

Part 2

## **Regional summaries**

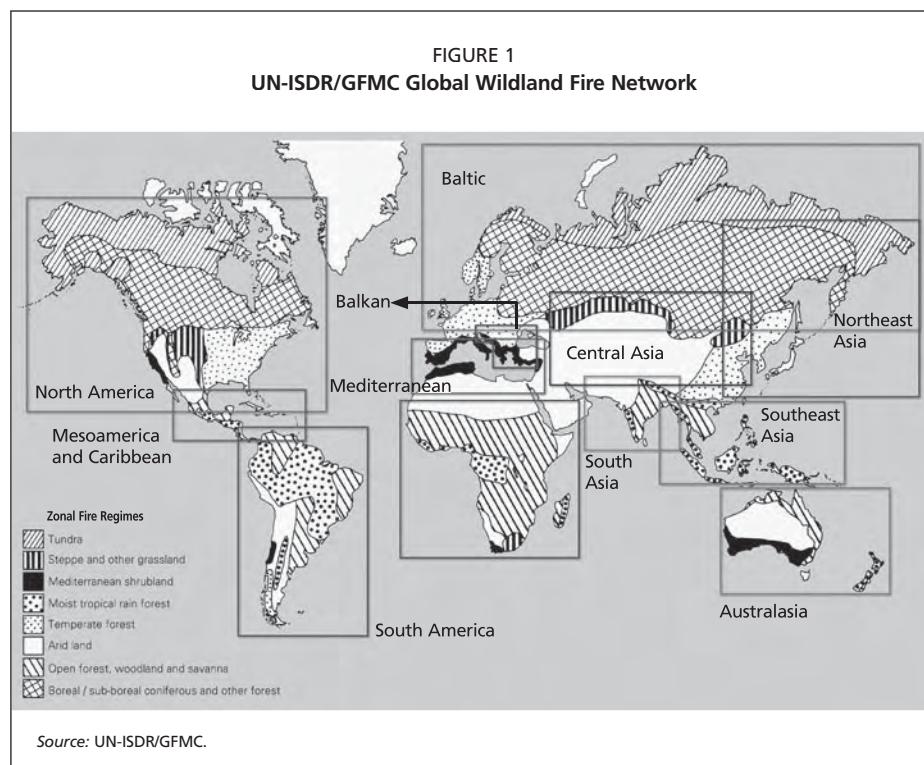


### 3. Background

Following release of the report *Global Forest Resources Assessment 2000* (FAO, 2001b), the FRA process entered its next reporting cycle. In July 2002 the Kotka IV expert consultation made recommendations on the direction of global FRAs, which were confirmed by COFO 2003. The recommendations included an update of global FRA data in 2005 and increased, direct involvement of countries in assessment and reporting, in particular the submission of national reports on the status and trends of a range of forestry parameters.

One recommendation for Global Forest Resources Assessment 2005 was the preparation of thematic studies, including the present study on fire, which is built on regional reviews of forest fire management in GWFN (Figure 1).

The purpose of this study is to provide data and information – to a greater depth than was possible in FRA 2005 – on the incidence, impact, management and issues relating to vegetation fires in unique regions around the globe. The data and information were prepared by specialists from each of the 12 GFMC regional wildland fire networks, which are also supported by FAO and UN-ISDR. In



March 2006 FAO published the regional working papers individually under the Fire Management Working Papers series.<sup>5</sup>

This thematic study assesses the fire situation in each region, including area extents, number and types of fires and their causes. The positive and negative social, economic and environmental impacts are outlined. An integrated approach to vegetation fire management is taken, including prediction, preparedness and prevention as key elements in reducing the negative impacts of fire, rapid response to extinguish fire incidents and restoration following fires.

The study also addresses key issues of institutional aspects of fire management, including the roles and responsibilities of stakeholders and their capacities for prevention and suppression, particularly the role of CBFiM.

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<sup>5</sup> Since 2005 the Mesoamerica region delineated on the map has consisted of two networks (Central America and the Caribbean). A thirteenth network covering South Asia was not yet established at the time of reporting for and compiling of the thematic summary report. The regional report was compiled by FAO and GFMC based on reports from the region – mainly in the UNECE/FAO *International Forest Fire News* – and from GFMC correspondents.

## 4. Sub-Saharan Africa

Historically, the use of fire in sub-Saharan Africa was controlled by traditional authorities, who restricted its use to certain planned occasions and events such as hunting. New fire legislation and no-burn policies were introduced during colonial times. Local practices and control mechanisms were revoked or became invalid and, although traditional authorities no longer controlled fires, the colonial officers implementing the fire bans were seldom present due to the remoteness of many areas.

Given this lack of supervision, fire was increasingly used by the local population at the beginning of the last century. The history of controlled burnings was forgotten, and people began believing that the indiscriminate use of fire was part of the inherited traditions. By 1970, almost all forest and woodlands in southern Africa were fully or partially burned every year.

Information for the regional working paper was obtained from 22 countries of sub-Saharan Africa (details are provided in FAO Fire Management Working Paper FM/9/E).

### EXTENT AND TYPES OF FIRE

*Africa sparkles with more routine fire than any other landmass.*

– Pyne et al., 2004

The overwhelming part of sub-Saharan Africa has distinctive wet and dry seasons, which favour regular vegetation fires. The wet season stimulates growth, while the dry season provides ideal conditions for burning. However, drought may lead either to increased fire danger, due to extreme fire weather conditions, or to a decrease in fire danger, as there is not enough fuel to sustain a fire. In addition, every few years the El Niño weather pattern provides climatic conditions that favour extended wildfire episodes.

Most fires, wanted and unwanted, occur in the savannah biome due to slash-and-burn practices or to the burning of agricultural residues. Large-scale burning of slash after forest harvesting is also a common practice in the forest plantations of southern Africa.

There are huge discrepancies in information between satellite-derived data and data collected on the ground, as well as discrepancies among the different satellite systems. The collection of reliable ground data is presently not feasible in the vast territories of the African continent, with the exception of a few countries. Remote sensing is presently the only reliable way to collect statistical fire data.

A review of the most recent satellite-derived assessments of the land area affected by fire in Africa was provided by an FAO study prepared for the 24<sup>th</sup> FAO Regional



Conference for Africa (FAO, 2006b). The study quotes the first global survey of burned areas, carried out by the Joint Research Centre of the European Commission, based on the detection of fire scars for 2000 by the SPOT-VEGETATION sensor. The survey showed that Africa is the most fire-prone continent. An estimated 2.3 million km<sup>2</sup> – or 7.7 percent of the continent – burned in 2000, i.e. 64 percent of the global total of just over 3.5 million km<sup>2</sup> (JRC-EU, 2005). Africa also had the highest number of fires (54 percent), as indexed by the number of fire scars. Burning in 2000 was most extensive in East Africa (873 840 km<sup>2</sup> or 15 percent of the area), Central Africa (539 225 km<sup>2</sup>, 13.5 percent) and Southern Africa (677 123 km<sup>2</sup>, 11.5 percent).

In 2004, the MODIS instrument on board the Terra and Aqua satellites of the US National Aeronautic and Space Administration detected active fires on the equivalent of 7.8 percent of Africa's land area, the same percentage as in 2000.

It must be remembered that most ecosystems of sub-Saharan Africa have evolved through the human use of fire. Thus these ecosystems, including their biodiversity, need fire to be maintained. However, too much fire, or the wrong kind of fire, is as detrimental as lack of fire, especially around the basins of the Sahara, Kalahari or Namib. Following uncontrolled burning, for example, water and wind erosion degrade former forest land into desert.

## CAUSES

[In Africa,] *anthropogenic fire originated and has resided longer than anywhere else.*

– Pyne et al., 2004

Lightning can be a significant ignition source, for example in western Namibia, where 60 percent of all fires stem from electrical storms. However, most fires in Africa are started by people. Considering the fact that fire and early human beings played important roles in shaping the environment in Africa for hundreds of thousands of years, one could come to the conclusion that people are also, in a way, a 'natural' cause of fire in Africa.

The slash-and-burn method is widely used in African agriculture to clear agricultural sites or remove agricultural residues. However, planned fires are often left unattended and can spread; thus negligence is the most common cause of fire throughout Africa. The list of agents is long – honey hunters, poachers, children at play, abandoned campfires, cooking and warming fires or escaped prescribed fire.

Arson may be caused by cultural or religious beliefs, misunderstanding of an 'African burning tradition', civil unrest and personal anger or fear (burning the bush to open it up). Arson fires are also commonly lit by marginal community members for the thrill or to feel empowered.

One of the underlying causes of frequent arson is the problem of 'ownership' or tenure. Very often the land belongs to the state or to an anonymous company, and most profits never reach the local population. Thus no sense of responsibility is created for the sustainable use of natural resources and the environment.

In forest plantations, large-scale prescribed burning is a standard practice to prepare sites for planting after harvesting. Firebreaks around and within the compartments are also prepared through burning. More than 10 percent of all plantation fires originate from these activities, due to lack of training of personnel (Goldammer and de Ronde, 2004).

## EFFECTS

Although estimates of the total economic damage caused by African fires are not available, ecologically and economically important resources are increasingly being destroyed by fires crossing borders from a fire-adapted to a fire-sensitive environment (Goldammer and de Ronde, 2004).

In general terms, unwanted fires change the species composition, vegetation structure and composition. As a result, soil properties are degraded and the soil productivity, both commercial and natural, decreases. In some biomes, the frequency of wildfires is widespread and alarming, such as in the forests and savannahs of West and East African countries (Pyne *et al.*, 2004).

The impact of wildfires on the extremely poor cannot be overstated. These people live at the margins of daily survival and are always the most vulnerable. Rural settlements (and also some urban ones) in the interface between densely settled land and lands carrying high fuel loads – and eking out marginal livelihoods – are also among the most vulnerable.

The occurrence of uncontrolled wildfires has a negative influence on the tourism industry of sub-Saharan Africa – a burned landscape hardly appeals to the tourist's eye. Tourists may also feel insecure if nearby fires are raging and destroying the environment.

FAO (2006b) provides a statement that summarizes the main impacts of vegetation fires in Africa on the atmosphere, and in particular on the global carbon cycle:

*The current estimates of the quantity of biomass burned globally each year from all sources is about 9 200 million tonnes. Overall, global wildfires consume 5 130 million tonnes, 42 percent of which is burned in Africa (including fires associated with deforestation). This burning releases about 3 431 million tonnes of CO<sub>2</sub>, as well as significant quantities of other emissions.*

## PREVENTION

Most African countries have established a national fire prevention programme, but implementation is a different story. As a preventive measure, fuel reduction is carried out primarily through prescribed burning between and around commercial forest plantations and nature conservation areas. Countries such as Botswana, Namibia and South Africa prepare quite extensive networks of firebreaks annually. But a problem in most countries of sub-Saharan Africa is the lack of even basic burning equipment, basic knowledge of fire behaviour and skills in the safe use of fire as a tool.

Knowledge of fire behaviour is a key factor in a successful prevention programme. The more that efforts are put into education and training of local farmers, the less

uncontrolled fires will occur. Apart from South Africa, most countries in sub-Saharan Africa do not have sufficient capacities, resources or skills in wildfire detection and suppression.

### **SUPPRESSION**

Most fire suppression resources in sub-Saharan Africa are urban or municipal, are located in capitals or bigger cities and do not respond to wildfires occurring in rural areas; sometimes they even lack the mandate to deal with fires in rural areas. There is little capacity within the private sector for fire suppression, with the exception of South Africa and a few other countries.

Government priorities change with time, but food-security issues usually remain at the top of the rural livelihood agenda. If a fire management budget is available, in most cases 95 percent of these funds are invested in improving fire suppression and monitoring capabilities, instead of in prevention and capacity-building.

### **INSTITUTIONS, RESPONSIBILITIES AND ROLES**

Traditionally, in the Southern African Development Community (SADC) and neighbouring sub-Saharan countries, the responsibility for fires lies with the Ministries of Environment/Agriculture and Rural Development. However, an increasing number of countries are following the South African example and giving national disaster management centres a share in this mandate. In the United Republic of Tanzania, joint involvement of forestry staff and staff of the Fire and Rescue Service Force has been suggested.

However, an important issue remains to be resolved, i.e. the leadership and authority of the fire chief conducting fire suppression activities. The role and authority of the chief have to be clearly defined, especially in commercial farming areas, in relation to regional authorities such as governors.

### **COLLABORATION**

Collaboration in fire management has been instituted in many African countries, given that they have few resources. In this way, win-win situations can often occur for the partners involved, as in South Africa, where local to national cooperation was developed.

The success and experience gained in handling a major fire emergency in Ethiopia, from February to April 2000, was the initial point for international cooperation in fire emergency management in sub-Saharan Africa (Goldammer, 2000). Subsequently, systematic, regional cooperative measures were initiated in 2002 through the creation of AfriFireNet. This network encourages countries to establish or expand cooperative and networking activities, and one of its first activities, the Wildland Fire Training Center Africa, was founded in cooperation with local partners in South Africa. GFMC and the former coordinator of AfriFireNet prepared the *Wildland Fire Management Handbook for sub-Saharan Africa* (Goldammer and de Ronde, 2004). In cooperation with the governments of Germany, Finland, Mozambique, Norway and South Africa, and with FAO



and UN-ISDR, a number of international training courses were successfully conducted over the last two years.

Another encouraging example of international cooperation in sub-Saharan Africa comes from West and Central Africa, where the first region-wide conservation treaty was signed on 7 February 2005 at the Congo Basin Forest Summit. The signing of the treaty and an agreement to protect over 7 percent of the Congo Basin forests are historic milestones for the future of the world's second largest moist tropical forest. "Central Africa is a model for the entire world on how to reach across borders to tackle the tough issues that are threatening wildlife, forests and the livelihoods of local communities" (Carroll, 2005).

### COMMUNITY PARTICIPATION

Since nearly all fires in the region are caused by human activity, the reasons for these fires must be addressed, rather than simply increasing suppression capacity or tightening fire legislation. Data on the underlying causes of fires are required, and only then will it be possible to develop national strategies for the appropriate use of fire as a management tool.

Some forestry and wildlife management agencies within the region have the basic infrastructure with which 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 the hundreds of thousands of fires in Africa occur as widely dispersed, small events, primarily related to agricultural seasons.

There is a need to raise awareness among local people and provide training to stakeholders at all levels in the proper use of fire as a management tool at the landscape level. By managing fires at the local level, resources, including forests, can be managed sustainably.

Very encouraging CBFiM programmes have been established in Burkina Faso, Mozambique, Namibia and South Africa (Goldammer *et al.*, 2002). The positive and promising results of these projects show that, in Africa, the community approach is probably the only sustainable, long-term solution to improving the fire situation at the grassroots level.

A major national South African fire management programme, Working on Fire (WoF), has created a remarkable people-centred approach to fire management – a labour-intensive initiative that provides training and empowerment for socially marginalized people ([www.fire.uni-freiburg.de/WoF/welcome.html](http://www.fire.uni-freiburg.de/WoF/welcome.html)). Since conclusion of the process to develop the regional fire working paper, WoF has assumed the leadership and coordination of AfriFireNet, with the support of GFMC. The programme is currently negotiating with neighbouring countries to make its experience available.

### NEEDS AND LIMITATIONS

The prevailing lack of financial, infrastructural and equipment resources for fire management in the SADC region and neighbouring sub-Saharan Africa is aggravated

by the lack of adequately trained human resources. The gap between decreasing preparedness capabilities in fire management and the increasing fire problems in the area requires an immediate response through capacity-building (Goldammer and de Ronde, 2004).

The expertise, motivation and technical means for the development of integrated fire management systems are already available in Africa. The major limitations are inadequate budgets, absent infrastructure, weak capacity and social and political environments that do not sufficiently enable or empower the affected population to deal with the fire problem itself. The challenge is to convince policy-makers to provide this support to communities.

These needs must also be considered within the context of the myriad other problems that face governments and communities in Africa, including wars, poverty, exploding populations, migration and health (and, in particular, HIV/AIDS). While unwarranted and uncontrolled burning may greatly affect sustainable resource management on a local scale, it may not yet appear sufficiently important to warrant the concern of policy-makers. That perception must be challenged as a first step towards more deliberate, controlled and responsible use of fire in Africa (Goldammer and de Ronde, 2004).

## **ANALYSIS AND RECOMMENDATIONS**

Integrated fire management approaches in sub-Saharan Africa face an incredible number of difficulties and obstacles. The lack of funding and of sound, sustainable fire management strategies are the most prominent ones.

Since fire management in sub-Saharan Africa is almost exclusively an agricultural issue, the key is to involve the agriculture sector in the controlled use of fire.

Each country should analyse its fire situation and specific causes and develop a strategy for fire management. In some countries, more effective action against arsonists is an important part of the solution, while in others, awareness of fire prevention and control need to be increased. Improved monitoring appears to be a general requirement, and fire reporting mechanisms should be established.

Given the lack of budgetary support, governments wishing to improve their fire situation should allocate a sustainable budget and create a position that deals exclusively with fire management. A clear mandate for all aspects of fire management would help coordinate efforts – be it a community approach, development of progressive and enabling legislation, capacity-building, danger rating or fire suppression.

International exchange of experiences, ideas, resources and sometimes even funding is important. The regional collaboration that was started through AfriFireNet should be built on. An additional option would be the establishment of one or more regional vegetation fire management centres – as centres of excellence – to assist and support countries in each region. There is already a huge reservoir of expertise available within the different regions of Africa.

There is a need, as well, to improve regional monitoring and increase scientific understanding of fires. Research is needed on the ecological dynamics, desired long-term ecosystem conditions and underlying causes of fire.

The adverse economic, social and environmental impacts of HIV/AIDS have reached catastrophic dimensions in many regions. HIV/AIDS education could be combined with local education in fire management in the countries worst hit by the pandemic. This educational activity would help lessen the occurrence of wildfires started in connection with land-clearing activities, which, over the past years, have increased due to labour shortages and the lack of experience of the often-orphaned youth now carrying out these tasks.

## 5. Caribbean

The Caribbean region includes some 20 island states ranging in size from 110 to 110 000 km<sup>2</sup>. Information was available from seven of these (Table 2). Although they are usually small in comparison with Mesoamerican mainland states, forest resources play an important role in their economies and the effect of fires can be significant (details are provided in FAO Fire Management Working Paper FM/12/E).

In common with the mainland, the island climate is determined by movement of the intertropical convergence zone, the prevailing trade winds and topography. Most islands tend to have drier western areas under the rain shadow of the central land mass. Mountainous areas are wetter than lowlands, owing to orographic effects. As rainfall diminishes, the dry season becomes more severe and fire hazard increases. The prevalence of hurricanes further raises fire hazard by building up fuel loads.

TABLE 2  
Land areas and available data on wildfire occurrence in the Caribbean

Country	No. of wildfires (annual average for period or for specified year)	Area affected (ha/yr)	Source
Antigua and Barbuda	No data	No data	
Bahamas	No data	No data	
Barbados	1 338 (2003)	No data	Jones (2004)
British Virgin Islands	No data	No data	
Cayman Islands	No data	No data	
Cuba	325 (1984–1998)	4 878 (1984–1998)	Rodríguez (2000)
Dominica	Range: from 50 (1986) to 222 (2001)	No data	James and Dupuis (2004)
Dominican Republic	141 (2000–2003)	4 660 (2000–2003)	González and Sierra (2004)
Grenada	100	No data	Thomas (2004)
Guadeloupe	No data	No data	
Haiti	No data	No data	
Jamaica	No data	No data	
Martinique	No data	No data	
Montserrat	No data	No data	
Netherlands Antilles	No data	No data	
Puerto Rico	No data	No data	
Saint Kitts and Nevis	No data	No data	
Saint Lucia	Range: from 22 (2004) to 200 (2001)	No data	Isaac (2004)
Saint Vincent and the Grenadines	No data	No data	
Trinidad and Tobago	315 (1987–2003)	4 082 (1987–2003)	Singh and Adam (2004)

## EXTENT AND TYPES OF FIRES

Vegetation types in the islands respond differently to wildfires; they can be grouped as follows:

- vegetation maintained by wildfires: pine forests in the Bahamas and the Dominican Republic; non-native grasslands and bamboo forests (mainly on the Windward and Leeward Islands);
- vegetation sensitive to wildfires and prone to fire damage: forest plantations of introduced species, e.g. Caribbean pine (*Pinus caribaea*) and teak (*Tectona grandis*); dry evergreen coppice forests in the Bahamas; flooded forests in Guadeloupe under exceptional, dry-weather conditions; lowland evergreen and semi-evergreen forests; dry deciduous forests; mangrove forests in transition to inland forest; and disturbed montane forests;
- fire-independent vegetation: undisturbed montane forests; humid montane forests at higher elevations; and mangrove forests in tidal zones.

Forest fires occur mainly within the dry forest types (1 000–1 500 mm mean annual rainfall), where most human settlements are located. Moist tropical forests and montane forests with higher rainfall (1 500–2 000 mm) are less susceptible to fires, but can burn in exceptionally dry years.

## CAUSES

As mentioned, forest fires occur mainly in dry forests. The risk of fire increases with logging, since reduction of the upper canopy triggers development of scrub and bush undergrowth, which dries up more quickly and is easier to ignite than the original understorey. Almost all fires in broadleaf forests seem to be caused by people. In common with other regions, increasing population pressure in the Caribbean has led to the reduction of forest area, associated with fires as a tool to aid clearance.

The main causes of fires are as follows:

- In rural areas, fires are used to clear land for agriculture and settlement, to improve pasture for livestock grazing and to facilitate hunting by clearing the area and driving animals out. When such fires get out of control, adjacent forest is burned. There is little motivation to control such fires if the neighbouring lands are state-owned or ownership is uncertain.
- Deliberate burning occurs as a form of protest against people or governments. Fires may be used to force settlement of disputes between neighbours, family members or interest groups over land use or ownership.
- Negligence is sometimes a cause, for example discarded cigarettes and, in areas close to urban settlements, campfires and children at play.
- There seems to be a widespread culture of starting fires for entertainment or some unspecified reason. In most cases affected forests are on public land, often in remote areas. Lack of supervision, low probability of being caught and lack of understanding of the damage caused increase the likelihood of fire. These fires are often described as malicious acts or antisocial behaviour, but appear to have a cultural or social dimension that requires research.



- Lightning is associated with heavy rainfall and thus unlikely to cause fires, although this does occur in native pine forests.
- Volcanic action can be a rare but catastrophic cause of fires, and may result in complete incineration of large areas.

Particular concerns in the region are the lack of awareness of the damage caused by fires and the prevalence of deliberate burning for unknown motives.

## EFFECTS

Damage can be extensive on some islands, but some effects are also beneficial – fire is a natural component of pine ecosystems and serves as a management tool.

As in the Mesoamerican mainland region, fire damages island ecosystems by debilitation, selective mortality and incineration of plant life, as well as by degradation of the soil. This leads to many effects, including changes in ecosystems (often with impoverishment of biodiversity and productivity), predisposition to disease and reduction of environmental services.

Many islands depend on tourism for their economy. Wildfires can have a particularly adverse effect on this by degrading – directly or indirectly – the landscape, air quality and the marine environment.

## PREVENTION AND SUPPRESSION

The smaller islands rely on basic methods of prevention, detection and control. On the larger islands (Cuba, Jamaica and Hispaniola), techniques are being developed that parallel those in Mesoamerica. Ignition sources are being reduced through campaigns to build awareness and enforce legislation. Techniques to control fire are improving. In some cases, early detection is supported by satellite and aerial surveillance. Most countries have ground patrols and some have a system of watchtowers. Fires are mostly extinguished by ground crews, aided by techniques such as backfiring and the use of fire traces.

## INSTITUTIONS, RESPONSIBILITIES AND ROLES

Several institutions are responsible for fighting fires. The national fire service is usually responsible for fires posing a hazard to people, with priority given to urban areas. The forestry authority is responsible for fires in forested areas under its jurisdiction. Additionally, environmental and/or conservation agencies may be responsible for special reserves or parks. The national defence force may also provide support where the capacity of the other institutions is limited.

Initiatives to increase cooperation and synergies among the countries of the Caribbean region have been underway since 2004:

- Participants in the Foundation Meeting of the Regional South America Wildland Fire Network, held in Curitiba, Brazil, in June 2004, proposed establishment of a Caribbean fire network within GWFN.
  - A meeting of the Regional Caribbean Wildland Fire Network was held in October 2004, followed by the Pan-American Wildland Fire Conference.
- A Caribbean fire management cooperation strategy was developed in 2005,

with the assistance and support of FAO project TCP/RLA/3010(C) and GFMC, to be integrated into the Regional Fire Management Cooperation Strategy for Latin America and the Caribbean. A regional report (Ramos Rodríguez, 2004) foresaw approval of a fire management working group within the Caribbean Subregional Group for the FAO Latin American and Caribbean Forestry Commission (LACFC). The Caribbean strategy aims to strengthen fire management networking with other regions sharing similar characteristics. The final strategy was presented during the commission's June 2006 session.<sup>6</sup>

### **COLLABORATION AND COMMUNITY PARTICIPATION**

The extent of collaboration and community involvement in firefighting depends on the size of the island and the number of institutions involved. On many of the smaller islands there can be close collaboration, and local community groups are enlisted to help fight fires. On the larger islands, there appears to be less integration.

### **NEEDS AND LIMITATIONS**

Needs and limitations are quite variable, due to the scattered nature of the islands and their differing sizes and economies. The 12<sup>th</sup> Caribbean Foresters Meeting, held in Puerto Rico in 2004, sought to identify the main issues and make recommendations (Eckelmann, 2004).

### **ANALYSIS AND RECOMMENDATIONS**

The Caribbean foresters offered the following analyses and recommendations:

- Deliberate arson, including setting fires for entertainment, is one of the major causes of fires.
- All states have indicated that awareness-raising may be one of the solutions. It should be a priority in fire prevention and control, and use educational programmes in schools and the media. There are already some excellent programmes to promote conservation awareness. School activities in particular should be given high priority.
- Tourism is important in island economies, and fire can have a negative impact. This underlines the need for interagency collaboration to increase the effectiveness of fire prevention and control. To facilitate such cooperation, standard protocols and operational procedures should be developed where these do not exist.
- Initiatives to promote community involvement in fire detection are closely linked to awareness and interagency collaboration. Such initiatives will become more effective as the role of fire is better understood, public confidence is placed in collaborating agencies and underlying socio-economic constraints are addressed.

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<sup>6</sup> The subregional strategies for the Caribbean, Central America and South America, as well as the Regional Fire Management Cooperation Strategy for Latin America and the Caribbean, are available on the websites of the regional wildland fire networks at [www.fire.uni-freiburg.de/GlobalNetworks/globalNet.html](http://www.fire.uni-freiburg.de/GlobalNetworks/globalNet.html).

- Many states have legislation that governs the use of fire, mainly in agriculture. However, the level of enforcement is generally low because of limited capacity, or because some laws are controversial. Responsibility for firefighting is divided among various agencies. Some legislation needs to be revised, as well, as it was originally laid down to regulate slash-and-burn agriculture.
- Many states indicate that there is a need to improve documentation of fires. This would ensure that the extent, causes and effects of fires can be better understood. Research strategies for fire management should be developed as well.
- Regional networking and exchange of ideas, such as those already carried out under the auspices of the Caribbean Foresters Network or the GWFN should be encouraged. The Caribbean Community (CARICOM) secretariat could be involved in implementing certain regional mechanisms.

## 6. Mesoamerica

There are eight countries in the region, covering a total land area of approximately 2.4 million km<sup>2</sup>, with a wide variety of climate, topographic and forest types, including desert scrub, subtropical montane forest and lowland, moist tropical forest. Reports were received from seven of the countries participating in the regional working paper process (Table 3) (details are provided in FAO Fire Management Working Paper FM/12/E).<sup>7</sup>

### EXTENT AND TYPES OF FIRES

There are extensive areas of fire-climax coniferous forests (i.e. the pine forests and savannahs) in which fire is an integral part of the ecosystem. The main environmental problems in the region are deforestation, which is estimated at 1.3 million hectares per year (equivalent to 1.8 percent annually), forest degradation and wildfires. Fires are many and serious, with the peak season in April and May.

### CAUSES

Mesoamerican countries reported many varied causes of vegetation fires, including: social inequity, devalued natural resources, a culture that does not respect forests,

TABLE 3  
Land area of countries and area affected by fire in Mesoamerica 1998–2004

Country	Land area (km <sup>2</sup> )	Area affected by fires (ha)						
		1998	1999	2000	2001	2002	2003	2004
Mexico	1 908 690	849 632	231 062	235 915	136 879	208 297	322 448	81 322
Belize	22 800	No data						
El Salvador	20 720	2 041	359	1 700	1 613	1 261	3 661	3 497
Guatemala	108 430	679 000	10 600	53 400	22 150	22 387	425 000	6 703
Honduras	111 890	96 623	54 986	63 593	82 356	63 442	56 655	8 409
Nicaragua	121 400	161 684	25 227	92 355	24 318	26 148	27 448	33 252
Costa Rica	51 060	64 893	11 192	36 896	57 511	50 337	32 372	35 228
Panama	74 430	77 586	3 397	2 204	4 247	3 739	17 765	1 723 <sup>a</sup>
<b>TOTAL AREA</b>	<b>2 419 420</b>							

Source: López, 2004.

<sup>a</sup> For Panama, in 2004, 1 723 ha corresponded to forest fires, with agricultural fires totalling 6 293 ha (2004).

<sup>7</sup> A detailed analysis of the fire situation in Mexico is included in the report for North America (Mexico is a member of the FAO North American Forestry Commission's Fire Management Working Group, which constitutes the UN-ISDR Regional North America Wildland Fire Network).

inadequate policies and lack of forest resource management by communities. Almost all fires are set by people, and the immediate causes are clearance for agriculture, arson, abandoned campfires, discarded cigarettes and hunting.

## EFFECTS

Damage resulting from wildfires can be very extensive. In pine forests, however, fire is beneficial, since it is an integral part of the ecosystem. It is also used as a tool in land husbandry.

In fire-sensitive ecosystems, fire causes immediate damage to ecosystems by debilitation, selective mortality and incineration of plant life, as well as degradation of the soil. This leads to many effects, including changes in ecosystems (often with impoverishment of biodiversity and productivity), predisposition to pests and diseases (e.g. infestation by *Dendroctonus* bark beetles) and reduction in environmental services.

Global climate change and local phenomena such as El Niño are leading to both drier spells, which increase fire risk, and to more intense storms, which build up fuel from debris. Smoke pollution from the resulting fires can be widespread, causing health problems and disruption of transport. Many lives have been lost due to the effects of smoke and fire, and there can be considerable damage to property. Overall, the influence of fire on national economies can be severe.

## PREVENTION

Countries in the region vary in the extent to which they have been able to manage fire. Many have now had several decades of experience. With regard to prevention, ignition sources are being reduced through campaigns to improve awareness and enforce legislation. Techniques to control fire are improving. Fire calendars are being used to improve prediction. Early detection is carried out via satellite and aerial surveillance, watchtowers and ground patrols. Access to fires and control of spread are being improved by road and firebreak construction. Fuel loads are being reduced through the increasing use of prescribed burning, or adoption of practices that reduce fire risk, such as agroforestry.

## SUPPRESSION

Most fires are extinguished by ground crews, with the aid of backfiring and fire traces. Where severe damage has occurred, steps may be taken to rehabilitate land through promoting natural regeneration or planting.

## INSTITUTIONS, RESPONSIBILITIES AND ROLES

A wide variety of institutions are involved in fire management. The main government agencies include those responsible for forestry, agriculture and livestock. Additionally, institutions concerned with the environment, protected areas and individual crops (e.g. coffee) may have a role. Agencies concerned with meteorology, tourism, health, infrastructure, development, legislation, national emergency, defence and fire and ambulance services are also involved in prediction, protection and general support.



Over the past few years, there have been various initiatives to address the issue of wildfires from a regional perspective and to build up institutional capacity:

- The first Mesoamerican Meeting on Cooperation Regarding Protection against Forest Fires was held in Guatemala in 2002. It aimed to identify specific activities for regional cooperation between Mexico and Central American countries.
- A workshop to develop a regional strategic plan for forest fires and pests was held later in 2002 in Honduras. On this occasion, the Regional Working Group on Fire Management was established under the Technical Committee on Forests of the Central American Commission on Environment and Development (CTB/CCAD).
- To begin implementation of the strategic plan, two more workshops were held in 2004 in El Salvador and Guatemala, focusing on developing an action plan for Central America and Mexico.
- The Central American and Mexican Regional Network on Forest Fires and Pests was officially established in 2004, in El Salvador, during a meeting of the Central American Council of Forests and Protected Areas. Council members are the directors of the national forest service of each country in the region.
- A meeting of the Regional Network of Central America and Mexico was held in October 2004, followed by the Pan-American Wildland Fire Conference.
- A fire management strategy for Central America was being developed in 2005 by the CTB/CCAD Regional Working Group on Fire Management, with the assistance and support of FAO project TCP/RLA/3010(C), to be integrated into the Regional Fire Management Cooperation Strategy for Latin America and the Caribbean. This strategy aims to unify technical criteria and establish dynamic interactions among the countries of the region (Scholz, 2005). For additional information, see Casaza (2005a, 2005b).

## COLLABORATION

As a result of the initiatives noted above, a number of collaborative actions are being carried out:

- Satellite detection of forest fires is being implemented through bilateral agreements by Mexico (National Commission for the Knowledge and Use of Biodiversity – CONABIO) with Costa Rica, El Salvador, Guatemala and Honduras.
- Honduras and Nicaragua are also collaborating on satellite detection of forest fires.
- Under the bilateral agreement between Mexico and Guatemala and the agreement between the Commission on Forest Pests and Fires in Central America and Mexico, two international Mesoamerican courses in forest fire protection have been given (in 2002 and 2003).
- A regional strategic plan for forest fires and pests, elaborated in Honduras in 2002, was executed with the assistance of the United States Agency for International Development (USAID).

- In the Trifinio forest area in the frontier zone between El Salvador, Guatemala and Honduras, collaborative forest fire prevention and control are being developed.
- In other frontier areas, forest fire prevention and control are being carried out in countries belonging to the Central America and Mexico Regional Network on Forest Fires and Pests.
- In Central America, two training processes have taken place: one supported by the Office for Disaster Assistance of USAID and the other supported by Mexico – the Mesoamerican Course on Forest Fires.
- Coordinated management of emergencies has been established in the frontier area between Guatemala and Mexico.
- An emergency coordination agreement was established for Costa Rica, Nicaragua and Panama.

### COMMUNITY PARTICIPATION

The involvement of communities in fire management is increasing as there is more awareness of local forest benefits and more trust is placed in the organizing institutions.

### NEEDS AND LIMITATIONS

Governments in the region increasingly recognize that prevention of forest fires is important – as well as control – but because of political constraints, many initiatives have not achieved concrete results. In recent years, however, both fire control and the strengthening of local fire prevention capabilities have been emphasized.

From the technical point of view, it is necessary to increase and adapt training to the required level in each country, improve planning, organization and detection so as to reduce response time; and implement formal systems for predicting forest fires at the regional level. As part of this process, the priorities are: decentralization of fire prevention and control activities to the level of communities, municipalities and civil organizations; and strategic planning and action to strengthen technical capacity, resources and equipment, in order to increase technical capability to predict, detect and monitor forest fires.

### ANALYSIS AND RECOMMENDATIONS

The incidence of wildfires in the region has a significant and deleterious effect on national economies and society. The causes of fire include land clearance for agriculture, arson, abandoned campfires, discarded cigarettes and hunting. The El Niño weather pattern has an effect on the fire hazard. Early detection is carried out via satellite and aerial surveillance, but fire control is still conducted largely by ground crews.

The region has trained human resources, as well as detection systems and basic equipment and tools for control. Recently fire control and the strengthening of local fire prevention strategies have been emphasized, but training must be increased and adapted to the required level in each country. Priorities are the decentralization of fire prevention and control activities, and strategic planning and action.

Political, social and environmental constraints have often limited efforts to introduce effective prevention and control. Various initiatives are being undertaken to address the issue of wildfires from a regional perspective, build up institutional capacity and promote collaboration. Bilateral initiatives are promoting such collaboration in cross-border areas.

In a brief presented at the Pan-American Wildland Fire Conference (López, 2004), it was suggested that the following activities should be carried out to strengthen regional cooperation:

- improve satellite systems for detecting and monitoring fires in the region and develop processes for predicting forest fires;
- revise the regional strategic plan for forest fires for Central America and Mexico and establish a regional forest fire management policy, taking into account the Central American Regional Forest Strategy, which is considered a strategic framework for the forest sector for the next 25 years;
- give priority to the problem of forest fires and provide resources through the countries of the Central America and Mexico Regional Network on Forest Fires and Pests;
- develop bilateral and regional cooperation mechanisms and projects in support of forest fire management, presenting such proposals for international financial and technical assistance;
- define objectives, procedures, cooperation formats, work mechanisms and protocols;
- create channels and procedures for communications that are easily implemented by the networks in Central America and Mexico in coordination with those in South America, the Caribbean and North America;
- develop a short-term work plan at the level of the regional networks, with clear roles and responsibilities and dates for presenting results.

## 7. North America

The North American region, constituting the Regional North America Wildland Fire Network, includes Canada, Mexico and the United States. Mexico is also a member of the Mesoamerican region and actively participates in both networks.

Forests cover a significant part of this region, from the boreal forests in northern Canada and Alaska to the moist tropical forests in southern Mexico. They pose a vast array of fire management challenges (details are provided in FAO Fire Management Working Paper FM/15/E).

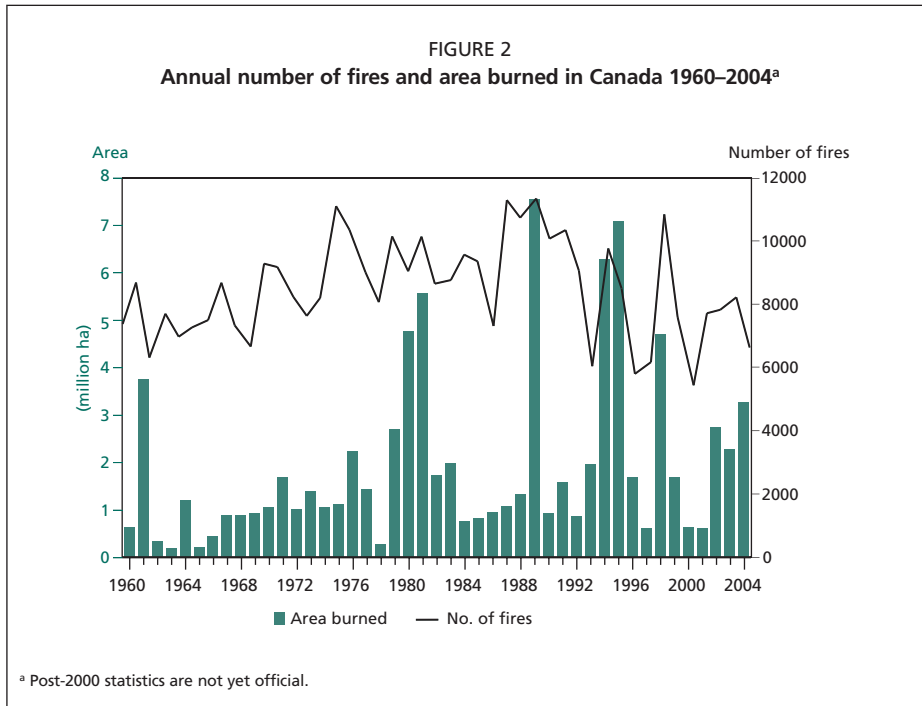
### EXTENT AND TYPES OF FIRES

Forest fires have been a dominant disturbance regime in Canadian forests since the last Ice Age some 10 000 years ago. Fire is natural and essential across much of Canada's forested landscape, and along with insects, disease, wind and natural regeneration, it helped shape the character of Canadian forests before the country was settled. Fire is particularly significant in Canada's vast boreal forest region, where primary boreal species such as pine, spruce, birch and aspen have adapted to fire to the point that it is essential to their existence, and adequate regeneration requires the high-intensity crown fires natural to this region. Periodic lower-intensity fires are also required to maintain surface fire regimes in other forest regions of Canada. Canadian forests are thus strongly connected to the fire regime, and maintenance of natural forests is crucial.

However, Canada is a forest nation, and the industrial use of forests is intimately linked to the country's cultural, economic and social development. The forest sector has become the largest contributor to Canada's positive trade balance. Forest recreation is also an expanding Canadian activity. Such extensive use of the forest requires adequate protection from fire. Reconciling the natural role of fire in ecosystem maintenance with the need to protect life, property and valuable products derived from the forest is a complex challenge.

The area burned by Canadian forest fires fluctuates greatly from year to year, from under 500 000 ha to more than 7 million hectares in extreme years. In comparison with the 1950s and 1960s, the average annual area burned has been increasing over the past three decades. During the 2000–2004 period, unofficial statistics indicate 7 321 fires and 1 689 424 ha of forest burned annually (Figure 2).

In Mexico, the average annual burned area over 2000–2004 was 197 000 ha on all lands. An analysis of fire occurrence from 1970 to 2005 indicates that the number of fires has tended to increase over time. This is widely assumed to be the result of population increases in forested areas, together with a change in climatic conditions. At the same time, the trend in burned area is decreasing (Table 4), most likely the result of more-effective suppression efforts.



**TABLE 4**  
**Annual number of fires and area burned in Mexico 1988–2004**

Year	Total number of fires on all lands	Total area burned on all lands (ha)	Area of forest burned (ha)	Area of other wooded land burned (ha)	Area of other land burned (ha)	Human causes (%)	Natural causes (%)	Unknown causes (%)
1988	10 942	518 265	188 622	55 164	274 479	84	1	13
1989	9 946	507 471	214 418	119 364	173 689	84	2	14
1990	3 443	80 400	23 143	20 772	36 485	85	2	13
1991	8 621	269 266	113 790	58 427	97 049	84	1	13
1992	2 829	44 401	12 440	9 100	22 861	84	2	14
1993	10 251	235 020	54 773	66 923	113 324	85	2	13
1994	7 830	141 502	32 703	48 740	60 059	84	1	13
1995	7 860	309 087	115 117	105 014	88 956	85	2	13
1996	9 256	248 765	57 139	102 202	89 424	84	1	13
1997	5 163	107 845	23 444	37 924	46 477	84	2	14
1998	14 445	849 632	198 487	298 903	352 242	85	2	13
1999	7 979	231 062	41 365	101 857	87 840	84	2	14
2000	8 557	235 915	40 475	94 285	101 155	85	2	13
2001	6 340	136 879	18 805	53 441	64 633	84	1	13
2002	8 256	208 297	31 988	88 507	87 802	85	2	13
2003	8 211	322 448	88 261	130 287	103 900	84	1	13
2004	6 300	81 322	10 514	32 861	37 947	85	2	13
Av./yr	8 013	266 328	74 440	83 751	108 137	84	2	13



In the United States, the last five-year period saw one of the most severe series of fire seasons since statistics have been recorded. Over 2.8 million hectares were burned in 2000, 2002 and 2004 (Table 5). The initial figures for 2005 indicate that over 3.48 million hectares burned, a figure more than twice the ten-year average. In 2002, the National Interagency Fire Centre reported that 2 381 structures were destroyed in fires.

The severity and impact of fires have been increasing for several years. There is significant year-to-year variability in both the number of fires and total area burned, but the overall trend is an increase in area burned.

## CAUSES

Canada and the United States are among the few countries to report significant numbers of fires caused by lightning. In Canada, it is responsible for an average of 35 percent of the number of fires, but 85 percent of the total area burned. Lightning fires occur randomly, often in significant numbers, over large areas, presenting access problems not usually associated with human-caused fires. Thus they often spread because detection and initial attack are delayed. Recreational activities, forest industry operations and homeowners living in or near the forest are primarily responsible for the accidental, human-caused fires that dominate in the protected forest regions of Canada.

In Mexico, population increases have generated an increasing demand for farmland. With more agriculture, the use of fire in farming activities is more frequent and fire risk has increased. There are more fires than in the past and the natural fire cycle has changed.

Most fires in the United States are also caused by people. However, the causes vary by region, with lightning being a major cause of fires on federal lands in the west and human-caused fires being more common in the east, where lightning storms are commonly accompanied by heavy rains. The summer storms in the

TABLE 5  
Annual number of fires and area burned in the United States 2000–2004

Reporting agency	2000		2001		2002		2003		2004	
	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)
Bureau of Land Management	3 288	538 791	3 312	305 724	2 402	403 527	2 919	136 483	2 721	510 818
Bureau of Indian Affairs	5 964	186 717	4 958	79 012	6 260	438 875	5 826	176 983	5 267	30 235
Fish and Wildlife Service	548	157 772	397	26 127	481	201 354	494	64 838	520	745 931
National Park Service	771	91 427	841	85 322	680	86 563	738	150 209	685	209 367
USDA Forest Service	9 788	853 399	9 236	217 947	7 485	635 960	8 902	69 317	7 120	182 875
State/private	103 971	1 497 948	84 362	693 466	74 812	1 093 875	64 318	1 074 514	65 973	1 249 635
<b>Total</b>	<b>124 330</b>	<b>3 326 053</b>	<b>103 106</b>	<b>1 407 597</b>	<b>92 120</b>	<b>2 860 154</b>	<b>83 197</b>	<b>1 672 346</b>	<b>82 286</b>	<b>2 928 861</b>

west tend to be 'dry', meaning that the precipitation evaporates before reaching the ground, or the amount of precipitation is not adequate to extinguish the fires started by the lightning strikes.

## EFFECTS

In Canada, in recent years, there has been a large increase in the number of homes and communities built adjacent to and among forest and other flammable vegetation. Living close to a forest is attractive to many former city dwellers, and expensive communities are growing up in the WUI. These homeowners have little knowledge of wildfires or of the need to protect their homes, and very few of these communities have building codes that require residents to build homes resistant to vegetation fires and/or to manage fuels on their property. The threat of WUI wildfires became common knowledge to all Canadians in the summer of 2003, when extreme fire danger conditions and multiple ignitions in the interior of British Columbia overwhelmed suppression capabilities. A total of 334 homes and 10 businesses were destroyed and over 45 000 people evacuated. The total economic impact to the province was measured in hundreds of millions of Canadian dollars.

In Mexico, losses to buildings and other infrastructure have not become a serious problem. While there are population centres within forest areas that could be affected by fires, they are usually surrounded by farming zones, or the fuel loads have been reduced so that fires do not burn intensely, if at all. The principal negative impacts from fires are to natural resources and the forest industry.

Damage to many ecosystems is very significant in terms of alteration of the fire regimes across Mexico. According to older members of the rural population, the natural fire frequency used to be from 50 to 200 years, but fire frequency in the last decades has increased to from five to eight years. This situation is particularly significant to the tropical forest ecosystems, where fires were almost unknown.

Economically, the 2003 fires resulted in losses of US\$337.03 million in wood, US\$6.57 million in firewood and US\$39.17 million in reforestation costs in the affected forest areas. This does not consider losses of biodiversity, the effects on erosion, the hydrologic cycle, scenic beauty and recreation, or the production of greenhouse gases.

In the 2003 fire season, the United States had an average area burned and a below-average number of fires. Nevertheless, the most critical period occurred later in the year, when approximately 304 000 ha burned in southern California, in and around Los Angeles and San Diego. The fires destroyed 3 640 homes, 33 commercial buildings and 1 140 other structures.

## PREVENTION

Public awareness of forest issues in Canada, including fire management practices, has been growing quickly in recent years, partly due to the success of public awareness programmes and expanded media coverage. This is particularly true with First Nations peoples<sup>8</sup>, forest landowners and former city dwellers moving to a WUI.

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<sup>8</sup> 'First Nations' peoples refers to any of the indigenous groups formally recognized by the Canadian government under the federal Indian Act of 1876. The term does not include non-Indian peoples such as the Inuit or the Métis.

In Mexico, within forest areas, prescribed burning is a preventive tool for fuel reduction. In areas of commercial forest production, prescribed burning is used for forest management as well as fuel reduction, reducing the damage from fires. Other preventive and silvicultural practices are used in conjunction with prescribed burning, such as the opening and maintenance of firebreaks, pruning and thinning, the use of debris as firewood and others. In some protected natural areas, firebreaks are constructed, but prescribed burning is not allowed.

Fuel management activities are a critical component of fire protection in the United States. Prescribed burning can be a very effective measure for reducing the risk of fire to communities and protected areas. However, fuel management activities, including the use of prescribed fire, are much more than just a prevention tool. They are used to restore and sustain ecosystems and enhance resources.

In the area of public relations, Smokey the Bear has been the symbol of US fire prevention activities since 1944. The purpose of the Smokey Program is to create and maintain public awareness of the need to prevent unplanned, human-caused fires.

## SUPPRESSION

Fire suppression costs are constantly increasing in Canada due 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 the protection of an expanding WUI zone. Changes in fire weather patterns mean that annual suppression costs, not including public and industrial losses, are not only increasing but are highly variable, averaging Can\$500 million (US\$382 254 million) and reaching Can\$1 billion (US\$765 million) in an extreme fire season. It appears that fire suppression as practised today will not be economically sustainable in the future, and Canada will not be able to meet current targets in terms of area burned and the control of escaped fires. This will affect wood supply and the competitiveness of the forest industry, along with some 300 forest-industry-dependent communities.

In the United States and Canada, two key objectives in controlling fires are early detection and initial attack when fires are small. This involves prediction of the most likely locations in which fires will start (both lightning- and human-caused fires) and the implementation of enhanced detection in those areas (primarily aircraft patrols). When fires are detected, initial attack forces are deployed by land or helicopter and are often supported by aircraft dropping water, foam or fire-retardant chemicals.

In Mexico, agencies and organizations at all levels of government assist in the fire suppression effort. They employ a range of resources, including ground crews or brigades, engines and helicopters. These resources respond to fires for the initial attack and then extend the attack using both direct and indirect suppression techniques. The Secretariat of the National Defense uses elements of the Mexican Army and Armed Forces for fire suppression. In 2005, they were used for 23 004 person-days.

In the United States, the total number of resources fluctuates every year and is based on budgets, fire-season severity and other variables. Resources used by federal agencies in 2002, a typical year, included over 15 000 firefighters, 277 ‘smokejumpers’,

over 1 700 management staff, 152 helicopters and 74 airtankers, as well as 92 other aircraft. The states and local jurisdictions provide additional resources for their areas of responsibility. While many state resources are available for national mobilization, most state and local resources are needed for local initial attacks.

Fire suppression in all three countries is managed through the Incident Command System (ICS), a management system used to plan and organize the strategic and tactical response to fires.

### **INSTITUTIONS, RESPONSIBILITIES AND ROLES**

In Canada, the bulk of forested land is public and is owned by the provinces/territories. Thus responsibility for forest management, and therefore fire management, rests with each of the 13 autonomous provinces and territories. The emphasis in national parks is on maintaining ecological integrity through prescribed landscape-scale burning and wildfire monitoring. In addition, 80 percent of aboriginal communities are located in forested areas, and these communities negotiate agreements for protection. A number of federal agencies are also involved in some aspect of fire management.

In Mexico, the Group for Interagency Coordination supports the National Programme of Protection against Forest Fires. The 12 secretaries of state in the Federal Government participate. The group provides support for fire management activities and ensures that resources for the prevention, detection and suppression of fires are coordinated. The National Forest Commission (CONAFOR) leads this interministerial working group for forest fire suppression and coordinates all efforts in protection at national, regional and state levels.

Current legislation in Mexico assigns responsibility for the prevention, detection and suppression of forest fires to the landowner, as well as to the authorities of the three levels of government (local, state and federal) based on their jurisdictions and the complexity of the problem. This new legislation has not yet been applied completely throughout the country.

Fire protection responsibilities in the United States depend on ownership patterns and on any protection agreements between agencies or owners. Federal, state, municipal, county and local fire districts all play a role in managing and suppressing fire. Each state has fire protection responsibility, with the jurisdiction defined by individual state statutes and regulations. Many have state forests and other state-owned land and some states have statutory responsibility to protect private lands as well.

### **COLLABORATION**

The three countries are members of the FAO North American Forest Commission. NAFC established a Fire Management Working Group over 40 years ago. It is still active and meets annually to plan exchanges, training, study tours and other cooperative activities.

The borders between Canada and the United States and between Mexico and the United States are covered by international agreements that authorize the exchange

of firefighters and provide for assistance on fires that cross international boundaries. There are national-level agreements and also local agreements between adjoining jurisdictions to address local needs. As a result, fire suppression resources in any of the three countries are available to respond to neighbouring jurisdictions as long as the terms of the agreements are met. Moreover, the countries are able to work together on fire suppression because they have all adopted the ICS.

During severe fire seasons, the United States has provided Mexico with technical assistance and equipment, and with specialized resources for infrared photography and photo interpretation.

Mexico is also an active participant with its southern neighbours in the Regional Mesoamerica Wildland Fire Network. It provides technical support to Guatemala for initial attacks in the common border zone and occasionally dispatches its armed forces or private helicopters for these attacks.

In 2000, federal agencies of the United States signed an agreement with Australia and New Zealand for the exchange of firefighters. While this arrangement is relatively new, Australia, New Zealand and the United States have engaged in a long-standing series of exchanges and joint technical and training programmes.

### **COMMUNITY PARTICIPATION**

There appears to be little formal community involvement in the region – or at least little was reported. In the United States, the FIREWISE programme provides information to homeowners and community leaders. The programme is a cooperative effort by federal agencies, the National Association of State Foresters, the US Fire Administration and the National Fire Protection Association.

### **ANALYSIS AND RECOMMENDATIONS**

All countries of the region recognize the positive role that fire can play in sustainable forest management, but in no country does an increasingly urban public appreciate this. Public awareness campaigns are needed not only for fire prevention, but also for information on the positive aspects of fire.

It appears that in all countries the number of fires and area burned are highly variable, but that the trend in damage is increasing. In response to this, there is increasing collaboration in firefighting. This collaboration could be extended to agreement on common terminology and the regional collection of data.

Mexico has many issues that complicate its fire management programme. There is a lack of public understanding of the complexities of the fire problem. Many communities use fire for forestry, farming or livestock management purposes, but others see fire as a problem to be totally excluded from forests. This translates into a lack of understanding by the public of the full range of issues of forest and fire management.

There is also a need to develop an effective programme of fuel management and prescribed burning for fire prevention. This might include legislative changes to ensure the protection and conservation of protected areas and to recognize that fire is an important tool in the sustainable management of forests.



In the United States and Canada, there has been a great increase in recent years in the number of homes and communities constructed adjacent to and within forests or among other flammable vegetation. Living close to a forest has become attractive to many ex-urbanites, and upscale communities are springing up in the WUIs. These homeowners have little knowledge of wildfires or the need to protect their homes.

A number of provincial/territorial fire management agencies and municipal governments are attempting to institute hazard mitigation programmes within and around these communities, but this is a formidable task, given the rate of WUI expansion and the increasing wildfire threat. These programmes should consider the biophysical aspects of hazard mitigation (e.g. fuel reduction/modification) together with the social aspects (e.g. public awareness/involvement).

In addition, communities in northern Canada, which are primarily indigenous or associated with resource-extraction industries, require better protection against the impact of fire through hazard mitigation. These communities depend on the forest around them for their livelihoods; thus even fires that do not impact a townsite directly can significantly affect the future of that community.

It is a generally accepted conclusion among scientists and a growing percentage of the public that climate change is a reality, and that impacts across the region will be profound – and largely unavoidable – over the next century. Research to date indicates that both the incidence and severity of forest fires will increase dramatically.

## 8. South America

The regional working paper on forest fires in the South American region covered the vegetation fire situation in the ten most affected countries (Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Paraguay, Peru and Uruguay). There was some limited information available for French Guiana, Guyana, and Suriname (details are provided in FAO Fire Management Working Paper FM/5/E).

### EXTENT AND TYPES OF FIRES

Wildfires are present in all ecosystems of South American countries, extending from 12°N to 56°S. The frequency, intensity and time distribution of wildfires during the year are variable in response to different human factors such as cultural practices, population density, tourism affluence and the characteristics of fire suppression activities. In addition to the human factors, wildfires are affected by environmental factors such as the El Niño effect, droughts and, in some instances, lightning.

Figures are not complete, because data are often unavailable, non-existent or inaccurate. Moreover, most countries do not distinguish the different forest types in the affected areas. Thus it is difficult to elaborate the national and regional wildfire statistics accurately.

The number of fires and the area burned annually vary widely. Most of the area corresponds to other wooded lands (26 percent), followed by other lands (20 percent) and forests (17 percent). During the 1990s, an average 25 000 wildfires burned 4.3 million hectares on average each year (Table 6).

The main areas affected were grasslands and protected natural areas in Argentina, Bolivia, Chile and Uruguay (20 percent) and not the intensively managed savannahs, shrublands and wildlands of Brazil (*cerrados*), Bolivia, Colombia and the Bolivarian Republic of Venezuela (13 percent). Twelve percent of the burned areas were native, moist tropical forests that are not intensively managed, mainly in the Amazonian watershed.

The Darien gap zone in Colombia (Silva, 2003) and peat in the highlands of Peru were also affected by fires. Several countries, especially in 1998, reported fires from forests throughout the southern, central, and eastern Amazonian watersheds (Nepstad, Moreira and Alencar, 1999; Nepstad *et al.*, 2001). Unfortunately, there is no quantitative data on the numerous fires that occurred across the Guyana Shield in Suriname and Guyana. Fires in moist tropical forests, which traditionally had not been affected by fire, have increased due to deforestation and land-use changes.

Fires occurring near WUIs have become a significant problem over the last decade, disturbing normal life in the main cities of Argentina, Chile, Ecuador and Uruguay (Viegas, 1997; Lopes, Sousa and Viegas, 2002).

TABLE 6  
Annual number of fires and area burned in South America 1990–2004

Year	Number	Area burned (ha)
1990	5 201	45 698
1991	11 279	9 759 804
1992	11 280	654 224
1993	7 533	1 861 720
1994	2 339	1 688 040
1995	11 490	979 165
1996	11 572	564 674
1997	66 807	5 585 369
1998	15 877	1 137 305
1999	43 016	13 592 352
2000	16 401	2 891 800
2001	17 966	4 888 276
2002	23 519	2 607 460
2003	29 158	3 667 640
2004	9 191	430 418

The fire season varies according to the onset of the rainy season. In the north of Argentina, Chile and Colombia, and in Bolivia, Brazil, Ecuador and Peru, fires occur mainly in autumn and winter, associated with the dry seasons. In the territories where the dry season occurs in late spring and early summer, wildfires occur mainly from January to May, as well as in November and December (the south of Argentina, Chile and Colombia, and in Uruguay and the Bolivarian Republic of Venezuela).

## CAUSES

Eighty-five percent of the vegetation fires in the region are caused by human activities. Most result from fires that escape from pasture and agricultural land maintenance activities, as a result of forest clearance, logging and hunting, cooking, rubbish- or waste-burning activities, as well as arson and accidents.

Nepstad, Moreira and Alencar (1999) stated that the combination of slash-and-burn cultivation with drought is causing an increase in moist tropical forest flammability. Areas farmed by slash-and-burn methods are not commonly included in the national statistics for fires, but this type of cultivation could be the cause of 60 percent of the recent increase in the area burned in Amazon basin countries.

Agrarian policies to promote expansion of the agriculture and livestock sectors lack adequate planning and control mechanisms. They are thus causing large-scale transformation of moist tropical forests to rangeland and to agriculture for soya, especially in Brazil, Bolivia, Colombia, Ecuador, Paraguay, Peru and the Bolivarian Republic of Venezuela.

Policies favouring the construction of oil and gas pipelines and highways in Brazil, Colombia, Ecuador, Peru and the Bolivarian Republic of Venezuela are also

leading to vegetation fires. These activities affect even protected areas. A report from UNEP (2002) indicated that agro-industrial, mining and transport policies prevail over forest policies and are indirectly promoting fire outbreaks.

Lightning or other natural causes account for 5.5 percent of fires. These occur in central and southern Patagonia (Rodríguez, 2000), the *cerrado* of Brazil (Mutch, 2003), the savannah biome of Colombia (Silva, 2003) and the eastern Bolivarian Republic of Venezuela. Heavy rains commonly accompany tropical thunderstorms and usually preclude the ignition of fires by lightning. Unknown causes account on average for 9 percent of the total number of fires.

## EFFECTS

During the 1990s, increasing numbers of fires were reported in most countries. They have caused serious environmental damage, killed and injured people, burned hundreds of homes and destroyed several villages and towns.

At least 742 people lost their lives and 429 were injured as a consequence of these wildfires. The highest loss of life was in Brazil, in the Roraima wildfires, in which 700 people died (UNEP, 2002). In addition, the smoke produced by wildfires has caused widespread respiratory and cardiovascular problems, in particular constrictive and obstructive lung disorders, while the number of cases of asthma, pneumonia, bronchitis, acute laryngitis, bronchiectasis and conjunctivitis have increased dramatically. Respiratory diseases have caused the death of children and old people in Sucre (Bolivia, 2004).

The greatest impact of vegetation fires in the region may be on moist tropical forests, where widespread fires have had grave consequences. The situation has become acute in Brazil, Bolivia, Colombia, Ecuador, Paraguay, Peru and the Bolivarian Republic of Venezuela. In French Guiana, Guyana and Suriname, the changes are less visible. The effect of fires on temperate forests and savannah are serious, but these ecosystems are fire-adapted to different degrees and the interrelationship of fire and vegetation within them is reasonably well understood.

Regarding greenhouse gas emissions, Barbosa and Fearnside (1999) estimated that about 3.5–4.0 tonnes of carbon were released as CO<sub>2</sub> for each hectare burned in Brazil. Thus about 4.4 million and 800 000 tonnes of CO<sub>2</sub> were released in 1998 and 2003 respectively. For Bolivia, Martínez and Cordero (2001) indicated that 82.6 million tonnes of CO<sub>2</sub> were released from savannah forest fires, followed by grassland fires. In Colombia, savannah fires were also recognized as a major contributor to the release of greenhouse gases (Silva, 2003).

An additional negative environmental impact of wildfires is soil erosion, which has occurred in the Andean mountains, in tropical and temperate forests and on the coast. Erosion processes caused floods and landslides in Bolivia, Brazil, Colombia, Chile, Ecuador, Peru and the Bolivarian Republic of Venezuela (UNEP, 2002).

Fires have a range of economic and environmental costs, from medical costs, timber losses and damage caused by floods, landslides or erosion to airport closures due to atmospheric haze. However, the real costs of wildfires in the region are unknown, mainly due to a lack of data.

## PREVENTION

Extension and training activities at the municipal level are the main preventive activities in some South American countries. Public and private campaigns were launched in Bolivia, Brazil, Chile and Ecuador after the occurrence of major fires. These campaigns included public meetings and targeted seminars addressed to rancher associations, farmers, municipal forestry units, local social groups, indigenous communities and the general public. The mass media were also used in these campaigns, including radio, television, posters and bulletins.

A second main topic in wildfire education is training in prescribed burning, which has been undertaken by a number of institutions and organizations (full details can be found in the regional working paper). In Bolivia, public meetings and seminars have been organized since 2000. In Brazil, training courses were run for farmers, dealing with prescribed burning and regulations regarding the use of fire in land management. In Ecuador, several organizations have run courses for farmers since 1996. In Colombia, workshops on prescribed burning were organized and a national booklet was published on wildfire prevention through prescribed burning. In Argentina, the Secretariat of Agriculture, Livestock, Fisheries and Food is conducting prescribed burning in forest plantations through research and extension projects.

In Brazil, Chile and Ecuador, the importance of providing information on fire to primary and secondary schools has been emphasized by both the regional Secretariat of Education and the Ministries of Education. NGOs are also carrying out capacity-building activities for primary school teachers in rural areas. In Argentina and the Bolivarian Republic of Venezuela, these activities include public meetings, courses and seminars, and a preschool programme is being arranged by the US National Fire Protection Association in Bahía Blanca, Argentina. However, fires and prescribed burning are not taken into account in the primary education curricula in Bolivia, Paraguay, Peru or Uruguay.

At higher levels of education, most universities include fire management in the curriculum for forestry training, either as a mandatory or voluntary subject. It is significant that universities in the region do not have master or doctorate degrees in fire prevention or firefighting.

Early warning systems of high fire risk conditions have been used in some countries since the 1990s, while other countries have just recently had access to the technology required. Satellite-based sensors that produce maps and written reports on fire danger rating and fire weather forecasts at national and state levels are common in many countries.

Wildfire detection and monitoring activities in the region are carried out by both traditional and modern technologies. In Chile, Colombia and the Bolivarian Republic of Venezuela, fire detection is done by spotting towers, aircraft and ground patrols, which require substantial infrastructure and coordination. In the Amazonian watershed, in particular, fire detection from planes is expensive and, given that it is limited by clouds and smoke, is feasible only in specific circumstances. The National Brazilian Space Research Institute (INPE) provides daily maps, with fire locations detected by the currently available space instruments. It also provides daily maps for

Bolivia, Paraguay, Peru and the Bolivarian Republic of Venezuela ([www.cptec.inpe.br/queimadas/](http://www.cptec.inpe.br/queimadas/)).

Regarding fire statistics, the Native Forests Resources Direction in Argentina is responsible for national wildfire statistics management. In Brazil, federal conservation units summarize the stored information. The Corporación Nacional Forestal (CONAF) in Chile and the National Directorate of the Fire Service in Uruguay are in charge of national wildfire statistics. In Uruguay, the directorate also carries out investigations into the causes of wildfire (Tamburi, 2004), while in Chile the national police investigate these.

Institutions in Colombia (Antioquía Autonomous Corporation – CORANTIOQUIA), Ecuador (Loja Municipality) and Peru (Universidad Nacional Agraria La Molina) intend to gather statistics at state, municipal and national levels, but they do not have official responsibility for them (Polanco and Javier, 2002; Manta and León, 2004). Bolivia and Paraguay have no databases of wildfire statistics, which makes it impossible to determine trends in fires or analyse causes.

The building up and improvement of wildfire statistics databases are essential activities in fire prevention. With them, one can study wildfire causes and allocate suitable resources to trouble spots.

References to ‘sustainable land use’ to reduce fire hazard in the region often intend forest management practices, maintenance of reserved areas for protecting biodiversity and the use of these areas by indigenous peoples. All countries have approved laws and established strategies and plans for forestry management practices, but only some of them have reached an adequate level of practice in sustainable forest management.

## **SUPPRESSION**

Argentina, Brazil and Chile usually combine their terrestrial and aerial resources for firefighting.

In Chile, CONAF has extensive experience in terrestrial and aerial fighting against wildfires at the national level. Argentina is divided into federal provinces, which all have the legal obligation to fight fires. However, when complex fires threaten to overrun the provincial firefighting systems, the law stipulates that assistance can be requested from the Fire Management Programme. In Brazil, the Arc of Deforestation Programme (PROARCO) and the National System for Wildfire Prevention and Suppression (PREVFOGO) combat wildfires and inappropriate prescribed burnings. They provide full coordination, establish strategic task forces and distribute resources to priority areas.

One factor contributing to large fires in the Amazonian watershed is the ineffectiveness of air attacks. Smoke from the tropical forest canopy makes it difficult to locate the source of the fire, and the canopy intercepts much of the water and the fire suppression agent.

Colombia, Uruguay and the Bolivarian Republic of Venezuela do not have adequate aerial suppression capability and mainly use ground suppression techniques. In Uruguay, firefighting is primarily concentrated in forest plantations.

Bolivia, Ecuador, Paraguay and Peru do not have professional ground crews. They use voluntary brigades from local communities, some brigades at protected natural areas and intermediate corps of voluntary firefighters with basic training and equipment.

In order to improve firefighting activities, training courses have been implemented by governments and NGOs in several countries. In particular, Brazil, Chile and Ecuador have undertaken such initiatives. Training is only partially implemented in Bolivia and is very limited in Paraguay and Peru.

### **INSTITUTIONS, RESPONSIBILITIES AND ROLES**

In most South American countries, natural resource policy is oriented towards the agriculture, mining and transport sectors. Because of the low contribution of the forestry sector to gross domestic product (with the exception of Bolivia, Brazil and Chile), the forestry administration has little economic or political power and a low position in the administrative agrarian hierarchy – and in the case of Colombia and Ecuador is virtually non-existent.

The political agenda for fires is mainly a reaction after the occurrence of a catastrophic event – or is connected with the vested interests of the political parties. It is not generally part of the development process, nor is it in line with national needs. There is also instability due to changes in governments and the problem of corruption, which facilitates the transformation of wooded lands into other land uses.

The institutionalization of wildfire management varies according to the responsibilities and roles of the organizations in charge, the hierarchy within the public structure, management capacity, available technology and economic resources. For example, the total yearly budget in Chile for fire prevention and firefighting to protect 3 million hectares of plantations was US\$22 million in 2004. Ninety-five percent of the budget is devoted to detection and firefighting, while just 5 percent is devoted to prevention. One-third of the total investment is covered by the state and the remaining two-thirds by private forestry enterprises.

Brazil obtained a loan of US\$15 million from the World Bank in 1998 to support the PROARCO programme for preventing and suppressing large-scale wildfires in the southern part of the Brazilian Amazon (Mutch, 2003). However, other countries, such as Bolivia, Ecuador, Paraguay and Peru, have very limited resources.

Argentina, Bolivia, Brazil, Chile and Uruguay each have one national government organization responsible for fire management, whereas Colombia, Ecuador, Peru and the Bolivarian Republic of Venezuela have several organizations. In Paraguay, there is no national government organization for fire management.

In mid-2002, the institutional group Prevention, Control and Mitigation of Wildfires was created in Ecuador to set up a new plan to fight forest fires and improve the management capabilities of state and municipal organizations. In Peru, the national system for wildfire suppression and prevention has not yet been established, despite the approval in 2001 of the law for its creation.

## LEGISLATION

The governments of the region use different legal tools for fires and prescribed burning. These are not integrated into a specialized law for wildfires, but correspond to regulations promulgated by different institutions in each country.

At least 153 national legal texts exist in the South American region, 57 of them devoted specifically to fires and prescribed burning, and the rest dealing generally with forestry issues and, to some extent, forest cover. However, most national government organizations related to fire management are not able to apply them for a variety of reasons: incompleteness of the regulations, lack of rules by which to develop the specific procedures for implementation and, finally, the fact that the provisions do not clearly give a mandate or legal responsibility to the relevant body.

In many countries, the absence of specific procedures for enforcement under the penal code for vegetation fires makes it difficult to punish people for illegal burning, even in the case of state-protected areas.

## COLLABORATION

Chile has the highest number of agreements in the region (six) on collaboration for fire management. It also has a standard annual operating plan, which details procedures to obtain emergency assistance within the country and at the international level. In Bolivia, Ecuador, Paraguay, Peru, Uruguay and the Bolivarian Republic of Venezuela, clear agreements have not yet been established.

Although widespread emergencies in recent years in all regions of the world have underscored the importance of establishing international agreements in advance of fire occurrences, Argentina and Chile are the only nations with operative bilateral emergency agreements in the South American region. However, even though countries did not have prior agreements, many national and international agencies and organizations successfully integrated their activities to fight the Roraima fires in Brazil and Colombia's fires in 1998, as well as the fires that occurred at the beginning of 2005 in Paraguay and Uruguay.

There is also international collaboration in joint research programmes on wildfires. International research organizations with regional counterparts are developing advanced research into the causes, effects and behaviour of tropical wildfires (for example, the Latin-American Tele-detection and Wildfires Network, the Regional South America Wildland Fire Network and the Latin America and the Caribbean Fire Learning Network). The use of remote sensing data is another priority research field. However, the critical problem remains of the effectiveness of detection and suppression activities in the moist tropical forests of the Amazon – a problem that has not yet been solved by international collaborative research.

## COMMUNITY PARTICIPATION

Local populations, particularly those that live in rural areas and suffer the negative impacts of wildfires most directly, have begun promoting campaigns of sensitivity against them.



Communal activities in fire management include the formation of local, volunteer firefighter brigades. Bolivia offers the model of registering and monitoring information on slash-and-burn authorizations at the municipal level. In Brazil, the Amazon Working Group has a network of more than 300 organizations. In 1998 it conducted a large-scale programme of field courses, with the goal of encouraging farm community leaders to form wildfire brigades in their own communities. The government is also preparing local brigades through PREVFOGO to prevent and fight wildfires in the conservation units.

In Chile, every fire season, local communities create their own firebreaks in high risk interface areas, making use of the national network programmes against fire (Sanhueza, 2003). In Ecuador, remarkable success was obtained in a project to train and equip volunteer firefighter brigades in all forestry districts of the country from 1985 to 1996 (Galindo, 2005).

In many countries, the private sector is contributing to strengthening firefighting groups. In Chile, the private forest industry is a good example of this participation, as well as in Argentina, where an increasing number of private consortia exist. Owners of small forest plantations in Ecuador have established local volunteer fire brigades during the dry season. In Argentina and Bolivia, local communities are involved in safety activities in interface areas to protect homes and in some forestry and protection clubs to protect fauna and flora.

## NEEDS AND LIMITATIONS

After assessing the different aspects of wildfire management issues in the member countries of the South American region, the following needs and limitations have been identified:

- In most countries, the wildfire issue is not a high priority in policy agendas.
- Most countries in the region are not able to provide the necessary funds to establish wildfire protection programmes.
- Laws, regulations and rules on wildfires and agricultural burning should be created or reviewed and modified.
- A low level of integration of the different actors, mainly related to fire prevention tasks, results in inefficiency and increased costs.
- There is a lack of highly qualified human resources to set the requirements at different decision-making levels of fire management, as well as of a national system for capacity-building and accreditation.
- Although the topic of wildfires has been incorporated into school programmes and training curricula in some countries, the handling of the topic is varied, both within and among countries.
- Fire terminology must be defined and used more consistently.
- There is a need to create and maintain a common, high-quality database, which allows a quantitative determination of forest types and other ecosystems affected by forest and land-use fires, and to determine the causes of inefficiency in fire management, as well as the economic losses due to fire.
- A common early warning system for the whole region is lacking, one that

aims to achieve harmonization of the different scales used to rank wildfire risk values.

- Appropriate equipment and tools for firefighters are necessary, both for their personal security and their work efficiency.
- Several administrations take the position that planes represent the answer to combating wildfires in tropical forests. However, the effects of aerial attacks are very limited in many forest types of the region, owing to clouds and the thick foliage.

## ANALYSIS AND RECOMMENDATIONS

- Common objectives, projects and programmes should be developed at both national and regional levels. This would strengthen the integration of various actors in fire management at the national level and contribute to the definition of regional positions. It would allow implementation of regional strategies for wildfires, help develop policies for the coherent, shared use of resources, and improve access to international financing.
- Coordination should be strengthened among the different actors and institutions within countries in order to improve the use of resources and raise efficiency and effectiveness in fire management.
- Greater participation of the various stakeholders in decision-making should be facilitated, assigning responsibilities for the reduction and restoration of areas affected by fires, sharing budgets and giving access to information sources.
- In order to improve prevention of fires, it is recommended that the topic be incorporated at all levels of education, exploring new forms of publicity and taking traditional knowledge into consideration.
- Since agricultural burning in South American countries can degrade forest resources rapidly, it is recommended that prescribed burning techniques be taught to farmers.
- Countries with limited capacity for fire management, such as Bolivia, Ecuador, Paraguay, Peru and Uruguay, could improve their institutions through collaboration among themselves and with countries such as Argentina, Brazil, Chile and Colombia, and could adapt some of the policies and programmes that have given good results.
- The collection, storage and analysis of data on vegetation fires should be improved at national and regional levels.
- Training and specialization of firefighter crews and training in the use of ground equipment must be emphasized before undertaking aerial suppression programmes. Programmes for professional instructors should be established and experiences exchanged, both within and outside the region.
- Links for international cooperation within the Andean-Amazonian region must be improved.