Part 1
Introduction and global analysis

1. Introduction

The role of fire in the world's vegetation is ambivalent. In some ecosystems, natural fires are essential to maintain ecosystem dynamics, biodiversity and productivity. Fire is also an important and widely used tool to meet land management goals and maintain the functioning of ecological processes. However, every year, wildfires destroy millions of hectares of forests, woodlands and other vegetation, causing the loss of many human and animal lives and immense economic damage, both in terms of resources destroyed and the costs of suppression. There are also impacts on society and the environment – for example, damage to human health and delays in transport from smoke, loss of biological diversity, release of carbon dioxide (CO_2) and other greenhouse gases, damage to recreational and amenity values and much more. Then there are the secondary effects: erosion, land- and mudslides, flooding – when high rainfall impacts steep slopes where the vegetation cover has been burned – and insect infestations following fires.

The positive and negative roles of fire must be recognized, as well as the need for holistic management, rather than just suppression.

Despite the severe social, economic and environmental impacts of fire, reliable, current information on extent, causes, impact and costs is insufficient. Yet such information is essential to the development of policies, legislation and plans for prevention and suppression.

TERMINOLOGY

There is some confusion over fire terminology. The scope of this paper might be presumed to be fires in forests and woodlands, yet relatively few countries can distinguish these categories in the information they collect on fires. Even if they were distinguished, there might be doubt as to whether the data refer to fires in the administratively defined forest (often called 'forest estate'), or in the forest as defined by the Global Forest Resources Assessment 2005 ('FRA 2005' – FAO, 2006a), which specifies canopy cover of more than 10 percent, area of more than 0.5 hectares (ha) and trees higher than 5 metres (m). Data on numbers and extent usually refer to fires in forests (FRA definition), other wooded land, rangelands, grasslands, bushlands, agricultural lands such as those used for shifting cultivation or grazing, or barren land – collectively known as 'wildland fires'.

This paper refers to fires in all types of vegetation. It does not use the term wildland fires, largely because of the difficulty of translating the term, while noting that it has been used by FAO in the past, specifically in *State of the World's Forests 2003* and *2005* (FAO, 2003 and 2005a).

SOURCES

The present study is presented in two parts: first, a global analysis, derived from 12 regional working papers submitted at the end of 2005, including global developments since submission of the papers (provided by the Global Fire Monitoring Center (GFMC – www.fire.uni-freiburg.de/)); and, second, summaries of the working papers themselves. The Bibliography lists cited references; Annex 1 suggests additional reading by region; Annex 2, a global table, documents the lack of reliable, current fire data; Annex 3 provides a glossary of selected fire terminology; and Annex 4 lists the FAO Fire Management Working Papers series, including the regional papers.

The regional working papers were prepared from country reports grouped according to the regions of the Global Wildland Fire Network (GWFN) of GFMC (see Part 2). Countries that contributed information to the working papers are listed in Table 1.

TABLE 1
Global Wildland Fire Network countries contributing to the regional working papers

Region	Countries[a]
Africa, sub-Saharan	Botswana, Côte d'Ivoire, Ethiopia, Kenya, Namibia, Senegal, South Africa, United Republic of Tanzania
Caribbean & Mesoamerica	Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Jamaica, Guadeloupe, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago
	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama
North America	Canada, Mexico, United States
South America	Argentina, Bolivia, Brazil, Columbia, Chile, Ecuador, Paraguay, Peru, Uruguay, Bolivarian Republic of Venezuela
Central Asia	Afghanistan, Armenia, Azerbaijan, Belarus, China (northern territories), Georgia, Islamic Republic of Iran, Iraq, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
Northeast Asia	China, Democratic People's Republic of Korea, Japan, Republic of Korea, Russian Federation (Far East)
South Asia	Bhutan, India, Nepal, Sri Lanka
Southeast Asia	Brunei Cambodia, Darussalam, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam
Australasia	Australia, New Zealand
Balkans	Albania, Bulgaria, Croatia, Greece, Serbia and Montenegro,[b] Slovenia, The former Yugoslav Republic of Macedonia, Turkey
Baltic and adjacent countries	Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Russian Federation (Republic of Karelia), Slovakia, Sweden, Switzerland, United Kingdom
Mediterranean	Algeria, Cyprus, Greece, Israel, Italy, Morocco, Portugal, Spain, Turkey

[a] A list of all member countries of each regional network is available at www.fire.uni-freiburg.de/ GlobalNetworks.html. Note that the GWFN country composition does not correspond to the six FRA regions, and some countries, or parts of countries, are represented in more than one GWFN region, i.e. China (Central and Northeast Asia), Greece (Balkans and Mediterranean), Mexico (Mesoamerica and North America), the Russian Federation (Baltic area and Central and Northeast Asia) and Turkey (Balkans and Mediterranean).
[b] Before the independence of Montenegro in 2006.

As several of the regional summaries and this global synthesis note, availability of information may not be high, let alone its reliability. For example, the true environmental, social and economic costs of fires are almost entirely unavailable, while satellite information on the extent of fires appears to be much more reliable (and often several times greater) than land-based assessments.

2. Global analysis

EXTENT BURNED

The global estimate of land area affected by fire in 2000 was 350 million hectares. This estimate was made by the Joint Research Centre of the European Commission (JRC-EU), based on fire scars detected by the SPOT-VEGETATION satellite sensor (JRC-EU, 2005). A significant proportion of this area must have been forest and woodland, but how much is not known.

Given the lack of common fire terminology and consistent data collection at the regional level, the figures derived from the regional working papers for yearly average area burned can only be described as representing 'vegetation fires'. In many regions, it is not possible to distinguish wildfires (unplanned and uncontrolled fire – see definitions in Annex 3) from land-use fires (fires intentionally applied in land-use systems, e.g. prescribed burning or traditional slash-and-burn agriculture and rangeland burning).

- Africa, sub-Saharan – 168 million hectares (from national statistics over a variable number of years); 230 million hectares (2000, from JRC-EU, 2005);
- Caribbean and Mesoamerica – 446 000 ha (2000–2004, three Caribbean and nine Mesoamerican countries, including Mexico);
- North America – 4.1 million hectares (2000–2004, excluding Mexico);
- South America – 2.9 million hectares (1986–2004);
- Central Asia – 2.0 million hectares (nine countries, FAO, 2006a), but the Global Burnt Area 2000 Project (GBA2000) reported 42 million hectares;
- Northeast Asia – 1 million hectares (1990–2004);
- South Asia – 4.1 million hectares (2000, mainly in India – FAO, 2006a);
- Southeast Asia – 6.9 million hectares (FAO, 2006a);
- Australasia – 54.5 million hectares (which is the Australian seven-year average for 1997–2003);
- Balkans – 156 000 ha (1988–2004);
- Baltic and adjacent countries – 32 000 ha;
- Mediterranean – 700 000 to 1 million hectares.

Comparisons between regions are meaningless, due to differences in the base date, area, population density and vegetation type. Even adjusting the regional figures on a unitary basis of, say, fires per head of population or fires per hectare of surface area is impossible because of the duplication of figures of countries in more than one region.

In addition, the figures reported by countries for vegetation fires may be highly inaccurate (see Annex 2 – Global Table). A comparison of the national statistics on areas burned with the satellite-derived data from the GBA assessment of 2000 showed that the national statistics of seven countries in Africa grossly underestimated the actual area burned. In the Russian Federation, during the 2002 fire season, satellite imagery

showed that 12 million hectares of forest and non-forest land had been affected by fire, while official figures reported 1.2 million hectares of forest land and 500 000 ha of non-forest land had been burned. In these two cases, and possibly others, the reasons for this under-recording include the difficulty and cost of ground and aerial surveys of fire-affected areas, as well as the lack of monitoring and recording of fire occurrence and their impact on non-protected forest and other lands. In the recent past, the wish to conceal ineffectiveness in combating fires has also certainly contributed to under-reporting.

Some countries are already detecting fires by satellite remote sensing (e.g. Mexico with four of its neighbouring Central American countries), while Mesoamerica and some other regions are suggesting the use of satellite systems for fire monitoring, especially given the physical difficulty and cost of ground surveys of burned areas.

Only one region, the Baltic area, reported that "most countries in the region are not facing major problems of fires in forests .…" The Balkans indicated an increasing trend in the number of fires in recent years, and both Central and Northeast Asia showed an increase in both the number of fires and the area burned.

The South American region reported that 120 000 ha of plantations had burned in 30 years. The African working paper also mentioned fires in plantations, and with the rapid increase in plantation areas during the past decade, the risk of fires in forest plantations must be growing.

The African regional working paper drew attention to the evolution of many ecosystems through the human use of fire and the need for fire in maintaining these ecosystems. The North American paper noted the natural role of fire, particularly in boreal ecosystems, where tree species have adapted to fire to the point that it is essential to their regeneration. Fire adaptation is seen in several other natural ecosystems, such as the pine forests of Central America and Mexico.

Most regions drew attention to the lack of reliable, up-to-date information on fires, and they recommended:
- definition of a common terminology and format for reporting fires; as a prerequisite for $\longrightarrow$
- development of a common database for fires; which would permit $\longrightarrow$
- analysis at country and regional levels of the direct and indirect causes of fires and the exchange of experience on all aspects of fire management.

Such analyses would support research into a range of issues and into the use of satellite remote sensing for fire monitoring and reporting.

CAUSES

> *... a box of matches remains the simplest and least expensive tool available to fire users.*
>
> **– FAO Fire Management Working Paper FM/10/E**

Almost all regions reported that people are the overwhelming cause of fires. Several regions estimated the proportion:
- Mediterranean – 95 percent;
- South Asia – 90 percent;

- South America – 85 percent;
- Northeast Asia – 80 percent;
- Balkans – 59 percent.

Even where causes were given as 'unknown', it is believed that most fires are caused by people. The list of human-induced causes included land clearing – especially for shifting cultivation – and other agricultural activities, maintenance of grasslands for livestock management, extraction of non-wood forest products (NWFPs), industrial development, resettlement, hunting, negligence (such as the careless disposal of cigarettes) and arson. In countries in transition towards a market economy, there has been an increase in abandoned agricultural land and thus a build-up of fuel. The most commonly mentioned causes were land clearing and other agricultural activities, negligence and arson.

Only in the very remote areas of Canada and the Russian Federation is lightning a major cause of fires (50–70 percent reported in parts of Russia). The remoteness of these areas often means that fires develop into serious conflagrations: 35 percent of the number of fires in Canada, but 85 percent of the area burned. In other regions, rain extinguishes most fires started by lightning.

Arson was frequently mentioned in the reports. Fires may be deliberately set as a form of protest or vengeance against others or against the government, for spite, entertainment (Caribbean) or employment in firefighting. In some cases, it is a cause of half the fires in the country. But it is not easy to apprehend arsonists: Australia reported that in the 2002/2003 fire season, of 10 000 fires of actual or potential arson, there were only 43 convictions, while the South American working paper noted that the absence of specific procedures for enforcement under the law for vegetation fires makes the law difficult to impose.

A trend in recent decades, in almost all countries, has been the movement of people from rural areas to cities (e.g. Australasia, the Mediterranean). Fewer people living in the country means that fires set for agricultural clearing are more likely to run out of control. In some regions of Africa, HIV/AIDS is causing severe mortality in adults, and fires started for agricultural clearing have escaped because of these labour shortages and the lack of experience among the often-orphaned youths carrying out the task. All these factors, including pressure from a growing urban population, have resulted in worse fuel management and increased fuel levels, augmenting the risk and scale of fires.

Urban people may have a very poor understanding of the dangers of fires and their consequences. The working papers for Australasia and North America both mentioned the problem of houses being established in zones at risk for fire. Urban dwellers also tend to perceive all fires as bad for the environment, leading to public pressure against prescribed burning (Australia). Increased numbers of fires at the wildland/urban interface (WUI) were also mentioned in the paper for South America.

Many regions identified the need for better public awareness campaigns – particularly among urban people – of the need for more holistic approaches to fire management.

The paper for South America also recorded severe droughts, widespread burning activities and wildfires related to El Niño events in 1992, 1993, 1997 and 1998. The influence of El Niño in creating weather conditions favourable to wildfires was also mentioned in the paper for Africa.

Research on climate change, quoted in the North American paper, indicates that the incidence and severity of fires "will increase dramatically", while the Mediterranean paper noted that increased air temperatures and reduced summer rainfall are predicted, leading to an increased fire risk not only in that region but in other fire-prone regions as well. The Caribbean and other papers also commented on the increased fire hazards likely to arise from climate change.

EFFECTS – THE DAMAGE CAUSED BY FIRES

Regional damage reports were largely descriptive (i.e. qualitative) rather than quantitative. Most regions discussed the environmental damage caused by fires – forest degradation, soil erosion, secondary insect attacks (e.g. *Ips* bark beetles in southeastern Europe) – as well as the effect of fires crossing from fire-adapted to fire-sensitive ecosystems, with the consequent effect on biological diversity, especially species composition, regeneration and stand structure.

Most regions also reported the effect of fires on climate through the emission of greenhouse gases, mainly CO_2. The Northeast Asian paper stated that the region may account for more than 2 percent of global biomass burning and carbon emissions yearly. The African region drew attention to a recent FAO study (FAO, 2006b) that estimated the impact of vegetation fires in Africa on the global carbon cycle. The current estimate of the quantity of biomass burned globally each year, from all sources, is about 9 200 million tonnes (Andreae, 2004). Overall, global fires in vegetation consume 5 130 million tonnes, 42 percent of which is in Africa. This burning releases about 3 431 million tonnes of CO_2, as well as significant quantities of other emissions. However, only a fraction of the carbon released by vegetation fires remains in the atmosphere. The cyclic nature of fire disturbance in fire-adapted and fire-dependent ecosystems involves sequestration of atmospheric carbon for regrowth of plant biomass. Thus natural or anthropogenic fires in those ecosystems with sustainable, fire-adapted regimes are not contributing to a net release of carbon into the atmosphere or to an increase in the natural or anthropogenic 'greenhouse effect' and global warming.

The Northeast Asian region drew attention to the effect of fires on permafrost sites, which may lead to degradation of forests due to the long restoration process. Other regions, e.g. Central and Southeast Asia, mentioned the environmental impact of fires in deep organic layers such as peat, which are difficult or impossible to control, as well as the continuing effect on human health of smoke emissions from these fires.

Some regions cited the loss of human lives, both in the general population and among firefighters. Perhaps the worst was that in Brazil, where over 700 people were killed in 1998. Several regions described the effect of haze pollution on human health. The Southeast Asian region referred to recurrent land-use fires that generate emissions seriously affecting the environment, human health and security.

The African region emphasized the impact of fires on livelihoods, especially of the extremely poor, but this effect on livelihoods and on the food security of the poorest, the disadvantaged, minorities and women was severe in all developing economies.

A few countries and regions quoted figures on fire damage – for example, US$107 million in India in one year and US$4.2 billion in Russia in 1998. Mexico reported losses in 2003 of US$337 million in wood, US$6.6 million in firewood and US$39 million in reforestation costs. Northeast Asia recorded losses in timber from forest fires on the order of US$0.5–1 billion yearly. Both Canada and the United States referred to losses of homes and businesses, especially in the WUIs, where homeowners had little knowledge of the danger from fire, and communities lacked building codes adapted to fire or to the management of fuel adjacent to properties. In 2003, 334 homes and 10 buildings were destroyed by fire in Canada, while in the United States, in the same year, 3 640 homes, 33 businesses and 1 140 other structures were destroyed. Added to those losses were the costs of evacuating residents.

A few regions (e.g. Africa and the Balkans), where there are countries with important tourist industries, cited the negative visual impact of fires on the appearance of the landscape.

There are, however, no agreed standards for the collection of data on fire damage. The paper for Australasia mentioned the difficulty of calculating even yearly firefighting costs. It referred to the existence of sophisticated methods for assessing the environmental impact of economic developments, while no assessments are made of the environmental impact of fires. Thus there is no data to support or prioritize inputs for the restoration of landscapes or ecosystems – despite the existence of the technical skills and capacity to do so.

PREVENTION

Fire prevention in most countries is targeted at people – the main cause of fires – through awareness-raising, education and participation in communities of interest. Australia referred to the extension of urban development into rural lands and the consequent need for public education there. The Mediterranean region noted that the message for urban people may stress the risk of fire and its potential consequences, while the message for rural people is often aimed at their own self-interest – i.e. at not destroying their resources. India reported that various projects have raised awareness in communities and have increased participation in prevention and suppression, reducing fire outbreaks by up to 90 percent in some regions.

The Australasian paper quoted an Australian source:

> *Those creating the risk historically have no direct interaction with those dealing with the results, the fires. Worse perhaps is the absence of any useful engagement with those creating the future risk – the risk that fire and emergency services, insurers and society will be dealing with in the future* [i.e. factors such as climate change, urban expansion, changes in lifestyle, etc.]. *This may well be a characteristic that is experienced more widely even outside Australia in the future.*
>
> **– Handmer, 2003**

Most countries have laws to prevent the setting of fire or to control the period during which fire may be used. Many have developed fire prevention programmes or plans. But few countries have the ability to enforce these legal provisions or the capacity to administer the programmes. A zero-burning policy by the Association of Southeast Asian Nations (ASEAN) came into effect in 1999, but is proving ineffective in reducing fires in Southeast Asia, as it appears that fire is a more fundamental need in the livelihoods of rural people than had been appreciated. Some modified guidelines are now being developed for prescribed burning by small-scale landowners. The inclusion of the great number of shifting cultivators in the fire prevention programmes in developing economies presents considerable challenges. They frequently have no formal land tenure, are used to customary/traditional forms of land management and hence are reluctant to risk change.

Several countries – in the Mediterranean region, for example – aim to reduce the fuel load through preventive burning or other fuel reduction methods such as controlled grazing. Training courses in prescribed burning were described in the South American paper. But such preventive burning may be opposed by an increasingly urban population, and the education of these people was identified as important by several countries. The United States noted that prescribed burning is not only a tool for prevention, but can also be used to restore and maintain ecosystems. The use of green or bare strips of land to prevent the spread of fire is common in many regions. China, for example, reported that at the end of 2000 the total length of bare firebreaks was 490 000 km, and of greenbelt fuelbreaks, 172 100 km.

Early warning systems and fire danger rating systems are increasingly being used throughout the world to give advance notice of periods of high fire risk. The ASEAN Specialized Meteorological Centre and the Southeast Asian Fire Danger Rating System have provided regional fire danger and meteorology information via their websites since 2000 – although difficulty in accessing and interpreting the information remains in some rural and semi-rural locations. Viet Nam has developed a national fire danger rating system, which is disseminated widely by various means, while Russia and countries of the Commonwealth of Independent States (CIS) reported similar systems. The GFMC Wildland Fire Early Warning Portal (www.fire.uni-freiburg.de/fwf/fwf. htm) provides access to all global, regional and national early warning systems.

A special problem is the prevention of fires in areas contaminated with radionuclides. The Central Asian region reported that 6 million hectares of forest lands were polluted as a result of the failure of the Chernobyl nuclear power plant in 1986, with the most polluted forest area covering over 2 million hectares in Belarus, in the Kiev region of the Ukraine and in the Bryansk region of the Russian Federation. Despite best efforts, every year hundreds of fires occur in these contaminated forests, peatlands and former agricultural sites. A report published after the Central Asia regional working paper revealed that radioactive emissions from fires burning in Central Asia in 2003 were recorded in Canada (Wotawa *et al.*, 2006).

There is a similar situation in Kazakhstan, where more than 450 nuclear tests, including some 100 atmospheric tests, were conducted from 1949 to 1989. Radioactive contamination is highest in eastern Kazakhstan, including the fire-

prone pine forests along the Irtysh River. Since 2004, the World Bank has financed the Kazakhstan Forest Protection and Reforestation Project, in which radioactive contamination and fire management are key project issues.

The relative neglect of fire prevention activities was documented by reports from many countries that most of the fire management budget goes for suppression, with a much smaller proportion for prevention.

SUPPRESSION

The suppression of fires starts with detection. Most regions rely on the early detection of fires by watchtowers and patrols, but increasing numbers also reported the use of satellites and aerial surveillance. Industrialized countries tend to use sophisticated equipment and advanced technology. Canada and the United States reported prediction of the most likely locations of fires (from either lightning or human causes) and enhanced detection through lightning detection systems and aircraft patrols. The Southeast Asian region, however, reported that the use of satellite detection of active fires peaked following the 1997/98 fire season, with the recognition of limitations such as coarse resolution of fire detection maps, cloudiness, time delays in information relay to field sites, and inaccuracy.

Fires are extinguished primarily by ground-based suppression forces using hand tools and mechanized equipment, aided by indirect techniques such as backfiring and the use of fire traces. The Mediterranean region mobilizes approximately 30 000 workers for firefighting activities each summer, and in particularly serious seasons, the number may swell to 50 000. The Southeast and Northeast Asian regions reported that although fire suppression resources are available they are often insufficient.

Ground-based firefighters are often reinforced – in Mediterranean countries for example – by fixed-wing aircraft (including amphibious models) and helicopters; the latter are often used to transport firefighters. The working paper for Southeast Asia stated that the use of helicopters is increasing in the region, especially for rapid access by fire crews. In the South American region, Argentina, Brazil and Chile usually combine terrestrial and aerial resources in firefighting, as do Canada and the United States. China reported that air-jet extinguishers are used for surface and grass fires, and fire-extinguishing bombs have been developed. The Mediterranean paper emphasized that if the land-based forces are not sufficient, the introduction of additional airborne forces will not improve overall efficiency. It may even retard future development, as resources that could have been better invested in the formation of land-based brigades are diverted.

Australia reported that aerial support to fire suppression cost over US$80 million equivalent in the 2002–2003 fire season, and aircraft costs constituted a large part of overall fire management costs. Canada drew attention to the constantly rising costs of fire suppression owing to a number of factors, including the use of more costly equipment, expansion of fire protection zones northward to match shifting forest operations, and increased costs associated with protection of an expanding WUI zone. Changes in the weather patterns affecting fire mean that annual suppression costs, excluding public and industrial losses, are not only increasing, but are

highly variable, averaging US$450 million equivalent, but reaching US$900 million equivalent in an extreme fire season. Fire suppression as practised today may not be economically sustainable: Canada will not be able to meet current targets in terms of area burned and the control of escaped fires. This will have direct effects on wood supply and the competitiveness of the forest industry, and on the approximately 300 communities in Canada that are dependent on the forest industry.

INSTITUTIONS, RESPONSIBILITIES AND ROLES

Countries have many different institutional arrangements for organizing fire management. The national fire service is usually responsible for fires that pose a hazard to people, with priority given to urban areas, while the forestry authority, at the national or state/provincial level, is responsible for fires in the forested areas under its jurisdiction. Environmental and/or conservation agencies such as national parks authorities may be responsible for fire management in reserves or parks. The national defence force may provide support where the capacity of the other institutions is limited, while agencies concerned with meteorology, tourism, health, infrastructure, development, legislation, national emergency and ambulance services may also be involved in prediction, protection and support. At the forestry/agriculture interface, the private sector, non-governmental organizations (NGOs), civil society and research and education/training institutions are increasingly engaged in dialogue and action with respect to the prevention and suppression of fire and restoration and rehabilitation following it.

The countries of the Mediterranean reported two trends in institutional arrangements:

- a system in which the forest service is responsible for forest fire prevention and control;
- a 'mixed' system, in which the forest service is responsible for forest fire prevention and the fire service takes over suppression and presuppression activities.

In most Mediterranean countries, forest authorities have full responsibility for fighting fires in the forest. European Union countries, however, use the mixed system, with various agencies involved, supported by expensive, mostly aerial fire suppression tools. There is also a movement away from fire suppression by the forest service to professional firefighters, which represents a shift from a fire management approach to a more operational one. While this may be correct in principle, it reduces the participation of forest management authorities in fire protection, creating more of a crisis-response character. Another reason for this development may be the increasing urbanization of European Union country populations, which do not understand the fire management approach and consider fire 'bad' and to be totally excluded. The Baltic region also reports that fire management is no longer the responsibility of forestry staff, but has been assumed by the fire and rescue services – which in general lack appropriate training and equipment for vegetation fire management. This operational approach is evidently not proving effective in the face of the increasing fire hazard.

The involvement of so many institutions in fire management means that coordination of their inputs is essential. In 1997 Turkey instituted a Fire Command Centre, which is responsible for all fire management issues and has evidently improved coordination. South Africa has established a National Disaster Management Centre, and a number of African countries are following this example. Russia has maintained a centralized, national forest-fire management system, with two departments – the Federal Forestry Agency and the Aerial Forest Protection Service – while the Ministry of Emergency Situations is involved in extreme conditions. However, in the wake of the decentralization process in Russia, more responsibilities are being delegated to the regions. Mexico has established a Group for Interagency Coordination with the participation of the 12 Federal Secretaries of State. The group will support fire management activities and ensure coordination of resources for the prevention, detection and suppression of fires.

Nevertheless, lack of coordination among the various responsible organizations for fire management remains a constraint in many countries. The paper for South Asia referred to "a lack of feeling of responsibility [for fire management] on both sides – government and local population. Tackling the difficult issue of fire is postponed by national Parliaments as soon as … the danger recedes." Similarly, in South America, the political reaction to fires occurs after a catastrophic event. Lack of political will may be the reason not only for lack of institutional coordination in fire management, but for problems in other fire issues as well, ranging from adequate budgetary provision for prevention to enforcement of fire control and other laws.

COMMUNITY PARTICIPATION

Community-based fire management (CBFiM) exists and is increasing in some developing countries. 'Communities of interest' are emerging, in which groups contribute towards fire management motivated by self-interest in a landscape threatened by fire. In most developed economies, however, it appears that communities *per se* participate less and less. In these countries, there has been a move away from a local-level approach, in which fire protection measures are part of forest management, towards a more high-input, operational model, in which professional, specialized units are involved and supported by advanced equipment, but only after the outbreak of the fire.

A significant step in CBFiM occurred in Bangkok in 2000 at the first international workshop on this phenomenon. Very encouraging CBFiM programmes have been established in the sub-Saharan region, for example in Burkina Faso, Mozambique, Namibia and South Africa, and in Southeast Asia. The results of these projects have shown that, in Africa at least, the community approach is probably the only sustainable, long-term approach to improving the fire situation.

Other countries have also reported CBFiM initiatives. In China, India, Nepal and Turkey, the response of local people and communities to fires has improved considerably in recent years, owing to public awareness campaigns dealing with attitudes towards forest resources, supported by new community regulations. Bolivia, Brazil and Chile have also had encouraging experiences. FAO is providing strong support to CBFiM training and projects.

NATIONAL AND INTERAGENCY COLLABORATION

In addition to cooperative arrangements for communities and other stakeholders, there is a need for close cooperation and coordination by the national, provincial and local agencies involved in fire management (see *Institutions, responsibilities and roles*, below). In countries in which fire management is solely the responsibility of states or provinces, such as Australia, interstate cooperation agreements or federal regulations have been developed for border-crossing fire events or emergency situations. In some countries, support to states from national/federal authorities is provided regularly (the Russian Federation and Spain). National agencies responsible for fire management in territories distributed over various states or provinces have created interagency coordination mechanisms and centres (Canada and the United States).

Interagency cooperation is practiced, by definition, by all those having shared responsibility for fire management. However, there is often a critical gap in the availability of adequately trained and equipped human resources for the specific tasks of vegetation fire suppression. In many countries in Europe, fire services are using fire suppression hardware, including personnel protection equipment, designed for firefighting in buildings or for the suppression of fires of hazardous chemicals, and they are often not adequately trained in the fundamentals of vegetation fire behaviour and safety. This has repeatedly resulted in an inability to control fires or in fatal accidents.

INTERNATIONAL COLLABORATION
Bilateral and multilateral agreements on mutual assistance

The regional working papers indicated that there is increasing collaboration among countries and among regions, but that there is also variation in the amount and type of collaboration. In some regions, such as South Asia, there is little reported collaboration in fire management, but in others, such as North America, parts of the Mediterranean and Australasia, collaboration among countries is strong.

The regional analyses report a total of 22 international emergency response agreements, 16 international agreements on other matters and six national inland agreements dealing with forest fires globally. Bilateral and other agreements for joint fire suppression or the exchange of fire crews are in force in several places, especially in border areas, for example Canada with the United States; China with Russia; among some countries of Mesoamerica; Mexico with the United States; Mongolia with China and Russia; Russia with Finland; and Russia with the Islamic Republic of Iran. Moreover, ad hoc agreements have been formulated to respond to emergency situations, such as in Brazil and Colombia in 1998 (www.fire.uni-freiburg.de/emergency/int_agree.htm).

The three North American countries have jointly adopted the Incident Command System,[1] enabling them to work together using a unified command structure and terminology.

---

[1] The Incident Command System is a standardized on-scene emergency management concept, specifically designed to allow its user(s) to adopt an integrated organizational structure equal to the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries.

Bilateral and multilateral emergency assistance is in place, for example the assistance offered by Australia and Singapore to Indonesia in 2005, or by the United States to Mexico, or that among Australia, New Zealand and the United States in severe fire seasons.

In view of the extreme fire and smoke pollution episodes since the late 1990s, during which a number of countries throughout the world requested foreign assistance for disaster response, the Joint Environment Unit, Emergency Services Branch, of the United Nations Environment Programme (UNEP), the United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA) and GFMC recognized the need for improved cooperation in early warning, information dissemination and response to vegetation fire emergencies. In 2001, Joint Interface Procedures were signed by UNEP, UN-OCHA and GFMC that led to increased efficiency in the provision of information and in coordination of the response (GFMC, 2006a).

International fire response exercises have been conducted with multilateral cooperation in the Baltic region (BALTEX Fire 2000), the European Union (France 2004) and the Balkans ("Taming the Dragon" 2002, organized by the North Atlantic Treaty Organization (NATO) and the Euro-Atlantic Disaster Response Coordination Centre, and EASTEX Fire 2005) (www.fire.uni-freiburg.de/emergency/International%20Wildland%20Fire%20Exercises.htm).

While this development is encouraging, there would seem to be potential for further collaboration, considering the scale of the problem.

International mechanisms and networking to enhance cooperation

As a contribution to – and in accordance with – the framework for the implementation of the United Nations International Strategy for Disaster Reduction (UN-ISDR), in 2000 the World Conservation Union (IUCN) and GFMC suggested the creation of an interagency working group on wildland fire. This proposal was in line with several declarations made in international conferences during the second half of the 1990s. It intended to bring together technical members of the fire community and the authorities concerned with policy and national practices in vegetation fire management in order to realize their common interests on a global scale. The UN-ISDR Inter-Agency Task Force on Disaster Reduction (IATF) agreed to establish a Working Group on Wildland Fire (WG-4) in 2000. From 2001 to 2003, WG-4 provided an international, interagency and intersectoral forum in which United Nations agencies and programmes, international organizations and civil society worked together to formulate a vision and common goals to enhance interagency and international cooperation towards "reducing the negative impacts of fire on the environment and humanity".[2]

---

[2] By consensus of the parties involved, this overall goal included promotion of the concept of integrated fire management, i.e. the recognition of the role of natural fires in ecosystem dynamics and the sound application of prescribed fire in land-use systems.

One of the priority activities to be addressed by WG-4 was establishment of 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", consisting of a set of regional networks that were either in place or would be initiated during the process of formation.

The 3rd International Wildland Fire Conference and the International Wildland Fire Summit (both held in Sydney, Australia, in October 2003) were used as platforms to convene representatives of the regional networks. The strategy formulated by the summit ("A Strategy for Future Development of International Cooperation in Wildland Fire Management") included agreement that "… 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" (GFMC, 2004a). A side meeting of regional fire management groups[3] recommended the maintainance and strengthening of a unified approach under the auspices of the United Nations.

After its scheduled termination at the end of 2003, WG-4 became the Wildland Fire Advisory Group (WFAG) under the auspices of UN-ISDR. WFAG represents an advisory body to the United Nations system, providing technical, scientific and policy-supporting advice through UN-ISDR and IATF and acting as a liaison between the United Nations system and GWFN and its supporting partners (UN-ISDR, 2006).

Regional wildland fire networks cooperating within GWFN do not follow a standardized establishment or *modus operandi*. Some are networking arrangements that were in place before 2001, including the FAO/UNECE/ILO Team of Specialists on Forest Fire (Baltic region), the ASEAN Agreement on Transboundary Haze Pollution (Southeast Asia), the Working Group on Wildland Fire of the FAO North American Forestry Commission (North America), FAO *Silva Mediterranea* (Mediterranean) and the Australasian Fire Authorities Council (Australasia). Newly established regional wildland fire networks cover the following regions: Central America, the Caribbean, South America, sub-Saharan Africa, Southeast Europe/Caucasus (formerly Balkan), Northeast Asia and Central Asia. The South Asia network is still to be defined (its foundation is projected for early 2007) (see Figure 1 in Part 2).

Important activities of the regional networks include:
- regional agreements such as the ASEAN Agreement on Transboundary Haze Pollution in 2001, which entered into force in 2003, and the Congo Basin Conservation Treaty, signed at the Congo Basin Forest Summit in 2005;

---

[3] WG-4; FAO/United Nations Economic Commission for Europe (UNECE)/International Labour Organization (ILO) Team of Specialists on Forest Fire; Fire Management Working Group, FAO North American Forest Commission (NAFC); and the Forest Fire Group of FAO *Silva Mediterranea.*

- regional plans for cooperation in fire management, such as the fire management cooperation strategies in the Caribbean, and Central and South America (with an overall regional strategy for Latin America and the Caribbean);
- establishment of training centres such as the Wildland Fire Training Center Africa, set up by the Regional Subsahara Wildland Fire Network (AfriFireNet) in cooperation with local partners in South Africa;
- regional meetings and declarations, including:
  - meeting of the prime ministers of the six member countries of the Shanghai Cooperation Organization (SCO) in September 2001, which documented the need for member countries to work together in various fields, including forest fire prevention;
  - Helsinki Declaration on Cooperation in Wildland Fire Management in the Baltic region (Helsinki, Finland, May 2004);
  - Antalya Declaration on Cooperation in Wildland Fire Management in the Balkans, eastern Mediterranean, Near East and Central Asia (Antalya, Turkey, April 2004);
  - conclusions of the International Technical and Scientific Consultation "Forest Fire Management in the Balkan Region" (Ohrid, The former Yugoslav Republic of Macedonia, April 2005);
- regional assistance, especially within the context of the enlargement of the European Union, to harmonize legislation, reporting and prevention.

United Nations specialized agencies, programmes and conventions are addressing vegetation fire, both sectorally and in accordance with their mandates (GFMC, 2005a). Their contributions include:

- FAO – promotion of international cooperation in vegetation fire management; technical cooperation programmes (TCPs) in the field, and information dissemination through seven regional forest commissions; global forest fire assessments jointly with GFMC (e.g. FAO, 2001a; GFMC, 2004b); *Fire management guidelines for temperate and boreal forests* jointly with GFMC (FAO, 2002a); *FAO wildland fire management terminology*, updated jointly with GFMC (FAO and GFMC, 2003); promotion of CBFiM; and a database of international agreements on cooperation in vegetation fire management;
- World Health Organization (WHO) – development of *Health guidelines for vegetation fire events* (Schwela *et al.*, 1999);
- World Meteorological Organization (WMO) – forecasting/early warning of El Niño, fire weather and smoke transport phenomena involving the global network of hydrometeorological stations;
- UNEP/UN-OCHA – Joint Environment Unit; Advisory Group on Environmental Emergencies; and World Summit on Sustainable Development Type II Partnership on Environmental Emergencies;
- International Tropical Timber Organization (ITTO) – support to national fire management programmes and participation of producer countries in the 3rd International Wildland Fire Conference;
- United Nations University – vegetation fire research and training focus through establishment of the University of Freiburg as an associate institute of UNU;

• UN conventions – agreement by the secretariats of the three Rio conventions (Convention on Biological Diversity – CBD, United Nations Convention to Combat Desertification – UNCCD and United Nations Framework Convention on Climate Change – UNFCCC) to give priority to fire-related environmental degradation (Workshop on Forests and Forest Ecosystems: Promoting synergy in the implementation of the three Rio conventions, Viterbo, Italy, April 2004).

After the International Wildland Fire Summit, which led to better international appreciation of the scale of the challenge posed by fires and to an informal statement of consensus on international collaboration, GWFN and FAO worked jointly on a Fram ework for the Development of the International Wildland Fire Accord (GFMC, 2005a). The documentation outlined the global situation major stakeholder groups that supported an international alliance to address global vegetation fire problems (United Nations, non-United Nations international organizations, NGOs, the scientific community, civil society and governments) and recorded major international events manifesting the interest of the international community in development of an international agreement on fire. Recognizing the importance of enhancing the fire management capabilities of all actors globally, the FAO Ministerial Meeting on Forests (Rome, 14 March 2005) (FAO, 2005b):

> *… called on FAO, in collaboration with countries and other international partners, including the International Strategy for Disaster Reduction, to develop a strategy to enhance international cooperation on wildland fires that advances knowledge, increases access to information and resources and explores new approaches for cooperation at all levels.*

At the Seventeenth Session of the FAO Committee on Forestry (COFO) (Rome, 15–19 March 2005) (FAO, 2005c), an Action Programme for FAO in Forestry was agreed. It included Recommendation No. 53:

> *… that FAO continue its support for regional and national networks to combat fire as well as insects and disease, in collaboration with relevant organizations such as the United Nations International Strategy for Disaster Reduction and the Global Wildland Fire Network, and further requested that FAO work with partners to develop voluntary guidelines on the prevention, suppression and recovery from forest fire.*

FAO has been coordinating a multistakeholder process towards a framework of priority principles of fire management, within which to provide policy, legal, regulatory and other enabling conditions for and strategic actions towards more holistic approaches. The draft text is available at www.fao.org/forestry/site/35487/en. It will be a voluntary, non-binding instrument tailored primarily to land-use policy-makers, planners and managers in fire management, including target users such as governments, the private sector and NGOs. Its scope includes the positive

and negative social, cultural, environmental and economic impacts of natural and planned fires in forests, woodlands, rangelands, grasslands and agricultural and rural/urban landscapes.

The definition of fire management covers early warning, prevention, preparedness (international, national, subnational and community), safe and effective initial attack on fires and landscape restoration following them. This international framework discusses cross-sectoral issues and elaborates principles and attributes in order to balance social, cultural, environmental and economic dimensions of fire management and outline key actions for the planning and management of fires.

The fire management principles will also provide a framework for achieving the Millennium Development Goals: in particular Goal 1 to eradicate extreme poverty and hunger, Goal 7 to ensure environmental sustainability and Goal 8 to develop a global partnership for development.

Capacity-building in fire management
Another main area of collaboration regards capacity-building in fire management. A number of international training courses have been conducted in the Mediterranean, southern Africa and Central America under the auspices of the Government of Spain, GFMC/UNU, FAO and The Nature Conservancy.

Fire research
The need for international cooperation in fire research was noted in a number of reports, although they did not refer to international cooperative research projects conducted before and during the reporting period (1998–2003), mainly under the auspices of the International Geosphere-Biosphere Programme. The Central Asian paper mentioned that several interdisciplinary research campaigns had been initiated in the period 1993–2000. The need for research into the use of remote sensing for fire detection was one topic mentioned in the papers, while others were carbon pools and flows affected by fire and the impact of fire on permafrost. The Fire Paradox research programme was launched by the European Commission in 2005, within its 6th Framework Programme (2006–2010), for the European Union and associated countries in Africa, Asia and Latin America. It will investigate the use of prescribed fire and suppression of fire in forest fire management. Expected to begin in 2006, it will be operational for four years.

Development of technologies for fire research, monitoring and management
Satellite remote sensing. The use of space-borne instruments for the detection, monitoring and impact assessment of vegetation fires is being promoted by the Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD – http://gofc-fire.umd.edu/). GOFC-GOLD is a panel of the Global Terrestrial Observing System programme, which is sponsored by the Integrated Global Observing Strategy. Its main goal is to provide a forum for international information exchange, observation and data coordination, as well as a framework for establishing long-term monitoring systems. The GOFC-GOLD Fire Mapping and Monitoring Theme aims

to refine and articulate international observation requirements and to make the best possible use of products from existing and future satellite observing systems for fire management, policy-making and global change research. Regional GOFC-GOLD fire networks have been developed in Africa, Eurasia, Latin America and Southeast Asia. Bilateral and multilateral agreements for the joint use of satellite assets have been developed, for example between Mexico and various Mesoamerican countries and within the Baltic region.

Progress has been made in using data from the following space-borne sensors in fire monitoring, assessment of areas burned and emissions:

- Advanced Very High Resolution Radiometer (AVHRR);
- Moderate Resolution Imaging Spectroradiometer (MODIS) on the Earth Observing System (EOS) Terra and Aqua satellites;
- Medium Resolution Imaging Spectrometer (MERIS);
- Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER);
- SPOT-Vegetation; and
- Measurements of Pollution in the Troposphere (MOPITT).

A new generation of dedicated space-borne sensors for fire characterization has been designed to provide more precise information on fire extent and characteristics, for example the Bi-spectral Infrared Detection (BIRD) mission of the German Aerospace Center (DLR).

Early warning. Fire danger rating is a mature science that in several countries has long been used to provide early warning of the potential for serious wildfires. Fire danger rating systems (FDRS) use basic daily weather data to calculate wildfire potential. FDRS early warning information is now often enhanced by satellite data, such as signals of high-temperature events for early fire detection and spectral data on land cover and fuel conditions. FDRS tools for early warning are highly adaptable and have demonstrated their application for a wide range of users, from independent remote field stations (local fire suppression and preparedness decisions) to global and regional fire information centres (large-scale decision-making, for example in multinational resource sharing). There are numerous examples of current operational systems that use geographic information system (GIS) technology and computer modelling of landscape-level fire danger, and which process and transfer early warning information very quickly via the Internet.

The European Commission DG Joint Research Centre set up, since 1999, a research group to work specifically on the development and implementation of advanced methods for the evaluation of forest fire risk and mapping of burnt areas at the European scale. These activities led to the development of the European Forest Fire Information System (EFFIS). Since the year 2003 EFFIS is part of the Regulation (EC) No 2152/2003 (Forest Focus) of the European Council and Parliament on monitoring of forests and environmental interactions. All the EFFIS activities are coordinated with DG Environment to reach the final users, Civil Protection and Forest Services, in the Member States. EFFIS is aimed to provide

relevant information for the protection of forests against fire in Europe addressing both pre-fire and post-fire conditions. (http://effis.jrc.it/Home/). On the pre-fire phase, EFFIS is focused both on the development of systems to provide forest fire risk forecast based on existing fire risk indices, and on the development of new integrated forest fire risk indicators (http://effis.jrc.it/Home/).

Historical knowledge of the conditions during wildfires and the utility of fire danger forecasts is important to the immediate development of early warning systems and to the planning and preparation associated with the impact of climate change. The UN Secretary General had requested development of a global vegetation fire information system, as laid out in the *Hyogo framework for action 2005–2015: building the resilience of nations and communities to disasters* (GFMC, 2006b). In 2005 an international consortium of institutions endorsed such an information system as a thematic component of the global multi-hazard early warning system.

The objectives of the global fire early warning system are to:
• develop a global early warning system for vegetation fire, based on existing and demonstrated science and technologies;
• develop an information network to quickly disseminate early warning of fire danger to global to local communities;
• develop a historical record of global fire danger information for early warning product enhancement, validation and strategic planning purposes; and
• design and implement a technology transfer programme to provide the following training for global, regional, national and local community applications:
  - early warning system operation;
  - methods for local to global calibration of the system;
  - use of the system for prevention, preparedness, detection and, where appropriate, fire response decision-making.

NEEDS AND LIMITATIONS

Each regional working paper included an assessment of the needs and limitations of member countries in fire management. However, the assessment was sometimes included in the section on analysis and recommendations, thus responses in the two have been combined in this overview of the main issues identified. In approximate order of frequency, the needs and limitations included:
• Harmonization of definitions and the development of a common system for data collection and reporting were seen as major needs, whose absence limits the development of common regional databases for analysis and for identification of topics for research.
• Awareness-raising among the public is a major need. This activity is a prerequisite for fire prevention, paying particular attention to the value of forests to rural people and promoting the positive as well as the negative roles of fire to urban people. Traditional knowledge may have a role in developing awareness-raising programmes.
• Information and data on the severe social, economic and environmental impact of fires were often lacking. However, this shortcoming was perceived

as unimportant by the general public, and this perception, itself, is a serious constraint on the development of effective fire management.

- Many regions noted the need for the public and policy-makers to understand fires as a continuing threat to livelihoods – especially of the poorest – and to development. Policy-makers must not react only when a fire disaster occurs.

- The shortage of consistent funding was seen as a major limitation in several regions, some of which mentioned that most of their limited resources were devoted to fire suppression rather than fire prevention.

- Arson was a widespread problem and a constraint on sustainable forest management, but effective action to charge arsonists was seen as difficult.

- Collaboration among agencies involved in fire management – and hence improved definition of responsibilities and country profiles – were needed by countries in many regions.

- Institutional development of the appropriate agencies, including decentralization of fire management and development of fire management plans, was seen as a need and a limitation.

- Capacity-building and training at all levels were seen as needs and limitations in several regions. Training of fire crews and others involved in fire management was seen as a need by some regions, although others recognized that the expertise exists and the need is for further training in more sophisticated techniques of fire detection and suppression. Several regions mentioned the need for training in the control of large fires, especially decision-support systems. Training may also include those outside the forest sector, particularly farmers, who in several regions were seen as benefiting from training in prescribed burning.

- Improved resources and equipment for predicting and detecting fires were referred to in several working papers as a need, with special reference to the use of satellite systems.

- Community-based approaches to fire management were seen as an important need. Meeting it will require addressing underlying social constraints and improving public confidence in the agencies responsible.

- Forest-sector policies and legislation related to fire can limit effective fire management in forests. They need to consider all related sectors, as well as implementation capacity.

- Fire-related policies and legislation of other sectors (especially agriculture and livestock) can limit fire management in forests. These are often perceived by countries as impacting the forest sector negatively, although it is recognized that they should be related to the actual needs of people in pursuing their livelihoods.

- Improved cooperation within and between regions was seen as a need by many regions, including development (or further development) of networking and the exchange of information. Development of compatible approaches to firefighting, such as the Incident Command System, was seen as a related need in regional collaboration.

- Regional plans for fire management were needed, including the identification of cooperation mechanisms.

- International and donor support in fire management was identified as a need by several regions, especially financial support to satellite warning systems and to the development of community-based fire management.
- Research was being done in some countries, but the results were not always shared. There is a need for regional research on fire management, including on the impact on ecosystems, the development of fire risk assessments/fire danger ratings, fire behaviour prediction and social studies linked to the causes of fire. Lack of adequate and continuing finance is a limitation to fire research.
- Looking to the future – risks may increase because of various environmental, social and economic trends, of which the most frequently mentioned was climate change. But other factors were also noted as important, such as more complex, natural vegetation systems with higher fuel loads due to land-use change, and increasing urbanization – especially at the wildland/urban interface.

CONCLUSIONS

Reports on fire were received from all 12 of the regions defined by UN-ISDR/ GWFN. Additional inputs on international collaboration and initiatives were provided by GFMC.

Fires in various types of vegetation continue to cause widespread social, economic and environmental damage in every part of the world. Based on satellite-derived evidence in 2000, the global estimate of land area affected by fire was 350 million hectares. Neither the number of fires nor the area burned appear to be decreasing, and there is evidence from some regions that the number is increasing, the size of individual fires is getting larger and the severity worse.

It is not possible, at present, to assess the extent of fires occurring specifically in forests and woodlands, due not only to the lack of reliable, current and consistent data, but also to the absence of common terminology and definitions. In a number of countries, a comparison of the reported area burned with the area detected by satellite showed that the reported area grossly underestimated the area identified by satellite imagery. Nearly all of the regional working papers recommended development of:

- agreed terminology and definitions for fires in all vegetation types;[4]
- a common system for data collection; and
- regional and global databases to record and report data.

People are overwhelmingly reported to be the main cause of fires, and agricultural clearing is one of the most frequently mentioned reasons. Training in prescribed burning may help reduce this source of fires. Arson, however, is also common and currently one of the most difficult practices to prevent or punish. Social research

---

[4] The *FAO wildland fire management terminology* (FAO and GFMC, 2003) includes a complete set of English definitions and incomplete and outdated counterpart terms or translations in French, Spanish and German. All other languages are lacking. A Russian version is in preparation.

is needed here. Lightning causes fires in some regions, largely in remote areas of Canada and Russia, where storms are not accompanied by heavy rains.

With increasing urbanization and the abandonment of rural lands, environmental pressures to refrain from fuel management, under-resourcing of fire authorities, and the emphasis on fire suppression have resulted in an increased risk in the incidence, scale and impact of fires, particularly in extreme fire danger conditions.

Several reports drew attention to the positive as well as the negative effects of fire. For example, some vegetation types are adapted to fire and require it for regeneration. Fire may be used to reduce fuel loads and thus reduce the risk of a catastrophic event. But increased urbanization means that city-dwellers are often not aware of these features of fire management, and there is strong popular and political feeling against any preventive use of fire.

Reports from some developed countries (including Australia, Canada, Mediterranean countries and the United States) referred to the increased risks to life or property arising from increased urbanization. Urban people appreciate life at the WUI, but may build their houses in high risk locations due to poor understanding of the danger of fire. Most regional working papers recommended public awareness campaigns as part of fire prevention campaigns, with different messages targeted at different groups.

Looking ahead, most regional working papers drew attention to the increased risk of fire that climate change will bring.

The papers also indicated the need for a change in attitude towards the dangers and consequences of fire by people and policy-makers. They should not just react when severe fire events occur; planning and prevention are required always. Many countries not only reported inadequate budgets and staff allocations for fire management, but that most resources were allocated to fire suppression, while increased efforts in prevention could have greater impact. Besides public awareness campaigns and prescribed burning, many countries saw the need for further development of early warning systems and fire danger rating (which already existed in a number of countries) and development of satellite-derived products for operational use in fire management.

Fires have caused extensive damage in recent years, leading to loss of life of civilians and firefighters, affecting human health on a wide scale through smoke haze, burning property and businesses and causing extensive environmental damage to fire-sensitive systems. Most reports noted that fires contribute to global warming and climate change, notably through the emission of CO_2 – perhaps as much as 5 130 million tonnes of vegetation may be burned each year, of which 42 percent is in Africa. There were very few estimates of the true social, economic and environmental costs and impacts of the damage caused by fire, which would allow more informed decision-making and the setting of priorities. The absence of these estimates may largely be due to lack of political or public appreciation of the need for them and the difficulty of collecting the data.

Most fire suppression is done by land-based firefighters and workers, reinforced in some countries by the use of aircraft to drop water or retardant and of helicopters

to transport fire crews to the fire site. These sophisticated methods are used not only in developed economies, but in several developing ones. They are effective, but very expensive, and cannot be used in isolation from sufficient crews on the ground.

Countries reported a wide range of institutions responsible for fire management, ranging from the national forest department, alone, to a number of different authorities concerned with fires. Some countries have institutional arrangements for the coordination of different agencies in emergency situations. But lack of a clear definition of responsibilities and of coordination between the various national institutions were identified by many countries as severe constraints on effective fire management.

Countries recognized the important role that communities can play in fire prevention and suppression, and some had been taking steps to promote CBFiM. However, in some countries where CBFiM was implemented in the past, it now appears to be diminishing in favour of high-tech detection and centrally coordinated suppression.

Generally there is increasing collaboration between countries within regions and between regions. There are, for example, a number of bilateral agreements for joint fire suppression, arrangements for regional training courses, several regional networks for the exchange of information and experience and some regional fire management plans.

There have been two global meetings on fire in recent years: the International Wildland Fire Summit, Sydney, 2003, and the Ministerial Meeting held at FAO, Rome, 2005 (FAO, 2005a). Both meetings have enhanced international cooperation, as have a number of high-level regional meetings. There are several international organizations and countries involved in promoting cooperation and offering support, the main ones being FAO, GFMC, The Nature Conservancy, Australia and the United States. The forthcoming fire management framework and the assessment to enhance international cooperation in fire management – a study currently in progress that will complement the framework – will contribute further to fire management and to collaboration among countries, regions and donors.

RECOMMENDATIONS

On the basis of the needs and limitations and conclusions given above, the following recommendations have been developed.

Political commitment

Recognition of the positive as well as the negative effects of fire and a strong commitment to the concept of fire management are recommended to all national policy-makers. Political commitment is required for the implementation of all the recommendations that follow, but is noted in particular for: provision of adequate and continuing budgets; the need for proactive rather than reactive responses to fire catastrophes; amendment of conflicting policies and legislation; and the definition of clear responsibilities for fire management.

Assessments

The urgent need for the collection of reliable data on fires was the recommendation identified by most countries in the regional working papers. It has two closely linked components:

- harmonization of terminology and definitions; and
- development of a common format for regional databases on fire.

Agreement between countries on the terminology and definitions to be used in reporting fires in vegetation is fundamental to the development of regional fire databases. The data can then be used as a basis for the detection of regional trends and the development of regional policies and plans. It is recommended that FAO, with its neutral role and experience in developing definitions for use in the Global Forest Resource Assessment (FRA) process, should provide the forum for such discussions. Other international bodies should collaborate in such discussions and provide technical input.

Several countries report the use of information from space-borne sensors, which appears to provide a reliable and timely methodology for the collection of data on fires. The offer of the GOFC-GOLD network of scientific institutions to assist FAO in developing and applying standardized methods for national to global fire impact assessments should be taken into consideration.

Training of national staff in the collection of fire data (including the interpretation of satellite imagery) will be essential; this is discussed under *Institutional strengthening*.

Awareness-raising

One of the main messages recommended for all target groups of awareness-raising campaigns was that fire has positive as well as negative effects, and there is an urgent need to recognize the role of fire planning and management. Particular target groups recommended for awareness-raising campaigns included:

- Policymakers, who should move from an attitude of reaction after the outbreak of severe fires to a proactive approach of planning and prevention. This should include increased budgets for prediction and prevention, which should lead to a reduction in the need for funds for suppression.
- Urban dwellers, who must appreciate the dangers of fire risk in building homes at the WUI and must understand the preventive benefits of burning to reduce fuel loads.
- Farmers, especially those who employ fire for land clearing. Training in prescribed burning may help reduce this common cause of runaway wildfires in many countries.

A general recommendation on awareness-raising campaigns relates to the need to share experiences among countries with similar needs.

Community-based approaches

It is recommended that all countries recognize that CBFiM offers one of the most sustainable, adaptive approaches for managing fire, especially for prevention. It is noted, however, that in some countries the practice of CBFiM appears to be

diminishing, due to reliance on the use of technically advanced means of detection and dedicated, centrally coordinated, professional suppression teams.

Nevertheless, all countries should consider the role of CBFiM in harnessing the expertise and experience of communities of interest in fire management programmes. Donors and international agencies should continue to support CBFiM training courses and workshops, and countries should exchange experiences in this area.

Institutional strengthening

It is recommended that countries consider the need to strengthen the various institutions responsible for fire management, including clear definition of the responsibilities of each institution (see *Institutions, responsibilities and roles*, above). Countries should also assess:

- the validity of fire management plans or the need for preparation of such plans where they do not exist, including the potential for decentralization of responsibilities;
- the impact of plans of other sectors on fire management plans, and provision for the resolution of conflicts;
- the need for training of fire personnel, or for retraining in more sophisticated fire detection, communication or suppression techniques, noting the trend towards large fires in some regions;
- the training of others outside the forest sector, including training in prescribed burning for farmers.

National funding

It is recommended that all countries review national budgets for fire, noting that without adequate and continuing funds, fire management plans cannot be implemented. The allocation of funds within plans should also be reviewed, giving due weight to prevention as well as to suppression of fires.

Provision should be foreseen for the replacement or upgrading of equipment, the introduction of new techniques, such as remote sensing, and training. Provision should also be made for research (see *Research and development*, below).

National cooperation

It is recommended that the role of all institutions and agencies involved in national fire management be reviewed to:

- improve interagency and multistakeholder collaboration through the involvement of all in the preparation of the national fire management plan and establishment of mechanisms to promote cooperative approaches;
- define responsibilities clearly and without overlap;
- resolve overlapping or conflicting policies or legislation.

International collaboration

It is recommended that countries collaborate within and between regions, sharing knowledge and experiences and developing reporting frameworks and regional policies related to fires. Regional networks should be consolidated and strengthened

and links developed with others, not only for the exchange of information, but also for training and regional fire plans.

Bilateral agreements should be promoted for joint fire suppression. In the field of cross-border firefighting, or where fire crews or expertise are shared, it is recommended that compatible approaches, such as the Incident Command System, are accepted as common standards and collaboration procedures developed.

International and regional collaboration should be continued at technical workshops and at high-level meetings of decision-makers and/or policy-makers to promote collaboration and to demonstrate political recognition of the importance of fire management.

Donor support

It is recommended that donor governments and agencies consider their potential to support fire management in a number of areas:
- equipment, training and research into advanced technologies for detection and prediction, especially satellite systems;
- training in community-based fire management;
- strengthening of regional fire networks and of the international dialogue facilitated by GWFN and WFAG;
- other aspects of fire research, noted in Research and development.

Research and development

A number of recommendations were made by countries and international institutions on directions for fire-related research. They included:
- development of a new generation of polar-orbiting and geostationary satellites with dedicated sensors for fire applications;
- investigation into the operational use of satellite systems for fire prediction, detection and assessment of the extent of burned areas;
- development of fire danger rating and people-centred early warning systems for different vegetation types and global to local application;
- studies of assessment methods of the social, economic and environmental costs and impacts of fires, including proposals for standardized procedures of data collection;
- social research into the motivation for arson;
- forecasts of the effects of global change (the coupled effects of climate change and demographic and socio-economic changes) on vegetation fires in different localities.