to a significant reduction of the terrestrial carbon pool. Thus, the sequestration of carbon in post-fire growth follows different cycles and pathways.

It is obvious, however, that the combined effects of extrinsic disturbance factors such as climate variability or climate change, land-use practices and ecosystem manipulations may negatively affect site productivity and "carbon carrying capacity" of ecosystems. The formation of "green deserts" are a consequence of inappropriate logging practices, sometimes combined with wildfire occurrence, and represent just one example of the effects of multiple disturbances that may lead to irreversible ecosystem degradation and consequently to a loss of carbon to the atmosphere. The same refers to the peatlands impacted by drainage, extreme drought and fire. Fires burning deeply or completely consuming organic terrain layers lead to a net release of carbon to the atmosphere and biosphere.

In conclusion it must be stated that it is prohibitive to derive from any area affected by fire alone that these events will contribute to long-term changes in the atmosphere. However, if a trend of changes in fire regimes (change of fire severity and/or fire-return intervals, and ecosystem recovery patterns) is observed it is permissible to derive changes of secondary fire impacts such as the influence of a net increase of carbon to the atmosphere.

3.3.2 The Year 2003 – An Indicator of Changes in Fire Regimes and Fire Impacts ?

The year 2003 turned out to represent an example of an extreme fire year in which the combined effects of

- extreme drought
- reduced capabilities of the fire management establishment
- inappropriate forest management involving extended clearcuts, and
- the socio-economic conditions in the regions and neighbouring countries

may have initiated a development which potentially will lead to a net loss of forest cover and contribution to atmospheric changes.

Most affected by drought were the regions Northwest and Southeast of Lake Baikal. Extremely low precipitation was recorded in the 10-month period between August 2002 and May 2003 in Buryatia Republic (total rainfall: 36.0 mm) and Chita Oblast (45.7 mm)[21]. Besides these precipitation data a vegetation health map generated by NOAA AVHRR satellite data shows a dramatic picture of vegetation stress and drought on 1 June 2003 – a situation much more extreme as compared to 1987, the last extreme drought and fire year in the Transbaikal Region (Figure 9).
In the same year 2003 the Aerial Forest Fire Service *Avialesookhrana* continued to be faced with insufficient budgets for operations. Thus, the organization had to reduce aerial observation flights that are crucial for early detection of wildfires and rapid response. Aerial surveys are also important for mapping of fire effects. Thus, with the reduced budgets it was not possible to suppress wildfires in an early stage. Consequently the wildfires grew large in size and became uncontrollable in most cases.

Another aggravating factor of the wildland fire theatre in the region around Lake Baikal, especially in Buryatia and Chita, is the increasing occurrence of arson fires. The underlying causes for arson fires are deeply rooted in the economic development of Southeast Russia, Mongolia and neighbouring China. The depletion of China's forest resources and the increasing demand for timber products on the market in China have created an enormous pressure on the forest resources of Mongolia and the Russian Federation. Observations in the Russian Federation and in Mongolia indicate that Chinese timber dealers have encouraged or bribed local people to set fires to forests in order to increase the permissible salvage logging areas and thus increase the timber export to China. In addition extended illegal logging and timber export has been observed during two on-site inspection missions in Mongolia and the Russian Federation by the first author during 2003.

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[21] Weather data were supplied by the Regional Avialesookhrana Airbases in Buryatia and Chita, with the kind assistance of Mr. Yevgheny Shuktomov, Mr. Anatoly S. Netronin and Viacheslav Lantsev.

A fourth factor contributing to the overall degradation of forest sites are the consequences of large clearcuts. In the dark coniferous taiga forests in northern part of Siberia large-scale clearcuts of the 1990s nowadays show no natural regeneration of forest. This is also observed in some southern light taiga forests where the combination of removal of seed trees, clearcut sizes extending the aerial seed transport distance for pines (ca. 500 m) and recurrent fires have resulted in large non-forested areas dominated by pure grass stands. These "green desert grasslands" are maintained by regular fires – a phenomenon that has been observed at large scale in Mongolia and China.

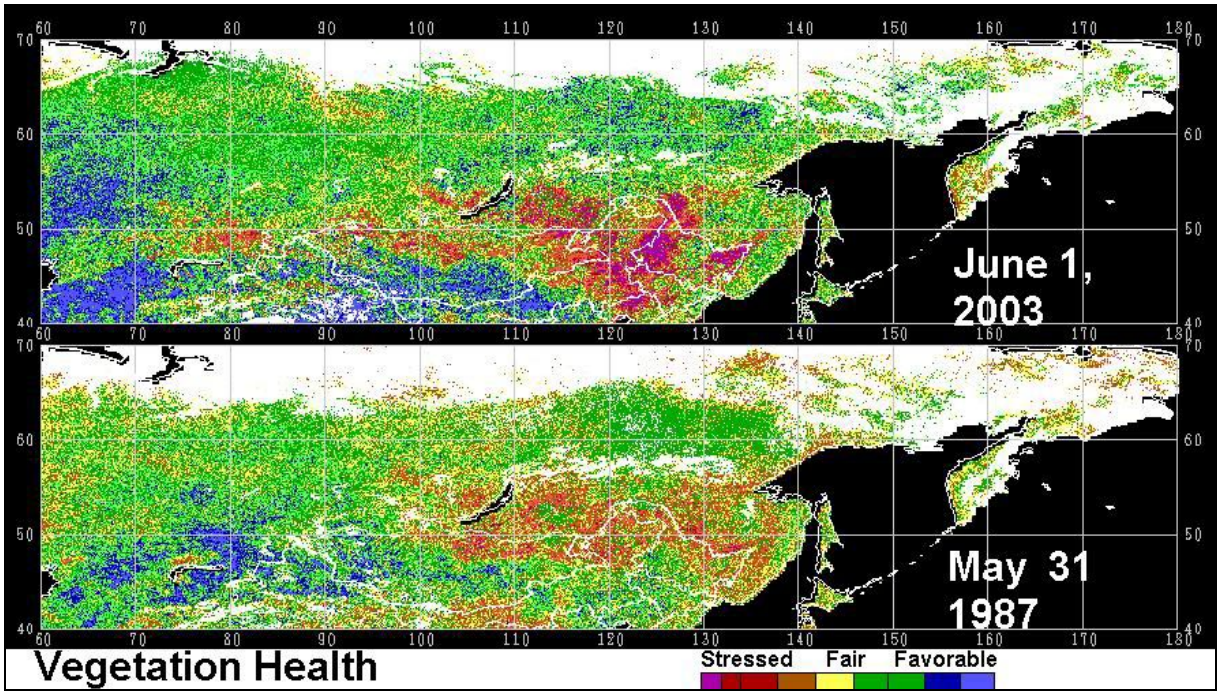

Figure 9. Vegetation health maps of Southern Siberia, Mongolia and Northern China on 1 June 2003 and 31 May 1987. The images is a colour-coded map of vegetation condition (health) estimated by the Vegetation and Temperature Condition Index (VT). The VT is a numerical index, which changes from 0 to 100 characterizing change in vegetation conditions from extremely poor (0) to excellent (100). Fair conditions are coded by green colour (50), which changes to brown and red when conditions deteriorate and to blue when they improve. The VT reflects indirectly a combination of chlorophyll and moisture content in the vegetation and also changes in thermal conditions at the surface. This new approach combines the visible, near infrared, and thermal radiances in a numerical index characterizing vegetation health. This approach is extremely useful in detecting and monitoring such complex and difficult-to-identify phenomenon as drought. The VT values below 35 are used for identifying vegetation stress which is an indirect drought indicator. The VT is very useful for early drought detection, assessing drought area coverage, duration, and intensity, and for monitoring drought impacts on vegetation and agricultural crops. For technical details for the background of the tool see Kogan (1997) and: http://orbit-net.nesdis.noaa.gov/crad/sat/surf/vci/index.html. Map courtesy F. Kogan, NOAA.

The combination of the impacts of an extreme drought, the decrease of fire management capabilities, in some cases also consequences of large clearcuts, and the increasing pressure of arson fires resulted in a fire season which may contribute to severe degradation of forest lands affected.

In order to assess the impact of the 2003 fires the regions Irkutsk, Chita and Buryatia three methods were used:

- Analysis of official reports of *Avialesookhrana*
- Satellite-derived data (NOAA AVHRR) based on fire counts and derived area burned, by the Sukachev Institute for Forest
- An aerial survey in the regions most affected by wildfires in September 2003

Table 2 shows the data of the *Avialesookhrana* reports and the satellite-derived data for forest and non-forest lands affected by fire in 2003. The aerial observation show that the share of forests affected by crown fires in Irkutsk was 17.4%, in Buryatia 11.9% and in Chita 1.5%, totalling 66,963 ha in the three regions.

The satellite-derived area burned for the same region provides a total area affected by fire almost ten times higher than the assessments by aerial observations. However, the satellite data do not allow to differentiate areas affected by fires of various severities, e.g. surface fires versus crown fires (stand-replacement fires). Considering the conservative assessments by the aerial surveys and the aerial survey conducted in Buryatia and Chita in September 2003 it was concluded that about 20% of the burned forest land in Irkutsk Region and Buryatia, and at least 10 percent in Chita – if not more – were affected by crown fires due to the extremely dry fire-weather conditions. The relative discrepancy between stand-replacement fire data by aerial observations in the three regions of ca. 70,000 ha versus satellite-derived area burned by high severity forest fires of about 2.3 million ha is larger than the relative discrepancy between the total area burned as assessed by aerial and space observations of 1.3 and 9.8 million hectares respectively.

Table 2. Comparison of wildfire data for the regions Irkutsk, Chita and Buryatia during the fire season of 2003: Agency reports vs. satellite-generated data. For details: See text.

Region	Agency reports based on ground and aerial observations				Satellite-derived data (NOAA AVHRR) based on fire counts and derived area burned			
	Number of fires reported	Total forest area burned (ha)	Thereof area burned by crown fires (ha + %)	Non-forest area burned (ha)	Number of fire events investi-gated	Total forest area burned (ha)	Thereof area burned by crown fires (adjusted %) (ha)	Non-forest area burned (ha)
Irkutsk	3244	184,201	32,184 (17.4%)	19,348	2,154	1,962,000	392,000 (20%)	85,000
Buryatia	2432	186,398	22,232 (11.9%)	6,853	1,887	3,390,000	678,000 (20%)	133,000
Chita	2441	853,004	12,547 (1.5%)	62,417	2,884	3,860,000	368,000 (10%)	365,000
Total Baikal Region	6117	1,223,603	**66,963 (5.5%)**	88,618	6,925	9,212,000	**1,456,000 (av. 16%)**	583,000

Table 3 provides a scenario of carbon release pulses to the atmosphere of various intensities and lifetimes. The assessment is based on area burned as depicted by NOAA AVHRR and processes by the Sukachev Institute for Forest (active fire product, this paper) and fuel consumption (FIRESCAN Science Team 1996, Stocks and Kauffman 1997, MacRae et al. 2004) and ecosystem recovery scenarios by vegetation type and fire severity.

Table 3. Prompt (pyrogenic) and net release of carbon from forest and non-forest ecosystems affected by wildfires in Irkutsk, Chita and Buryatia regions during the fire season of 2003. For details: See text.

Fuel type and fire type	**Area burned in 2003** **(ha)**	**Available fuel consumed by fire (F) and subjected to post-fire mortality (M)** **(t/ha dw)**	**Ecosystem and fuel load recovery period (equivalent to atmospheric residence time in the atmosphere)** **(years)**	**Prompt release of carbon by fire per area unit** **(t/ha)** **&** **Total 2003 (Tg) [4]**	**Post-fire release of carbon due to mortality and decay (t/ha)** **Total by recovery period) (years)**	**Net release of carbon due to reduction of sequestration potential [5]** **(Tg) [4]**
Grassland, Steppe Surface Fire	583,000	F: 4-6 M: --	F: 1	2-3 -- **1.17 - 1.75 Tg**	-- --	 --
Pine-Grass Forest Surface Fire[1]	3,878,000	F: 4-6 M: --	F: 1	2-3 -- **7.76 - 11.63 Tg**	-- -- --	 --
Pine Forest **Surface Fire[1]**	3,878,000	F: 8-30 M: 40-75	F: 10-25 M: 100+	4-15 -- **15.51 - 58.17 Tg**	-- **155.12 – 290.85 Tg**	-- --
Pine Forest Stand-Replacement Fire, long-term recovery [2]	728,000	F: 30-40 M: 50-150[2]	100-200+	F: 15-20 M: 25-75 **10.92 – 14.56 Tg**	-- **18.2 – 54.6 Tg**	-- --
Pine Forest Stand-Replacement Fire, no recovery [2]	728,000	F: 30-40 M: 50-150 [2, 3]	∞ no recovery (green desert)	F: 15-20 M: 25-75 **10.92 – 14.56 Tg**	-- **18.2 – 54.6 Tg**	**18.2 – 54.6 Tg**
Resulting Total Carbon Release to the Atmosphere						
Total Carbon Released				*Prompt pyrogenic release in 2003* **46.28 – 100.67 Tg**	**Successive release (various recovery periods)** **191.52 – 400.05 Tg**	**Net release** **18.2 – 54.6 Tg**

Notes: The scenario is based on the following assumptions:

[1] It is assumed that half of the 7,756,000 ha forests affected by surface fires burned with low intensity in the grass layer only and did not cause post-fire mortality. The remaining 50% were burned by medium- to high intensity surface fires consuming larger amount of surface fuels. Despite the adaptation of these forest to regular surface fires the post-mortality due to fire and secondary stresses due to the drought condition s of 2003 will lead to a post-fire mortality of 20-25% of the standing trees which are then subjected to decay.

[2] Half of the stands affected by stand-replacement fires are salvage-logged (harvested timber considered neutral concerning carbon release) and will regenerate naturally (due to close proximity to seed sources, under the assumption that appropriate logging practices will exclude harvesting of undamaged stands); the other half is salvage-logged but deteriorating to open grassland due to lack of seed sources and/or subsequent short-return interval fires.

[3] Carbon release by decay as a consequence of post-fire mortality in stand-replacement fire sites which were subsequently salvage-logged (ca. 50% max.) is considered to be equal to average logging slash decay (range: 50-150 t dw /ha).

[4] Total carbon release is expressed in Teragram (Tg) (1 Tg = 1 million t).

[5] Net release of carbon is calculated by the net loss of carbon sequestration capability by a site degraded due to multiple factors such as fire, climate change, and human intervention. The calculation is simplistically based on the assumption that 50% of the dry weight of the phytomass combusted is released to the atmosphere. In reality a major portion of this carbon is deposited in land and water ecosystems, practically in the form of non-degradable elemental carbon.

This carbon emissions scenario for 2003 represents a crude approach towards an assessment of the short-term to long-term effects of fire on carbon release and the possible post-fire sequestration patterns. In this scenario the ecosystem recovery mechanisms, however, are hypothetically optimistic, i.e. assuming that ecosystem degradation will be restricted to only half of the forest area affected by stand-replacement fires.

In reality, however, the currently practiced exploitation of forests in Southern Russia involves non-sustainable practices governed by the interests of oligarchs, bribed local structures, influence of the mafia and of criminal acts of foreign exploiting firms, sanctioned by the governments of neighbour countries.

Thus, the prospects for the future development of increasingly fire-affected forests are not encouraging.

The use of earlier investigations to determine area burned and carbon fluxes for monitoring the impacts of wildland fires must be considered. The example of a quick look at comparing fire scar maps of the 1987 fire season with the fire season of 2003 shows a strong overlap of the area burned Southeast of Lake Baikal (Figure 10). The reasons for a repeated large-scale fire situation in this region within 16 years can be attributed to the cyclic fire occurrence in grasslands and grass-forests. The overlap of area burned as depicted by AVHRR can also be a problem of low resolution. It should be considered to reprocess the historical data with the same algorithms that have been used recently.

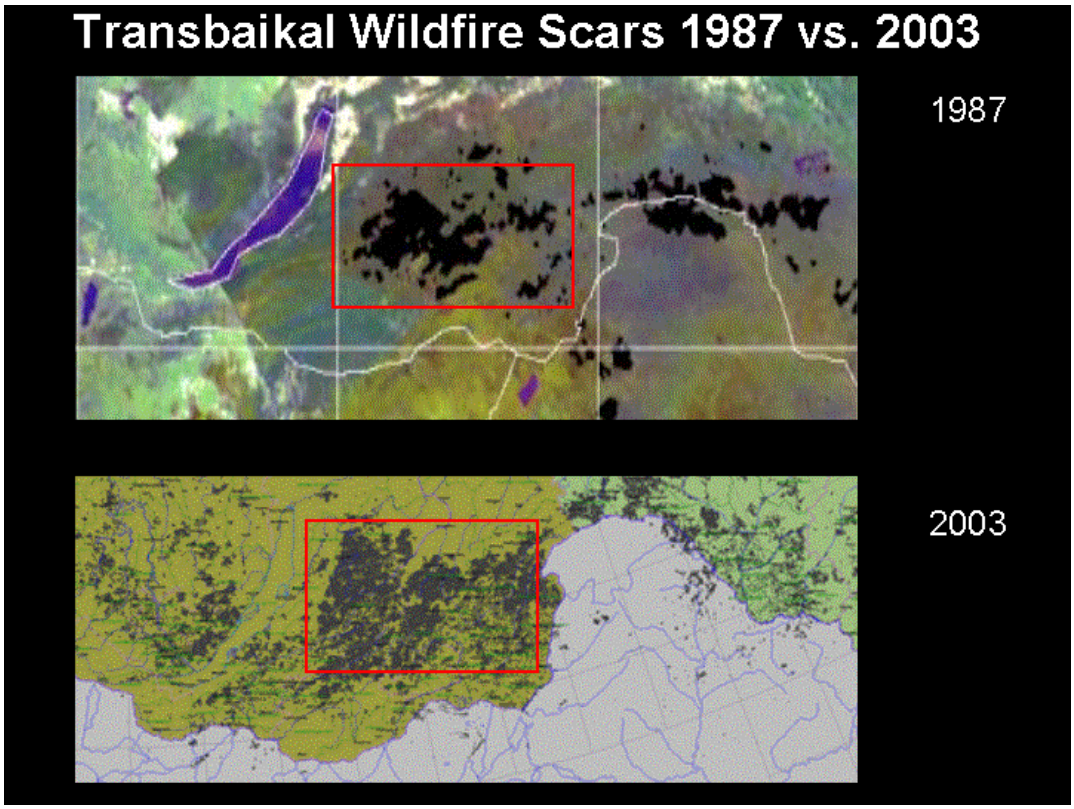

Figure 10. Comparison of the NOAA-AVHRR satellite-derived area burned in the region Southeast of Lake Baikal in 1987 (Cahoon et al. 1994) and 2003 (Sukhinin 2003). A major overlap of the area affected by fire during both episodes implies the necessity to revisit the datasets and the conclusions concerning the consequences of the fires on ecosystems and carbon fluxes.

4. Towards Enhancing International Cooperation in Fire Management

The magnitude of wildland fire occurrence in the Russian Federation and other countries in the boreal zone during the last decade have created a considerable attention in the international community, especially in the various institutions and groups involved in forest monitoring. In addition international organizations have become aware of the ecological and economic importance of the global boreal forest and role of its terrestrial carbon pool for the stability and functioning of the global atmosphere.

Beginning in 1991 a large number of cooperative projects between the Russian Federation and Western countries have been initiated to address common interests in forest fire research, including aspects of atmospheric and climate research. Annex I of this paper provides an overview of these activities between 1991 and 2003 that reveals that joint research has made tremendous progress during the last decade, especially in the fire ecology research and remote sensing of wildland.

However, regardless of the scientific progress a deficit has been noted worldwide in appropriate prevention, preparedness and response measures to reduce the increasing destructiveness of wildland fires. Countries in transition from centrally planned economies to market economies, including the Russian Federation, have suffered a decline in institutional and economic capabilities to meet the challenges arising from these changes. Thus, it was recognized in the early 1990s to create mechanisms within the United Nations to exchange views and provide expert advice to governments and international organizations to enhance joint efforts in reducing the negative impacts of wildland fires on the environment and humanity.

In the 1980s the Russian Federation was invited to become member of the FAO/ECE/ILO Team of Specialists on Forest Fires. Since 1993 the Team was successful in organizing a series of focussed conferences aimed at proving advice to the fir management community and to policy makers. Most important was the strategic meeting “Forest, Fire, and Global Change” held in Shushenkoe, Russian Federation, in 1996 (Goldammer 1996). It laid the foundation for a comprehensive strategic vision for international cooperation in fire management[22].

Four years later a first proposal was submitted to the United Nations system to establish an inter-agency and inter-sectoral body under the auspices of the UN International Strategy for Disaster Reduction (ISDR), to be mandated to serve as an advisory body on wildland fire to the UN on one hand, and as an outreach arm of the UN to regions and countries on the other hand. In accordance with the Framework for the Implementation of the International Strategy for Disaster Reduction (ISDR) the World Conservation Union (IUCN), the Global Fire Monitoring Center (GFMC), and the UN-FAO/ECE/ILO Team of Specialists on Forest Fire, proposed to create an interagency "Working Group on Wildland Fire". This proposal was in line with several declarations made in international conferences after Shushenskoe 1996. The proposal intended to bring together both the technical members of the fire community and the authorities concerned with policy and national practices in wildland fire management to realise their common interests of fire risk management and disaster reduction at global scale. The UN Inter-Agency Task Force for Disaster Reduction (IATF) at its second meeting on 11 October 2000 agreed to establish the Working Group on Wildland Fire (Working Group 4 [WG-4]).

The Working Group represented an interagency and inter-sectoral forum of UN and other international agencies and programmes. One of the priority activities of WG-4 was:

- Establishment of, and operational procedures for, a global network of regional- to national-level focal points for early warning of wildland fire, fire monitoring and impact assessment, aimed at enhancing existing global fire monitoring capabilities and facilitating the functioning of a global fire management working programme or network.

At the 2nd meeting of WG-4 (3-4 December 2001) it was decided to give priority to the establishment of the "Global Network of Regional Wildland Fire Networks" (Figure 11 and 12).

[22] See IFFN No. 15 (September 1996): http://www.fire.uni-freiburg.de/iffn/org/ecefao/ece_3.htm

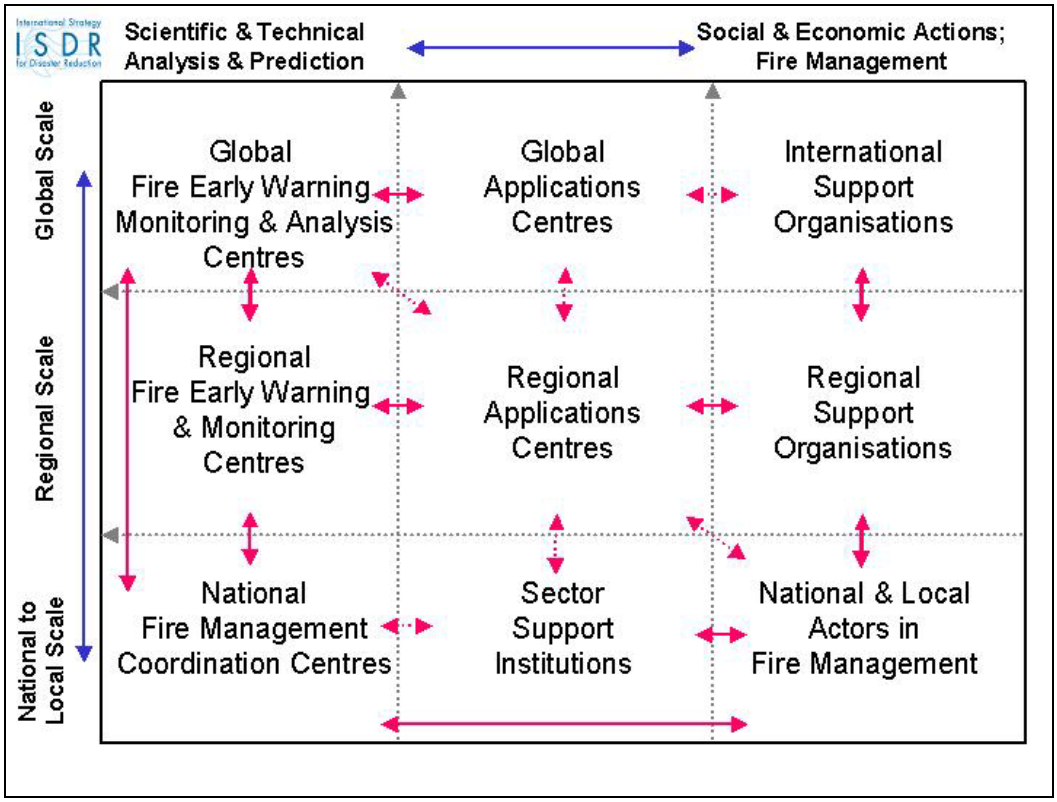

Figure 11. Schematic view of relationships and multi-directional flow of information, data, knowledge and advice in a global wildland fire network.

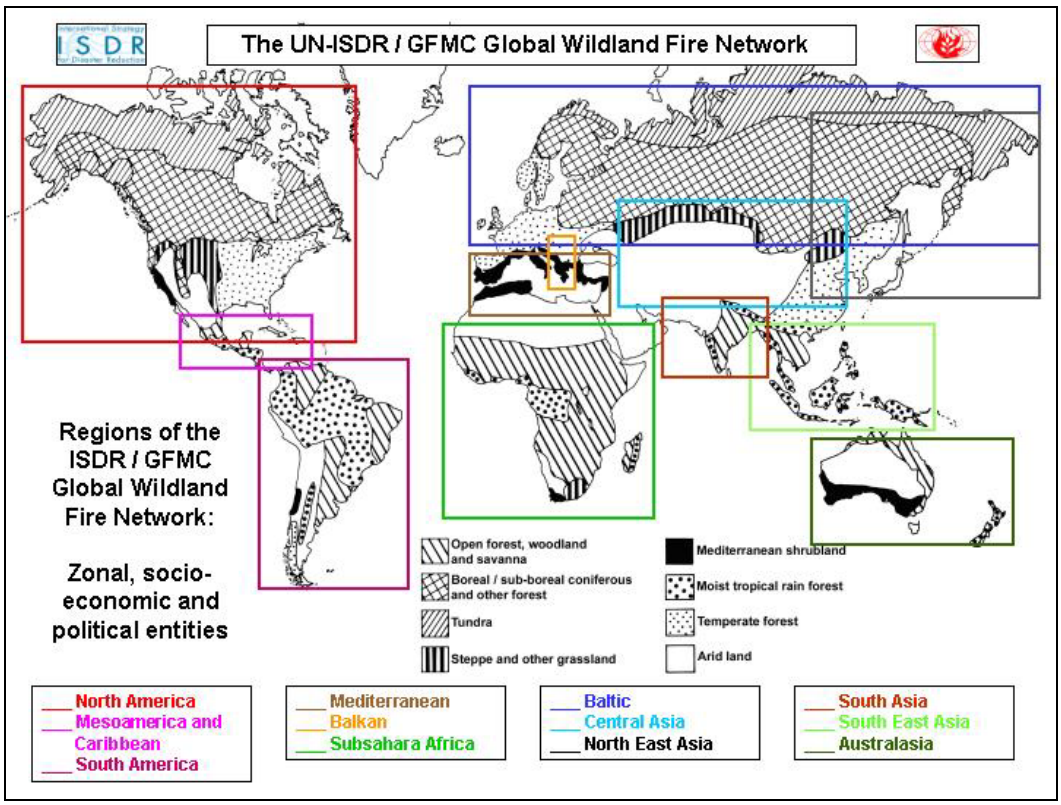

Figure 12. Delineation of regions within the Global Wildland Fire Network. Due to the size and inter-zonal extent of its territory the Russian Federation is encouraged to participate in three regional networks (Baltic, Central Asia, East Asia).

The "Global Wildland Fire Network" consists of a set of informal or formal regional network structures that are in place or will be initiated during the process of formation. The envisaged timeframe for setting up the network was 2002-2003. The International Wildland Fire Summit (Sydney, 8 October 2003) was used as a platform to convene representatives from regional networks. The strategy agreed by the Summit ("Strategy for Future Development of International Cooperation in Wildland Fire Management") included the following agreement[23]:

> *"The Regional Wildland Fire Networks will be consolidated, developed and promoted through active networking in information sharing, capacity building, preparation of bilateral and multilateral agreements, etc. This process will be facilitated through regional Wildland Fire Conferences and Summits in cooperation with the International Liaison Committee and the UN-ISDR Working Group on Wildland Fire".*

During the Summit a side meeting was held on 5 October 2003 with the regional fire management groups functioning under the auspices of the UN:

- ISDR Working Group on Wildland Fire (Russia member)
- UN ECE/FAO/ILO Team of Specialists on Forest Fire (Russia member)
- Fire Management Working Group, FAO North American Forestry Commission (NAFC)
- Forest Fire Group of FAO *Silva Mediterranea*

A key output of the joint meeting was the recommendation to create a successor body of the working Group (which was limited to two years lifetime) under the auspices of the UN. The GFMC reported to the 8th Meeting of the UN-ISDR Inter-Agency Task Force for Disaster Reduction (5-6 November 2003) and recommended:

> *"The Working Group suggests the IATF to support the further establishment and strengthening of the Global Wildland Fire Network as a key instrument to foster the international dialogue und efficient cooperation in the arena wildland fire. Given the inter-sectoral nature of wildland fire and the number of UN agencies and programmes involved, as well as other international organizations and civil society, it is suggested to maintain an advisory body for the UN within the IATF."*

The proposal has been accepted by the IATF to create a **Wildland Fire Advisory Group** (WFAG) under the auspices of the ISDR. The WFAG will represent an advisory body to the UN system aimed at:

- providing technical, scientific and policy-supporting advice to the UN family through the International Strategy for Disaster Reduction (UN-ISDR) and the IATF, and
- acting as a liaison between the United Nations system, the Global Wildland Fire Network and its supporting partners.

It is envisaged to work with supporting partners of the WFAG will be

- UN agencies and programmes
- UN conventions (notably UNCBD, UNCCD, UNFCCC)
- Collaborative Partnership of Forests (CPF) and the UN Forum on Forests (UNFF)
- Other international organizations
- Non-government organizations, notably the IUCN-TNC-WWF Global Fire Partnership
- Government agencies
- Inter-governmental institutions and agreements
- Civil society
- Academia
- International Liaison Committee (ILC) of the series of International Conferences on Wildland Fire
- Global Fire Monitoring Center (GFMC) acting as convener and secretariat

On behalf of the ISDR-WG-4 / Wildland Fire Advisory Group the Global Fire Monitoring Center (GFMC) is continuing to facilitate the functioning of the Global Wildland Fire Network by supporting the establishment of Regional Wildland Fire Networks and enhancing inter-regional communication and cooperation.

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[23] http://www.fire.uni-freiburg.de/summit-2003/introduction.htm

The GFMC will liaise with existing operational and proposed international networks, notably:

- UN-mandated regional teams (ISDR Wildland Fire Advisory Group, ECE/FAO/ILO Team of Specialists on Forest Fire, Fire Management Working Group of the FAO North American Forestry Commission, Forest Fire Group of FAO *Silva Mediterranea*)
- FAO Forest Department
- Global Observation of Forest Cover - Global Observations of Landcover Dynamics (GOFC-GOLD) Fire Implementation Team (a subset of the Global Terrestrial Observing System - GTOS)
- Advisory Group on Environmental Emergencies (AGEE) and the Joint Environment Unit of the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) and the United Nations Environment Programme (UNEP)
- Biomass Burning Experiment (BIBEX) of the International Geosphere-Biosphere Programme (IGBP), International Global Atmospheric Chemistry (IGAC)
- International Union of Forestry Research Associations (IUFRO) 8.05 Forest Fire Research
- The IUCN-TNC-WWF Global Fire Partnership

Meanwhile a "Framework for the Development of the International Wildland Fire Accord" has been jointly agreed between the GFMC/ISDR, FAO and GOFC-GOLD. The framework provides a roadmap between 2004 and 2005 towards development of a global agreement in wildland fire management (GFMC 2004).

The active participation of the Russian Federation in all of the international groups, including those working under the auspices of the United Nations, ensures that experiences and views can be shared concerning international cooperation in reducing the negative effects of fire on the environment and humanity.

5. Conclusions

Based on examples of the most recent fire seasons this paper aimed to highlight problems and trends of wildland fire occurrence and impacts in the Russian Federation. The paper reveals that much work has been achieved to prove scientifically that sustainable functioning of the boreal forest is threatened. However, additional in-depth application of remote sensing monitoring tools is required to consolidate our understanding of current and future trends.

The situation in Russia is quite similar to the current fire situation in tropical forests: Interaction or cumulative effects of multiple stress factors (wildfire, climate extremes, human interventions…) are resulting in impoverishment of the ecological functioning and the economic productivity of the boreal forest. In addition human populations are becoming increasingly vulnerable to the effects of vegetation cover degradation by fire and other stresses.

It is therefore important that joint efforts of the community of wildland fire scientists and managers direct the attention of governments, international organizations and policy makers to respond to this escalating situation. The tools, mechanisms and collaborative agreements that are in place must receive adequate support to meet the challenges ahead.

Acknowledgements

The authors gratefully acknowledge the in-depth discussion of this paper with Anatoly Shvidenko, International Institute for Applied Systems Analysis (IIASA). Don Cahoon discussed methodologies and relevance of his investigations of the wildfires burning in the area in 1987. The regional vegetation health maps for 1987 and 2003 were generated especially for this paper by Felix Kogan (NOAA NESDIS).

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ANNEX I

Calendar of Cooperation Activities between the Fire Establishment of the Russian Federation and International Partners during the Period 1991-2003

Right from the beginning of the opening process of the Soviet Union and the Russian Federation fire scientists, engineers and managers began an intensive exchange program with Western countries. A short narrative calendar of these events reveal the broad range of activities. Details of regular exchange visits between firefighter crews and delegations with Russia are not included..

1991 First exploratory visit of a joint German-US mission to the Soviet Union. Subsequent integration of Soviet / Russian fire management personnel and scientists into technical and scientific networks, such as the UN-FAO/ECE Team of Specialists on Forest Fire and the research conducted under the International Geosphere-Biosphere Programme (IGBP)

1992 Set up of a joint Fire Working Group of the International Boreal Forest Research Association (IBFRA)
- Initiation of the Russia-US exchange programme of fire management personnel

1993 First East-West scientific conference "Fire in Ecosystems of Boreal Eurasia" at the Academy of Sciences, Siberian Branch, Krasnoyarsk, with the participation of all boreal countries
- First international fire research campaign in Siberia (Fire Research Campaign Asia-North [FIRESCAN])
- First NATO Advanced Science Institute (ASI) on Science and Technology Policy in Novosibirsk, with joint German-Russian participation
- Preparation of satellite downlinks (NOAA AVHRR) for forest fire monitoring (joint activity with NASA)

1995 Russian participation at the XX World Congress of the International Union of Forestry Research Organizations (IUFRO), Forest Fire Research Group 8.05.00; Tampere, Finland (July 1995)

1996 UN-FAO/ECE Conference "Forest, Fire and Global Change", Shushenskoe, Russian Federation
- Launch of the IGBP Northern Eurasia Study (Yakutia 1996, Central Siberia 1997) with participation of fire scientists

1997 Preparation of the TACIS project "Improvement of Forest Fire Response System" with subsequent implementation 1999-2001

1998 Participation of Russia in the UN-FAO/ECE First Baltic Conference on Forest Fires, Poland

1999 TACIS/IGBP-supported workshop "Fire on Ice", Khabarovsk, Russian Federation (see below)
- TACIS project information website established on the Global Fire Monitoring Center (GFMC) homepage
- Preparation of the NASA-US Forest Service funded research project on "Effects of Fire on Carbon Sequestration, Global Climate and Ecosystem Processes" (field implementation in 2000)
- Formation of a Fire Group within the programme "Global Observation of the Forest Cover" (GOFC) of the Committee of Earth Observation Satellites (CEOS) with Russian participation, followed by a boreal focus workshop in Novosibirsk (2000)

2000 Procedures of regular information flow from Russia to the Global Fire Monitoring Center (GFMC) establish through partnerships with Avialesookrana, the Sukachev Institute for Forest (Krasnoyarsk), and the Institute for Solar Terrestrial Physics (Irkutsk)
- International Fire Management Training Course at the Global Fire Monitoring Center (GFMC), Germany, with Russian and US participation (April 2000)
- UN meeting and international exercise "Baltic Exercise on Fire Information and Resources Exchange - BALTEX FIRE 2000" in Finland, with Russian participation (June 2000)
- GFMC fact finding mission on forest fire research and management in Western Siberia in support of the TACIS Russia Forest Fire Information System, Avialesookhrana; Ekaterinburg, Tjumen and Pushkino, Moscow Region (August 2000)

- First German Forum on Disaster Reduction, with demonstration of the concept of international fire brigades, with Russian participation (Avialesookhrana) and the Russian-German consortium "Helion Procopter" (September 2000)
- Meeting of the NATO-Russia Joint Scientific and Technological Cooperation Committee on "Forecasting and Prevention of Catastrophes" with German-TACIS participation (October 2000)
- Begin of funding and implementation of the project “Fire Effects in the Boreal Eurasia Region” (FIRE BEAR), a forest fire research study located in central Siberia funded by NASA's Land Change Land Use Change Science Program.

2001 Implementation of the Eurasian Fire Danger Rating project in cooperation between GFMC, Canadian Forest Service, Avialesookhrana and Sukachev Institute for Forest
- First exchange program with GFMC staff (integration of three junior GFMC staff in fire crew in Tjumen Aviabase, August 2001)
- Meetings of leaders of Avialesookhrana and GFMC, Protocol and Cooperation Agreement signed, at GFMC, Germany (November 2001)
- Russia appointed member of the Working Group on Wildland Fire, United Nations International Strategy for Disaster Reduction (UN-ISDR), Inter-Agency Task Force for Disaster Reduction; first Working Group meeting, UN Geneva (December 2001)

2002 Initial meeting of the Northern Eurasian Earth Science Partnership Initiative (NEESPI), Moscow (February 2002)
- Second meeting of the UN-ISDR Working Group on Wildland Fire, GFMC (March 2002)
- Russia appointed member of the International Liaison Committee (ILC) of the 3rd International Wildland Fire Conference and International Wildland Fire Summit. Two ILC meetings with Russian participation in Sydney (August 2002) and Portugal (November 2002)
- Consolidation of Northern Eurasian Regional Information Network (NERIN), Siberian/Far Eastern Regional Network and the Western Russian/Fennoscandian Regional Network of the Global Observation of Forest Cover/Global Observation of Landcover Dynamics (GOFC/GOLD) programme

2003 All-Russian Forestry Congress with GFMC participation at Round Table on “Key Ways of Protection of Forests from Fire in the Russian Federation”, State Kremlin Palace, Moscow (February 2003)
- Fourth Meeting of the International Liaison Committee (ILC) in preparation of the 3rd International Wildland Fire Conference and International Wildland Fire Summit, Melbourne, Australia (March 2003)
- Follow-up planning meeting of the Northern Eurasian Earth Science Partnership Initiative (NEESPI), Suzdal (April 2003)
- GFMC Russia mission: (1) Routine meetings with Avialesookhrana; (2) 5th International Scientific Conference "Wildland Fires: Initiation, Spread, Suppression and Ecological Consequences" (Krasnoyarsk Region); (3) Revisit of the Bor Forest Island Fire Experiment of 1993 (Krasnoyarsk Region) (June-July 2003)
- International Workshop on New Approaches to Forest Fire Management at an Ecoregional Level; Khabarovsk (September 2003)
- GFMC survey of areas burned in Chita and Buryatia Regions, Russian Federation, during the fire season of 2003; Irkutsk, Ulan Ude, Russia (September 2003)
- Russian delegation participates at the 3rd International Wildland Fire Conference and International Wildland Fire Summit; Sydney, Australia (October 2003)
- Preparation of installing a satellite downlink for the Moderate-Resolution Imaging Spectroradiometer (MODIS) at the Remote Sensing Laboratory, Sukachev Institute for Forest, Krasnoyarsk, for forest fire monitoring.

RECENT PUBLICATIONS

Forest Fires – The Story of a War

Each and every year, forest fires claim a portion of our forests. The number of fires and the acreage devastated differ from year to year, but some years are undeniably more spectacular. Such was the case with the year 2002 when, between 1 and 10 July, the *Société de protection des fôrets contre le feu* (SOPFEU) was faced with a catastrophic situation. Lightning cut through the boreal forests, leaving in its wake a torrent of flames. In the high protection area, below the 52nd parallel, 142 wildfires destroyed almost 231,500 hectares of forest – the equivalent of 463,000 football fields. North of that limit, in non protected territories, 105 unimpeded blazes devoured 863,191 hectares of wooded land. The smoke from these fires wafted all the way to the island of Montreal, to Washington and to New York City. This cataclysm actually propelled five million tons of tar, soot, ash and coal into the atmosphere. The total energy released by the combustion of millions of trees was equivalent to 8,200 nuclear bombs of the type dropped on Hiroshima.

In order to adequately answer question relating to the protection of our heritage, *Forest Fires. The History of a War* will tell you about the evolution of the technical means and human efforts deployed against this terrible scourge. It gives a historical account on the organization of prevention and detection means, and the fight against forest fires since 1869. you will discover the various organizations that have strived to protect the forests of Quebec and Canada against these ravaging fires, and continue to do so.

This remarkable work ist the result of steady and devoted research bearing on over a century (1869-1972) of a war to safeguard the Canadian environment.

Bachelor of arts and Wildfire Canada 2000 Award winner, Patrick Blanchet has been a history consultant for the government of Quebec. More recently he has devoted himself to the production of a documentary with the Trinôme Inc. production house, for the Historia channel.

Patrick Blanchet. 2003. Forest Fires – The Story of a War. Cantos International Publishing, Ic. Montreal, 182 p. (ISBN 2-89594-013-4)