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Global Forest Resources Assessment 2005 – Report on fires in the Caribbean and Mesoamerican Regions

by
A.M.J. Robbins

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The purpose of these papers is to provide early information on on-going activities and programmes, and to stimulate discussion.

Comments and feedback are welcome.

For further information please contact:

Mr. Petteri Vuorinen, Forestry Officer (Forest Fire Management)

Mr. Peter Holmgren, Chief

Forest Resources Development Service

Forest Resources Division, Forestry Department

FAO

Viale delle Terme di Caracalla

I-00100 Rome, Italy

e-mail: petteri.vuorinen@fao.org

peter.holmgren@fao.org

or: FAO Publications and Information Coordinator:

andrea.perlis@fao.org

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FOREWORD

Fires impact upon livelihoods, ecosystems and landscapes. Despite incomplete and inconsistent data, it is estimated that 350 million hectares burn each year; however, the nature of fires determines whether their social, cultural, environmental and economic impacts are negative or positive. Up to 90 percent of wildland fires are caused by human activities primarily through uncontrolled use of fire for clearing forest and woodland for agriculture, maintaining grasslands for livestock management, extraction of non-wood forest products, industrial development, resettlement, hunting and arson - thus any proactive fire management needs to adopt integrated, inter-sectoral, multi-stakeholder and holistic approaches. The situation varies markedly in different regions of the world.

As a supplement and complement to the Global Forest Resources Assessment, 2005, this working paper is one of a series of twelve prepared by regional and country contributing authors to provide a greater depth of data and information on fire incidence, impact, and management issues relating to the twelve UN-ISDR Regional Wildland Fire Networks around the world.

The working paper series assesses the fire situation in each wildland fire region, including the area extent, number and types of fires and their causes. The positive and negative social, economic and environmental impacts are outlined. Prediction, preparedness and prevention as key elements in reduction of the negative impacts of fire, rapid response to extinguish fire incidents and restoration following fires are addressed.

The working paper series also addresses institutional capacity and capability in wildland fire management, including the roles and responsibilities of different stakeholder groups for prevention and suppression, particularly the unique role of community-based fire management.

From these working papers, a FAO Forestry Paper on Fire Management will synthesize the highlights from each region, but also provide a global summary of important lessons that can be used in fire management in the future. These papers are a valuable resource in the process to prepare the Fire Management Code, the Global Strategy to Enhance International Cooperation in Implementing the Fire Management Code and associated capacity building.

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This working paper is the product of a global team of dedicated people willingly giving of their time and specialist expertise within each of the twelve UN-ISDR Regional Wildland Fire Networks.

A.M.J. Robbins, as the author, obtained key information and data for this working paper from Bahamas, Barbados, Belize, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Grenada, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Saint Lucia, Saint Vincent & the Grenadines, Trinidad and Tobago, and from Puerto Rico, Montserrat, and Guadeloupe.

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1. Background

Following the release of the Global Forest Resources Assessment 2000 (FRA 2000) report in 2001, the global FRA process has now entered its next reporting cycle. FAO's Committee on Forestry (COFO) 2003 confirmed the directions of global FRA's that the Kotka IV Expert Consultation recommended in July 2002. Recommendations included the preparation of an update of the global FRA-data in year 2005 and to increasingly involve countries directly in the assessment and reporting, in particular to submit national reports on the status and trends of a range of forestry parameters. More information about FRA 2005 is available at www.fao.org/forestry/fra.

FRA 2005 also included thematic studies, including e.g. on forest fire, forests and water, and mangroves. The thematic study on wildland and forest fire in 2005 is built on regional reviews on forest fire management through the United Nations International Strategy for Disaster Reduction (UNISDR) Global Wildland Fire Network (GWFN). The current report is a contribution and makes a review of the ISDR Caribbean and Mesoamerican Regions.

This Working Paper FM/12/E has been written by Mr A.M.J. Robbins and does not reflect any official position of FAO.

2. Caribbean Region

2.1 Introduction

Reports about wildland and forest fires were only available for certain island states in the region. The most recent were prepared for the 12th Caribbean Foresters Meeting, held in 2004 at the International Institute of Tropical Forestry, Puerto Rico. The notes on individual islands are based almost entirely on these reports. A regional summary of working group presentations at the meeting was prepared by Eckelmann (2004) and forms the basis for most of the regional comments. Some points have been taken from a paper presented at the Pan-American Conference on Wildland Fire, Costa Rica in October 2004 (Rodríguez, 2004).

2.2 Extent

The Caribbean region includes some 22 island states ranging in size from 110 km² to 110 000 km². Although mostly small in comparison with Mesoamerican mainland states, their forest resources play an important role in their economies, and the effect of fires can be significant.

In common with the mainland, island climate is determined by: the movement of the inter-tropical convergence zone, 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 due 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 load.

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

- *Vegetation maintained by wild fires*: Pine forest type in the Bahamas and Dominican Republic; non-native grasslands and bamboo forests (mainly on the Windward and Leeward Islands).
- *Vegetation sensitive to wild fires and prone to fire damage*: Forest plantations of introduced species, e.g. Caribbean pine and teak; 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 types*: Undisturbed montane forests; humid montane forests at higher elevations; and mangrove forests in tidal zones.

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

Table 1. Land area of countries and available data on wildfire occurrence

Country/Territory	Land area (km ²)	Number of wildfires average for period, or for specified year	Total area affected	Source
Antigua and Barbuda	440	No data	No data	
Bahamas	10 010	No data	No data	
Barbados	430	1338 (2003)	No data	Jones (2004)
British Virgin Islands	150	No data	No data	
Cayman Islands	260	No data	No data	
Cuba	109 820	325/yr (av. for 1984-1998)	4 878 ha/yr (av. for 1984-1998)	Rodríguez (2000)
Dominica	750	50 (1986) to 222 (2001)	No data	Arlington and Dupuis (2004)
Dominican Republic	48 380	141/yr (av. for 2000-2003)	4 660 ha/yr (av. for 2000-2003)	González and Sierra (2004)
Grenada	340	100/yr	No data	Thomas (2004)
Guadeloupe	1 690	No data	No data	
Haiti	27 560	No data	No data	
Jamaica	10 830	No data	No data	
Martinique	1 070	No data	No data	
Montserrat	110	No data	No data	
Netherlands Antilles	800	No data	No data	
Puerto Rico	8 870	No data	No data	
Saint Kitts and Nevis	360	No data	No data	
Saint Lucia	610	22 (2004) to 200 (2001)	No data	Isaac (2004)
St.Vincent & the Grenadines	390	No data	No data	
Trinidad and Tobago	5 130	315/yr (av. for 1987-2003)	4 082 ha/yr (av. for 1987-2003)	Singh and Adam (2004)
TOTAL AREA	228 000			

2.3 Causes and effects

As mentioned earlier, forest fires occur mainly in dry forest types. The risk of fire increases with logging since reduction of the upper canopy triggers development of scrub and brush undergrowth, which dries up quicker and is easier to ignite than the original understory. Almost all fires in broadleaf forests seem to be man-made. In common with other countries, increasing population pressure has led to reduction of forest area, associated with fire as a tool to aid clearance.

The main causes are as follows:

- In rural areas, fires are used to clear land for agriculture, to improve pasture for livestock grazing, for settlement, and to facilitate hunting by clearing the area and driving out animals. When such fires get out of control, adjacent forest is burned. There is less motivation to control if neighbouring lands are state-owned or ownership is uncertain.
- In areas close to urban settlements, campfires and children at play appear to be common causes.
- Deliberate firing occurs as a form of protest against people or government. Fires may be used to force settlement of disputes between neighbours, family members or interest groups over land use or ownership.
- 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 out of sight. 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 dimensions requiring research.

- Lightning is associated with heavy rainfall, and therefore unlikely to cause fires, although this does occur in native pine forests. Discarded cigarettes are sometimes a cause. Spontaneous combustion or glass refraction of sunlight is very unlikely as a cause.
- Volcanic action can be a rare but catastrophic cause of fires, and may result in complete incineration of large areas.

Annex 1 summarises those causes reported in the literature for both the Caribbean and Mesoamerican regions, but a particular concern in the region is a lack of awareness of damage caused by fires, and prevalence of deliberate burning for unknown motives. For available statistics and trends on the number of fires and extent of forest affected, see the individual country notes.

Damage can be extensive on some islands. Annex 2 summarises reported effects for the Caribbean and Mesoamerican regions (some of these are beneficial, since fire is a natural component of pine ecosystems, and is used as a tool).

As in the Mesoamerican mainland region, fire damages island 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 ecosystem (often with impoverishment of biodiversity and productivity), predisposition to disease, and reduction of environmental services.

Climate change in the wider region is tending to lead to drier spells and more intense storms, particularly hurricanes, which increase fire risk and hazard.

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.

2.4 Prevention and extinction

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 improve awareness, enforce legislation, and improve techniques in control of existing fire. In some cases early detection is supported via satellite and aerial surveillance. Most countries have ground patrols, and some have a system of watchtowers. Fires are mainly extinguished directly by hand, aided with indirect techniques such as backfiring and the use of fire traces. Annex 3 summarises the reported forms of fire management in the Caribbean and Mesoamerican regions.

2.5 Institutions, responsibilities and roles

The responsibilities are covered by several institutions. The national fire service is usually responsible for fires that pose 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 be concerned with providing support where the capacity of the other institutions is limited.

Since 2004 initiatives to increase cooperation and synergies within the countries of the Caribbean region are underway.

- During the Foundation Meeting of the Regional South American Wildland Fire Network in Curitiba, June 2004, it was proposed to establish a Regional Caribbean Wildland Fire Network within the Global Wildland Fire Network (GWFN).
- A meeting of the Regional Caribbean Wildland Fire Network, followed by the Pan-American Wildland Fire Conference, was held in October 2004.
- A Caribbean Fire Management Cooperation Strategy is being developed in 2005 with the assistance and support of the FAO Project TCP/RLA/3010 (C) and the Global Fire Monitoring Center (GFMC), enclosed in the Regional Fire Management Cooperation Strategy for Latin America and the Caribbean. The Caribbean Strategy, for which a regional report “*Aspectos políticos, institucionales y legales relacionados con el manejo de incendios forestales en la Subregión del Caribe*” was prepared by Rodríguez (2004), foresees the incorporation and approval of a *Fire Management Working Group* within the Caribbean Sub-regional Group for the

FAO Latin American and Caribbean Forestry Commission (LACFC). This regional strategy aims to strengthen a Caribbean Fire Management networking to open new opportunities for the development of ties between other regions sharing similar characteristics. The final strategy will be presented during the next session of the LACFC in June 2006. For more information, see Casaza (2005a, 2005c).

2.6 Collaboration and community involvement

The extent of collaboration and community involvement 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.

2.7 Needs and limitations

Needs and limitations are very variable due to the scattered nature of the islands, their differing sizes and economies. A recent meeting of Caribbean Foresters aimed to identify the main issues, and helped to analyse the situation and make recommendations, as noted below.

2.8 Analysis and recommendations

The following points are based on the outcome of the 12th Caribbean Foresters Meeting, held in Puerto Rico in 2004, with some additional comments added:

- All the states have indicated that awareness creation is a priority in fire prevention and control, as well as having educative programmes in schools and on the media. There are already some excellent programmes to promote conservation awareness (e.g. using national birds as a key feature) that should be integrated, given the close relation between incidence of fires and maintenance of biodiversity. School activities should be given high priority.
- Closely linked to awareness creation and interagency collaboration are initiatives to promote community involvement in fire detection. These will become more effective as the role of fire is better understood; public confidence is placed in the collaborating agencies; and underlying socio-economic constraints are addressed.
- Many states have legislation that governs the use of fire, mainly for agriculture. The laws define techniques for fire prevention, institutional arrangements to obtain fire permits, as well as penalties. However, the level of enforcement is generally low because of limited capacity, or because some laws are controversial to implement. Some legislation needs to be revised, since it was originally laid down to regulate slash and burn agriculture, and does not take into account new aspects of fire management.
- Many states indicate that there is a need for improved documentation and recording of fires. This should be addressed so as to ensure that there is a better understanding of the extent, causes and effects of fires. Also research strategies for fire management should be developed.
- The need for interagency collaboration is well appreciated and should be encouraged to increase effectiveness of fire prevention and control. To facilitate cooperation, standard protocols and operational procedures should be developed where these do not exist.
- Regional networking and exchange of ideas, such as those already carried out under the auspices of the Caribbean Foresters Network, or under the Global Wildland Fire Network (GWFN) should be encouraged. The Caribbean Community (CARICOM) Secretariat could be used to implement certain regional mechanisms.

3. Mesoamerican Region

3.1 Introduction

This summary is based on reports by López (2004), presented at the Pan-American Conference on Wildland Fire, Costa Rica in October 2004, and Martínez and Sanhueza (2003), presented at the International Wildland Fire Summit, Sydney, Australia in October 2003. Details about the individual countries along with further references will be found in the individual country notes.

3.2 Extent

There are eight countries in the region, covering a total land area of approximately 2.4 million km² with a very wide variety of climate, topography and forest types, including desert scrub, subtropical montane forest, and lowland tropical rainforest. There are extensive areas of fire-climax coniferous forests (i.e. the pine forests and savannas) where fires are an integral part of the ecosystem. The main environmental problems in the region are forest degradation (deforestation is estimated at 1.3 million ha/yr., equivalent to 1.8% per year) and wildfires. These are many and serious and the peak season in the region is April-May.

Table 2. Land area of countries and area affected by wildland fire (ha) (1998-2004)*

Country	Land area (km ²)	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 **
TOTAL AREA	2 419 420							

* Source: López (2004)

** Note: in Panama 1 723 ha corresponded to forest fires, with agricultural fires totalling 6 293 ha (year 2004).

3.3 Causes and effects

The countries report a wide variety of causes. Annex 1 summarises these as reported in the literature for both the Caribbean and Mesoamerican regions. The principal underlying causes in Mesoamerica include social inequity, devalued natural resources, lack of a culture that respects the forest, inadequate policies, and lack of forest resource management by communities. Almost all fires are started by people, and immediate causes are clearance for agriculture, arson, recreation, smokers and hunting.

Damage resulting from wildfires can be very extensive. Annex 2 summarises reported effects for the Caribbean and Mesoamerican regions. Note that some of these are beneficial, since fire is an integral part of pine ecosystems, and is used as a tool in land husbandry.

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 ecosystem (often with impoverishment of biodiversity and productivity), predisposition to pest and diseases (e.g., infestation by *Dendroctonus* bark beetles), and reduction in environmental services.

Climate change in the region (both global and local, such as the *El Niño* effect) is leading to drier spells which increase fire risk, and more intense storms which increase fire hazard from build-up of fuel. Smoke pollution from the resulting fires can be widespread, leading to deterioration of health and disruption of transport services. Many lives are lost directly due to effect of smoke and flame, and there can be considerable damage to property. Overall the influence on the national economies can be severe.

3.4 Prevention and extinction

The countries in the region vary in the extent to which they have been able to manage fires. Many now have several decades of experience. With regard to prevention, ignition sources are being reduced through campaigns to improve awareness, enforcing legislation, and improving techniques in control of existing fire. 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 is being improved by road and firebreak construction. Fuel loads are being reduced through the increasing use of prescribed burning, or adoption of practices such as agroforestry that reduce fire risk. Most fires are extinguished directly by hand, with indirect help from backfiring and fire traces. Where severe damage has occurred, steps may be taken to rehabilitate land through promoting natural regeneration or planting. Annex 3 summarises the reported forms of fire management in the Caribbean and Mesoamerican regions.

3.5 Institutions, responsibilities and roles

There is a wide variety of institutions involved. The main government agencies include those responsible for forestry, agriculture and livestock. Additionally, institutions concerned with individual crops (e.g. coffee), the environment and protected areas may play a role in fire management. 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 decade, there have been various initiatives to address the issue of wildfires from a regional perspective and build up institutional capacity.

- In 1996, the Central American Regional Technical Committee for Forest Fires (*Comité Técnico Centroamericano para el Manejo del Fuego* - COTCAMAF) was established.
- In 1998, a Workshop on Forest Fires in Honduras generated increased governmental interest, when it was agreed that each country should develop action plans for the dry season of 1999.
- A first Mesoamerican Meeting on Cooperation Regarding Protection Against Forest Fires was held in Guatemala in 2002. It aimed to identify specific activities of 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. At this occasion a regional working group on fire management was established under the Technical Committee on Forests/Central American Commission for Environment and Development (CTB/CCAD).
- To begin implementation of this strategic plan, two more workshops were held in 2004 in Guatemala and El Salvador, focusing on developing an action plan for Central America and Mexico.
- A Central America and Mexico Regional Network on Forest Fires and Pests was officially established in 2004 during the meeting of the Central American Council of Forests and Protected Areas (CCAB/AP), held in El Salvador. CCAB/AP's members are directors of the national forest service of each country in the region.
- A meeting of the Regional Network of Central America and Mexico, followed by the Pan-American Wildland Fire Conference was held in October 2004.
- A Fire Management Strategy for Central America is being developed in 2005 by the Regional Working Group on Fire Management of CTB/CCAD, with the assistance and support of the FAO Project TCP/RLA/3010 (C) and the Global Fire Monitoring Center (GFMC), enclosed in the Regional Fire Management Cooperation Strategy for Latin America and the Caribbean. This strategy, for which a regional report "*Documento base para elaborar la Estrategia Mesoamericana de Cooperación en el Manejo del Fuego*" was prepared by Scholz (2005), aims at unifying technical criteria and establishing dynamic interaction between the countries of the region. For additional information, see Casaza (2005b, 2005c).

3.6 Collaboration and community involvement

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

- Satellite detection for forest fires in Mexico (CONABIO), Guatemala, El Salvador, Costa Rica and Honduras (bilateral agreements between Mexico and each country).
- Satellite detection for forest fires between Nicaragua and Honduras.
- Under the bilateral agreement between Mexico and Guatemala and the Commission on Forest Pests and Fires in Central America and Mexico, two international Mesoamerican courses for forest fire protection have been held (2002 and 2003).

- The 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 established in the frontier zone between Guatemala, El Salvador and Honduras, forest fire prevention and control are being developed.
- In other frontier areas, forest fire prevention and control are being carried out between countries belonging to the Central America and Mexico Regional Network on Forest Fires and Pests.
- In Central America there have been training processes: one supported by OFDA/USAID and the other supported by Mexico - “Mesoamerican Course on Forest Fires.”
- In the frontier area between Guatemala and Mexico, there exists coordinated management of emergencies.
- There is an emergency coordination agreement between Costa Rica, Nicaragua and Panama.

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.

3.7 Needs and limitations

Governments in the region increasingly recognize that prevention and control of forest fires are important, but because of political constraints, many initiatives have not achieved concrete results. However, the region does have a trained human resource base, with detection systems and basic equipment and tools for control. During recent years there has been an emphasis on fire control and strengthening of local fire prevention strategies.

From the technical point of view, it is necessary to increase and adapt training to the level of each country, to improve planning, organization and detection so as to reduce response times, and to implement formal systems for predicting forest fires at the regional level. As part of this process, 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, so as to increase technical level for predicting, detecting and monitoring forest fires.

3.8 Analysis and recommendations

The incidence of wildfires in the region has a significant and deleterious effect on national economies and the social structure. Despite longstanding efforts to introduce effective prevention and control, efforts have often been limited by political, social and environmental constraints. However, the many initiatives proposed for the region, if followed through, should make a significant improvement.

In the Central America and Mexico Regional Brief on International Cooperation in Wildland Fire Management, presented at the Pan-American Wildland Fire Conference (2004), it was suggested that the following activities should be carried out to strengthen regional cooperation.

- Strengthen satellite systems for detecting and monitoring fires in the region and start 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 (EFCA), considered as a strategic framework for the forest sector for the next 25 years.
- Give priority and provide resources to the problem of forest fires, 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 among the networks in Central America and Mexico with those in South America; in the Caribbean; in North America; and with the Global Fire Monitoring Center (GFMC).
- Develop a short-term work plan at the level of the regional networks, with roles and responsibilities, defining dates for presenting results.

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- Truesdale, D., R. Martínez, and B.J. Stocks. 2006. Global Forest Resources Assessment 2005. Thematic Report on Forest Fires in the North American Region. FAO Working Paper FM/15/E.

Annex 1. Reported causes of wildfires in the Caribbean and Mesoamerican regions

Fundamental (underlying or facilitating) factors	Socio-economic	Poverty			
		Ignorance / lack of awareness			
		Lack of education			
		Unemployment			
		Inequity			
		Lack of or unclear tenure			
		Over-population	Regional by migration		
		Peer pressure	National		
	Politics	Corruption			
		Inadequate legislation			
		Un-enforced legislation	Illegal activities	Settlement Logging Unauthorised burning	
	Conflict	Drug			
		Civil war			
		Between countries			
	Culture	Youth gangs			
		"Fire talk"			
	Technical	Improper land-use			
	Natural	Climatic extremes (hurricanes / <i>El Niño</i>)			
		Geological extremes (volcanic activity)			
	Natural	Lightning			
		Solar (lens effect)			
		Volcanic			
	Human (anthropogenic)	Direct ignition		Deliberate, because of	Boredom
					Malice
					Pyromania
				Mistake / negligence	Vandalism
					Curiosity
Arson					
Discarded cigarette/match					
Indirect ignition (flame or spark) from uncontrolled (escaped) fire used for:				Itinerant agriculture (slash and burn)	Fire after accident (e.g. vehicle)
					Crop clearance (e.g. sugar)
				Land use change	
				Hunting	
				Fishing	
				Mining	
				Charcoal production	
	Rubbish clearance				
Recreation	Bonfires				
	Barbeques				

Annex 2. Reported effects of wildfires in the Caribbean and Mesoamerican regions

EFFECTS ON ECOSYSTEMS (which lead to effects on people and property)					
Plants debilitated	Susceptibility to diseases/plagues	Aesthetics diminished	Tourism reduced		
			Well-being diminished		
		Productivity reduced	Ecosystem changed		
			Biodiversity reduced		
Plants selectively killed in fire climax ecosystem (e.g. pine forest)	Fire occurrence unchanged	Fire climax maintained			
		Forest management facilitated			
	Fire intensity increased	Pioneer species encouraged	Aesthetics diminished	Tourism reduced	
				Well-being diminished	
		Grass invasion		Fire risk increased	
			Pasture improved		
			Weeds removed		
			Pasture overgrazed		
	Fire intensity reduced or eliminated	Reduction in plant life	Desertification		
		Fuel build-up	Catastrophic fires		
Plants selectively killed in non-fire climax ecosystem	Plant composition changed	Biodiversity reduced	Broadleaf invasion	Change of forest type	
				Increased biodiversity	
		Change of habitat	Options reduced	Economy suffers	
				Livelihoods reduced	
Plants selectively killed in replacement planting	Fire risk increased (e.g. if conifers or eucalyptus used)		Aesthetics diminished	Tourism reduced	
				Well-being diminished	
Vegetative material incinerated	Unwanted/waste material removed	Conversion to farmland facilitated			
		Illegal crops removed (e.g. drugs)			
	Fertiliser provided	Crop growth facilitated			
	Carbon storage lost	Carbon dioxide released			
	Atmosphere modified by smoke and heat	Gas composition changed	Health impaired	Respiratory problems	
				Eye problems	
		Particle pollution	Climate changed	Weather extremes	
				Growth improved	
			Visibility lowered	Transport accidents	
				Aeroplanes grounded	
	Soil exposed to rain or wind	Soil eroded	Sedimentation in water	Aesthetics reduced	Tourism diminished
				Well-being diminished	
Physical gullyng			Health impaired	Respiratory problems	
				Eye problems	
Soil structure degraded	Water retention reduced Water yield more variable	Climate changed	Weather extremes		
			Growth improved		
Fertility lost	Productivity decreased	Wind borne (effects as above)			
Albedo changed	Microclimate change Global climate change	Hydropower inefficiency	Economy suffers		
			Energy supply constrained		
		Potable water quality reduced	Health diminished		
		Aesthetics diminished	Tourism reduced		
		River / sea water turbidity	Local well-being reduced		
			Fishing diminished		
			Coral reefs decline		
			Mortality		
			Property damage		
			Land degradation		
			Personal injury		
			Physical damage		
			Poor health		
			Livelihood diminished		
			Economy suffers		

DIRECT EFFECTS ON PEOPLE				
Direct injury or death				
Warmth provided	Livelihood improved			
Visual satisfaction	Well-being improved?			
Grudge satisfied	Conflict			
DIRECT EFFECTS ON PROPERTY				
Damage or destruction				

Annex 3. Reported forms of fire management in the Caribbean and Mesoamerican regions

STRATEGY / TACTICS/ OPERATIONAL TECHNIQUES				
PREVENTION	Ignition sources reduced	Awareness created		
		Legislation enforced		
		Controlled techniques used		
	Prediction improved	Fire calendars prepared		
	Capacity strengthened	Training improved		
CONTROL and EXTINCTION	Access facilitated	Roads prepared		
		Fire breaks constructed		
	Detection improved	Aerial surveillance		
		Ground patrols used		
		Watchtowers used		
	Spread limited	Firebreaks constructed		
		Fuel load reduced	Fires prescribed Agroforestry adopted	
	Intensity limited	Prescribed fires		
	Fire extinguished	Directly	Manual	
			Mechanized	
Indirectly		Backfiring Fire trace		
REHABILITATION		Natural regeneration		
		Planting		

Annex 4. Country information

CUBA

Extent, causes and effects

Cuba covers 109 820 km². In 1959 its forests had diminished to 13% of land cover, but are now 21% as a result of planting (mainly of pine, eucalypts and *Casuarina*). Due to the inflammability of these species, along with increased population pressure, fire risks have increased. Most of the fires occur during the distinct dry season.

Fires are mainly caused by human activity when clearing agricultural land and improving pasture. They are used to facilitate cultivation and harvesting of sugar cane, and usually carried out under controlled conditions, using firebreaks; by reducing fuel load; and burning only when weather is suitable.

Forest fires in Cuba (1984-1998)

Years	No. of fires	Average Area burned (ha)	Average size (ha/fire)
1984	296	3 854	13
1985	390	4 800	12
1986	552	6 651	12
1987	269	3 220	12
1988	369	4 545	12
1989	310	2 929	9
1990	307	3 127	10
1991	566	6 582	11
1992	312	4 442	14
1993	182	5 380	29
1994	237	6 152	26
1995	363	8 731	24
1996	211	3 905	18
1997	255	4 708	18
1998	259	4 144	16
Total	4 878	73 170	
Average	325.2	4 878	15.00

Major causes of forest fires in Cuba (1989-1998)

Years	Incendiary		Negligence		Lightning		Unknown	
	Number	%	Number	%	Number	%	Number	%
1989	11	3	130	42	84	27	85	27
1990	12	4	166	54	36	12	93	30
1991	47	8	156	28	26	5	337	59
1992	38	12	123	39	19	6	132	42
1993	14	8	73	40	51	28	44	24
1994	17	7	134	56	21	9	65	27
1995	32	9	157	43	15	4	159	44
1996	7	3	83	39	24	11	97	46
1997	7	2	110	43	49	19	89	35
1998	9	3	71	27	36	14	143	55
Totals	194		1 203		361		1 244	
Averages	19.4		120.3		36.1		124.4	
%	6		40		12		42	

Planning and management

The organization and management of fire protection is undertaken by the Forest Department in the Ministry of the Interior. In conjunction with the Ministry of Agriculture, specialized measures for fire prevention have been set out. These are regulated by a national programme of the Ministry of the Interior in collaboration with the Ministry of Science, Technology and the Environment, and the National Council of Civil Defence. Actions include increased vigilance during drought periods; use of lookout towers and aerial detection; prioritization of ecological regions; collaboration as required with other entities; and increased awareness creation.

There are more than 30 Forest Fire Control Units (UCIF) situated in high-risk forests which operate all year. Volunteer brigades, comprised mostly of local villagers, are also used for the protection of the forest and fauna. In the case of extensive forest fires, the government and political authorities help with resources.

Reference

Ramos Rodríguez, M.P. 2000. An overview of forest fires in Cuba. *International Forest Fire News* No. 22, 20-23.

JAMAICA

Extent, causes and effects

Jamaica covers nearly 11 000 km² of which 30% is forest, and 30% mixed land-use (disturbed broadleaf/fields, bamboo/fields, bamboo/disturbed broadleaf and pine plantations/other). Fire has always been present, and currently is a result of land clearing, pasture improvement, pest removal, garbage removal, and crop management. Fire/sparks from charcoal kilns, cooking sites, and cigarettes are also causes. Recently, a so-called "fire culture" has developed among young people who maliciously set fire to bamboo and other brush.

Planning and management

In 2001 a Fire Response Strategy for bush fires became a component of the National Fire Management Plan. In 2002 a Jamaica Bush Fire Management Action Plan was produced. The Jamaica Fire Brigade responds to suburban and accessible bush fires, sometimes assisted by the Jamaica Defence Force. On crown lands and forest reserves, Forestry Department staff will attempt to extinguish small fires. Legislation is adequate for prosecution, and since 2003 enforcement has been supported by armed patrols of the Special Constabulary Force.

To improve future fire management, the Forestry Department's planned Local Forest Management Committees could take an active role in fire fighting, in collaboration with other agencies, supported by local farmers. Continuing education will focus on the destructiveness of fire and alternatives such as composting and mulching. Periods during which burning is not allowed may be imposed, along with water restrictions in time of drought.

Reference

Barrett, M., and P.E. Virgo. 2004. Jamaica country report: wildland fire, management and land restoration. Paper prepared for the 12th Caribbean Foresters Meeting, held at the International Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 8-11 June 2004.

DOMINICAN REPUBLIC

The Dominican Republic covers 48 380 km². Its forest area declined to 10% in the early 1980s, but has increased to 28% in 2001 as a result of reforestation. Records of fire have been kept since 1962, and the areas most affected are the national parks and reserves, and other forested areas. The main cause is slash and burn agriculture for cropping and pasture. Other causes are use to facilitate hunting, uncontrolled fires resulting from cooking and heating, and deliberate fires started out of malice. About 5% of fires result from lightning.

Forest fires in the Dominican Republic (1990-2003)

Year	No. of fires	Total area affected (ha)	Average area per fire (ha)
90-99	86 (average)	4 453 (average)	52
2000	114	3 303	29
2001	132	8 123	62
2002	123	1 185	10
2003	195	6 031	31

A programme of training has been started for technicians and firefighters, along with the elaboration and implementation of a national programme of prevention, management and control of forest fires.

References

González, J.E., and J. Sierra. 2004. Forestry activities in the Dominican Republic: emphasizing forest fires. Paper prepared for the 12th Caribbean Foresters Meeting, held at the International Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 8-11 June 2004.

Myers, R.L., J. O'Brien, D. Mehlman, and C. Bergh. 2003. *Evaluación del manejo del fuego en los ecosistemas de tierras altas de la República Dominicana*. Informe técnico. The Nature Conservancy.

BAHAMAS

The Bahamas cover 10 010 km². Fire has been an integral part of the pine forests of the islands (locally called pineyards) - as well as in the Turks and Caicos in the same archipelago. There are also fire-maintained ecosystems of freshwater marshes, wet prairies, palm savannas and salt marsh. Most fires now have a human origin, though in the past many were started by lightning.

Under a normal fire regime, it is considered that unmanaged and unharvested pineyards would be all-aged, made up of small even-aged stands. However, as a result of exploitation and hurricane effects (which increase fuel load), along with changes in fire frequency and intensity, the pineyards are currently largely even-aged with little regeneration, although still healthy.

To regain a more sustainable forest, with a variety of ages and biodiversity, a recent study has recommended that fire management plans and capacity should be developed, giving priority to national parks. Public education about the beneficial and deleterious effects of fire is required. Forest management plans need to give attention to appropriate cultural techniques, along with a programme of research concerning fire history, different regimes, effect on habitat e.g. of the Bahamas parrot, freshwater recharge and supply; and implications of climate change.

Reference

Myers, R.L., D. Wade, and C. Bergh. 2003. Fire management assessment of the Caribbean Pine (*Pinus caribaea*) forest ecosystems on Andros and Abaco Islands, Bahamas. The Nature Conservancy.

PUERTO RICO

A report was not available, but it was noted that the management of forest fires in Puerto Rico comes under the USDA Forest Service, and that the Caribbean National Forest (*El Yunque*) trains fire crews, which since 1991 have been dispatched to fight fires in other US National Forests. An Incident Management Plan is implemented, and in the event of fire or other natural disaster, an Incident Management Team, made up of forestry personnel, is formed and deployed. Some team members have been trained in special skills of fire suppression or as helicopter support crew. The International Institute for Tropical Forestry, part of the USDA-FS, is located on Puerto Rico, and hosted the 12th Meeting of Caribbean Foresters on wildfires.

Reference

Information provided from the website: <http://www.fs.fed.us/r8/caribbean/fire/index.shtml>.

MONTSERRAT

Although a report was not available, Montserrat (110 km²) is noted here because of its volcanic activity. Although fires had not been a significant problem for the island, the volcanic eruption of Sufrière mountain in the south, which started in 1995, incinerated most of the watershed, destroying vegetation by lava and pyroclastic flows. This has resulted in severe effects on tourism, water supplies, and livelihoods in general. The island was billed as the "Emerald Isle of the Caribbean". From a research point of view, the affected area is potentially valuable for studying colonisation of vegetation after such catastrophic fires.

GADELOUPE

The archipelago (1 690km²) has few, scattered fires, used to improve pastures and to manage food crops and sugar cane. Paradoxically, most wildland fires reported during the last decade occurred in flooded forests. Such forests dry quickly in the dry season, are composed of inflammable *bloodwood* trees, have extensive roots and fallen leaves, and are near to fields that are frequently burned. Damage is however quite limited.

The archipelago benefits from the experience of France's forest policy, legislation and management, and fire management comes under the French Forest Service of Guadeloupe.

Reference

Debroize, N. 2004. Wildland fires, management and restoration in Guadeloupe. Paper prepared for the 12th Caribbean Foresters Meeting, held at the International Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 8-11 June 2004.

DOMINICA

Dominica (750 km²) is the largest of the eastern Caribbean states, with extensive and varied natural forest (including a World Heritage Site). Altitude reaches 1 300 m, and rainfall 7 500 mm. In rain-shadow areas on the west coast, there is a pronounced dry season. Wildland fires affect four main vegetation types: marsh, dry forest, forest seasonal (semi-evergreen/semi-deciduous/transitional), and savanna-type vegetation. Repeated burning of the drier forest types has led to its degradation, and introduction and spread of lemon grass. There has been a loss of bird habitat and effect on fruit/seed dispersal.

Over the past decades, the Dominican Fire and Ambulance Services have noted a marked increase in the number of fires responded to, and also those not attended because of remoteness. The main concern is to protect people, personal property, agricultural holdings and biodiversity of the affected areas. The Services, in collaboration with the Forestry and Wildlife Division, through their Fire Prevention and Environmental Education Units, are creating awareness programmes - mainly aimed at what is perceived (as on other islands) to be an emerging culture of "fire starters". These programmes are considered essential to safeguard Dominica's tourist attraction as "Nature Island of the Caribbean".

Bush fires responded to in Dominica (1980-2003)

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
No. of fires	84	67	51	181	83	131	50	253	79	80
Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. of fires	71	131	99	88	217	169	114	186	129	139
Year	2000	2001	2002	2003						
No. of fires	131	222	75	179						

Reference

James, A., and J. Dupuis. 2004. The impact of bush fires on the vegetation of Dominica. Paper prepared for the 12th Caribbean Foresters Meeting, held at the International Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 8-11 June 2004.

SAINT LUCIA

Saint Lucia (610 km²), like many other island states, is volcanic in origin with a wide range of rainfall and severity of dry season. The majority of fires occur along coastal zones within the moist/dry forest on the west. Fires are started mainly to control pests, prepare land for crops, and eliminate degraded fodder. The Saint Lucia Fire Service has traditionally been the only entity responsible for extinguishing wildfires. The Forestry Department's responsibilities lie within the area of soil, wildlife, biodiversity and water conservation, while that of the Fire Service is to prevent loss of life and property. The National Conservation Authority and Land Conservation Board may also be involved in managing fires.

There is concern that wildfires may be endangering flora and fauna and adversely affecting tourism, such as in the World Heritage Site of the Pitons. To improve fire management, a national wildland fire policy is being recommended as an integral part of the national land use policy, along with greater collaboration between agencies, improved statistical data, research and application of best practice.

Bush fires in the northern districts of Saint Lucia (2000-2004)

Year	Total of all fires	Bush fires	
		Total	%
2000	262	42	16
2001	427	200	47
2002	444	60	14
2003	595	198	33
2004	82	22	27

Reference

Isaac, C. 2004. Wildland fire management in Saint Lucia. Paper prepared for the 12th Caribbean Foresters Meeting, held at the International Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 8-11 June 2004.

BARBADOS

Barbados (430 km²) is flat to hilly, with little remaining natural forest. The predominant land use is sugar cane cultivation, and small gardens and farms. The main effect of fire is to increase damage to crops by livestock and monkeys, due to degradation of alternative fodder and fruit sources. Soil erosion is made worse, leading to increased discharge into the sea, affecting marine health and tourism.

In 2003, the number of recorded wildfires was 1 338, double that in 2000. Most fires are thought to have been started for fun by youths. Fires are difficult to control as there are few inland water sources. Look-out stations focus on sugar-cane fields and not the wildlands.

The Barbados Fire Service places emphasis on extinguishing house fires. Prevention of fires by awareness creation has been ineffective since there has been little public interest, and it is considered that schools need to be better targeted. The Forest Department's Soil Conservation Unit has worked in the Scotland District (where most forest occurs and fires start) focusing on minimising the areas burned, rather than number of fires started. Potential solutions include cultivating land as firebreaks, using evergreen species, and improving silviculture to reduce fuel load.

The effectiveness of management and restoration programmes is limited by lack of funding, research, planning, participation and appropriate legislation.

Reference

Jones, N. 2004. Wildland fires, management and restoration (in Barbados). Paper prepared for the 12th Caribbean Foresters Meeting, held at the International Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 8-11 June 2004.

ST. VINCENT AND THE GRENADINES

St. Vincent and the Grenadines (390 km²) has forests mainly on the upper mountainous watersheds. Extensive agricultural land use is found on the lower slopes. Wild fires became a noted problem in 1988, and are increasing throughout the state, particularly in the drier zones where impact is most felt. Many areas have been populated by introduced grasses (Lemon, Guinea and Elephant) that exacerbate the frequency of fires. Where grasses are removed to construct residences, fire frequency is reduced.

Fire is used as a tool for clearing land, hunting and crop establishment. Most wildfires start when these are uncontrolled. The Forestry Department is the main agency responsible for wild land fire management. Legislation appears to be adequate but needs to be advertised and enforced. Management is being improved by better documentation of fires using GIS. Control of fires includes establishment of fire traces and suppression of grasses by reforestation. The use of wardens and fire patrols is acting as a deterrent to uncontrolled fires. An education programme focuses on schools, communities and mass media.

Reference

Glasgow, A. 2004. Wildland fires mitigation and control in St. Vincent and the Grenadines. Paper prepared for the 12th Caribbean Foresters Meeting, held at the International Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 8-11 June 2004.

GRENADA

Grenada (340 km²) - the "Spice Island" - has a range of natural forest types, mostly on the mountainous watersheds, with many land uses in the lowland areas - typically the cultivation of nutmeg. About 100 wild fires occur annually, primarily in lowland coastal woodland areas. Fires are usually less than one hectare, caused mainly by careless burning and cigarette smoking. In certain areas, fires may be caused by sulphur associated with volcanic activity. As well as other common deleterious effects, wildfires pose a serious threat to biodiversity, especially the Grenada Dove, which lives in the dry forest habitat.

Control of wild fires in Grenada is the responsibility of the Grenada Fire Department, and management of dry forest is the responsibility of the Forestry and National Parks Department in the Ministry of Agriculture, Lands, Forestry and Fisheries.

Reference

Thomas, A. 2004. Wildfire management and restoration in Grenada. Paper prepared for the 12th Caribbean Foresters Meeting, held at the International Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 8-11 June 2004.

TRINIDAD AND TOBAGO

The islands of Trinidad and Tobago (5 130 km²) have features and flora more similar to South America than the Caribbean.

Trinidad has 48% forest cover, with eight forest types (evergreen seasonal, semi-evergreen seasonal, deciduous seasonal, dry evergreen, seasonal montane, montane, swamp forests and secondary forests). Additionally there are some 15 000 ha of plantation (teak, pine, cedar and mahogany). There is a distinct dry season, although rainfall pattern can vary markedly. The worst dry season on record occurred in 2003. Bush and forest fires are frequent occurrences and cause extensive damage, and are becoming a major concern. The watersheds of the Northern Range have been especially vulnerable.

Increasing areas of forest are being replaced by fire-prone grasses, leading to severe siltation and flooding of low-lying areas.

The causes are mainly human: slash and burn agriculture, hunting, rubbish clearance, and uncontrolled fires for cooking and heating. This has been exacerbated by negligence and vandalism associated with unplanned squatting communities, in particular on State forest reserves - as well as establishment of high-cost housing in rural areas. It is estimated that fires cause loss of forest cover at 40ha/yr., and lead to a significant increase in fire-climax grasslands with less biodiversity. Overall value of damage by fires (through loss of timber, reduced yield, remedial work, related flooding and siltation, and rehabilitation works) is estimated at several million dollars annually.

Under normal conditions in Trinidad, fires do not cause irreversible damage, although severe weather conditions have caused major problems in the past, such as in the Mora forests of eastern Trinidad. Young plantations are also very vulnerable.

Summary of Forest Fires in Trinidad (1987-2003)

Year	No. of Fires	Area Burned (ha)
1987	502	21 420
1988	583	5 495
1989	146	970
1990	234	1 100
1991	229	680
1992	431	2 710
1993	228	1 570
1994	256	2 600
1995	516	7 245
1996	178	2 664
1997	156	446
1998	764	10 289
1999	167	988
2000	91	927
2001	464	5 309
2002	62	273
2003	347	4 723

A National Forest Fire Plan Committee, set up in 1988, has been providing a general policy and planning framework for addressing forest fire issues at national level. The committee is multi-sectoral, including NGO representation, and serves as an advisory body. It coordinates the activities of various state agencies and non-governmental organizations, as outlined in the Forest Fire Protection Plan, the aims of which cover education, prevention, suppression, and community mobilisation.

Tobago forms part of the same nation state as Trinidad. Rainfall is variable, but also with a distinct dry season. The natural vegetation includes mangrove swamps in the west, littoral scrub, semi-deciduous forests mostly in the north-east, and tropical rain forest (lowland and lower montane rain forest) at higher elevations. The island has had extensive localised wildland fires caused by clearance of land for agriculture, control of pests, to aid hunting, and to reduce rubbish.

The prevention and control of wildland fires is governed primarily by the legislation of the Agricultural Fires Act and the Forest Act. Wildland fire management is undertaken by the State Fire Services Department and the Department of Natural Resources and the Environment (DNRE). The DNRE has a cadre of forest officers in its Watershed Management Unit who lead in fire detection and control, whereas the Fire Services is responsible for fires where human life is under threat.

Land ownership has impacted on development of fire management and restoration programmes. It is not possible to exercise these programmes fully on privately owned land, where noticeable areas of fire climax vegetation (scrub and grassland) have arisen.

Strategies to reduce fires include reforestation using mixed local hardwoods (which are fire retardant) and discouraging pure stands (e.g. teak and pine) on watersheds; public education; and encouraging appropriate land-use techniques - especially agro-forestry - among private land-owners. Community and participatory approach in fire management and restoration efforts are being introduced to foster community ownership of and responsibility for the natural resources.

References

Anonymous. 2004. Country Report - Tobago. Wildland fires, management and restoration. Paper prepared for the 12th Caribbean Foresters Meeting, held at the International Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 8-11 June 2004.

Singh, K., and A. Adam. 2004. Country Report for Trinidad: Wildland fire, management and restoration. Paper prepared for the 12th Caribbean Foresters Meeting, held at the International Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 8-11 June 2004.

MEXICO

Extent, causes and effects

Mexico covers an area of approximately 1.9 million km², with a wide range of climate including desert, tropical moist and montane forest. There are 141.7 million ha of forest, of which 56.8 million ha are temperate and tropical, and 58.4 million ha are arid and semi-arid.

Almost all fires start as a result of human activity. The main causes are clearance for slash-and-burn agriculture in the tropical zones, and for improving pasture in the temperate areas. An average number of fires for 1988-2004 was 8 013, affecting 266 328 ha annually (33 ha/fire average).

Forest fires are classified according to intensity. Some forest types have little or no natural fire, e.g. rainforest. In some ecosystems, such as pine forests, fires may be an integral part and do not cause substantial damage, only affecting the understory. Severe fires damage a large part of the vegetation, including the overstory, and may lead to the vegetation being replaced by another type.

Effects are varied – there may be substantial reduction in productivity; invasion by fire climax species (e.g. fern); and adverse effects on wildlife, biodiversity and the whole ecosystem as well as having a direct effect on people and property.

From 1994-2000 there was a period of drought, reaching a peak in 1998 as a result of *El Niño*, when over 14 000 fires affected nearly 850 000 ha, and 72 people died during fire control. Extensive collaboration between many agencies was required, following by an intensive rehabilitation programme using artificial and natural regeneration and conservation techniques.

Planning and management

Until 1999 the Federal Secretariat for the Environment, Natural Resources and Fisheries (SEMARNAP) was responsible for fire management. Following 1999, the National Forest Commission (CONAFOR) was established and assumed responsibility for fire activities.

Agencies and organizations at all levels of government assist in the fire suppression effort. They employ a range of resource types, including hand crews or brigades, engines, and helicopters. These resources respond to fires for initial attack and extended attack using both direct and indirect suppression techniques. Fire suppression is managed using the Incident Command System (ICS).

Number, extent and causes of fires in Mexico (1988-2004)

Year	Total Number of Fires on All Lands Number	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

The National Forest Commission (CONAFOR) has the following resources:

- 7 to 15 helicopters.
- 1 874 firefighters organized into 152 professional brigades. In 2005, they were used for 50 337 person days.
- 11 engines equipped for forest fire suppression.

The 152 brigades have official patrol routes for the detection of fires. There are 79 observation towers in important areas of the forest, as well as the detection by civil aeronautics (airlines and commercial pilots) and the general population using toll free phone numbers.

The Governments of the States of México, Michoacán, Chiapas, Jalisco, Guerrero, Morelos, Colima, Baja California, Oaxaca, Coahuila, Nuevo León, Yucatán, Campeche, Zacatecas, Puebla and Federal District have 5 731 firefighters organized into 338 brigades for the use of the states and municipalities. In 2005 they were used for 83 614 person-days. Many communal lands (*ejidos*), community organizations and organized groups of forest producers train and equip volunteers to respond to fires in their areas. These brigades provided 96 125 person-days in 2005.

The Secretariat of the National Defense uses elements of the Mexican Army and Armed Forces for fire suppression. In 2005 there were used for 23 004 person-days.

The Incident Command System (ICS) was introduced in Mexico three years ago. It is the method used by CONAFOR for the management of fires and started with a systematic approach of training key technical personnel in the priority areas for protection against forest fires. Nevertheless there is a delay in the adoption of ICS on the part of the other agencies at the three levels of government.

CONAFOR has a Training Center in Guzman City (Jalisco) that is used for teaching national level courses. This Center is equipped with classrooms, auditorium, dormitories, and dining room for 60 students. Courses are held at regional level in other training facilities.

Every year CONAFOR prepares a national fire management plan titled "The National Programme of Protection against Forest Fires". This plan contains analysis, objectives, strategies and actions with goals for the country. This Programme is prepared with data and the planned activities for the 32 programmes of the CONAFOR representative in each state of the country.

In the second half of 2005, a national level process started for the development of a National Strategic Programme of Protection against Forest Fires and Fire Management. The programme goal is to develop and meet the objectives for protection and conservation of all forested areas in the country. This will be a long-term programme, will contain the objectives and actions to initiate and will encourage the participation of all levels of government, the states and municipalities, the social and private sectors, and NGOs

Land use practices and forest management plans that reduce fire hazard and risk are being introduced. Where grazing is an integral part of forest use, a legume (*Vicia villosa*) is being introduced as a supplementary feed. In tropical forest areas, alternatives to slash and burn agriculture are being promoted, including perennial cultivation and agro-forestry. Since 1999, a Federal programme has been promoting job opportunities in firebreak establishment, where alternative income from the forest is limited.

Heightened awareness about fires has led to increasing community involvement and collaboration between agencies.

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BELIZE

Belize covers approximately 22 800 km² and has a forest cover made up of pine forest/savanna (15%); broadleaved forest (60%); and swamps, open savannas and mangroves (25%). Approximately 40% of the land area is under some form of protection.

Underlying factors effecting incidence of forest fires are: the movement of families in search of agricultural land to areas near to forests; opening up of roads through forests; licences issued to concessionaires; and the presence of tourist facilities in or near forests.

As a result of prolonged exposure to storms and hurricanes, the forests have frequently been damaged or degraded, creating a high fuel hazard. The first law concerning use of fire was created in 1934 as a result of the effects of a hurricane that struck Belize at that time. During the colonial period, the occurrence of fires was low, but has now seriously increased.

Fires are started as a result of: land clearance by farmers; pest control; burning of rubbish, hunters, sawmillers and natural causes (e.g. lightning). The forests most affected are pine forest and broadleaved forest damaged by Hurricane Iris. Most fires are started by hunters, for pest control and for agriculture. Some fires are deliberately caused by people who like to see fires, and a very low percentage occur because of natural causes. The most affected departments are Cayo (in the west) and Stan Creek and Toledo (in the south).

Fire prevention is being tackled through planning, training and environmental education, using radio and TV, newspapers and workshops, and also by word of mouth. Capacity is being built up through courses and workshops on the use and control of fires, techniques of prevention and use of equipment. Courses are practical, interactive and participative.

Emphasis is placed on fire detection using lookout towers and ground patrols. When fires occur, they are controlled using Forest Department brigades, the national and British armed forces, and volunteers from concessions, NGOs etc.

The organization is well defined, but resources (e.g. funds, fuel and food) are often limited, and there is a need for integration. Forecast of fire risk is carried out with the help of the meteorological service.

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EL SALVADOR

El Salvador covers 20 720 km², of which forest now covers only 2%. The rate of deforestation is currently about 45 km²/yr. which is cause for serious concern. Most of the vegetation is deciduous, with evergreen forest found at higher altitudes. Common species are pine, oak, and liquidambar.

Some of the factors effecting forest fires are: a "fire culture"; lack of awareness; use of forest resources for fuel; and lack of educational programmes. Although there are no historical records, it is assumed that from the colonial period onwards, fire occurrence has increased following deforestation for cultivation of indigo, cereals and sugar.

Fire management is being developed in several ways. Community awareness is promoted via the Committee for National Emergencies and the *Alcaldías*. During the dry season, fire prevention programmes are aimed at villagers, using a variety of means of communication. Training courses are run for members of the *Sistema Nacional de Emergencia y Comunidades*. Forest fire brigades have been formed, controlled by the army, national civil police, and non-governmental organizations, commanded by the fire service and coordinated by the Committee for National Emergencies.

Human resources and equipment consist of the brigades, specialists, vehicles and trucks, radio communication system, aerial survey planes and helicopters.

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GUATEMALA

Extent, causes and effects

Guatemala covers 108 430 km², with a mountainous topography reaching 4 220 metres. Forest covers 36% of the country (2% coniferous, 26% broadleaved, 7% mixed forest and 0.2% tropical). A further 15% of the land area is covered with brushwood and scrub. Population is approximately 12 million, with 65% living in rural areas, forming about 19 000 communities of 2 000 persons each. Agriculture is the main economic activity for over half the working population. Farmers practice shifting cultivation, using traditional slash and burn agriculture.

Wildfires have recently become a serious problem. Almost all fires are started by people, mostly along the agricultural boundaries. The most susceptible vegetation types are pine forest and pasture, although all can be at risk during the dry season. Most regular fires are low intensity, but can be high intensity if fuel builds up.

In 1997, heavy rains and frosts generated high fuel loads in dry forests, and in 1998 the *El Niño* phenomenon caused drought and high temperatures. This resulted in severe fire losses, and spurred renewed action by government organizations to document and control fires. In 1999, fires were significantly less due to reduced fuel load. Although the number of fires increased in 2000, their extent and number has been reducing in succeeding years.

Wildfires according to forest type and cause (1998-2002)

Year	Total Fires	Total Area Burned (ha)	Area of Forest Burned (ha)	Area of Other Wooded Land Burned (ha)	Human Causes (no.)	Natural Causes (no.)	Unknown Causes (no.)
1998	498	678 795	644 855	33 940	460	0	38
1999	374	10 623	10 060	563	341	0	33
2000	944	53 404	48 972	4 432	731	0	213
2001	918	22 884	22 150	734	717	3	198
2002 (to 7/5)	528	9 591	8 220	1 371	335	1	192

The main effects are on the hydrology and atmosphere. Degradation of watershed vegetation and soil leads to irregular water supplies (scarcity and flooding) and pollution, causing poor health. Degradation of the atmosphere by smoke and pollution lead, *inter alia*, to respiratory and eye problems, and poor visibility for aircraft. Fires have also had a significant impact on many of the 97 protected areas.

Fires have also exacerbated occurrence of diseases. In 1999 the population of *Ortogeomys* sp. (cricket) and *Heteromys* sp. (rats) increased. In 2000, there was a mass outbreak of pine bark beetle (*Dendroctonus frontalis*).

Planning and management

After the devastating fires following *El Niño*, the Guatemalan government set up the National System for Prevention and Control of Wildfires (SIPECIF) headed by a National Commission for the Prevention and Control of Forest Fires (CONPRECIFOR).

SIPECIF aims to create environmental awareness in the population, helping reduce wildfires through communication campaigns, training, elaboration of a national strategy, radio spots, community meetings, extension, and providing legal leverage. It has a Coordinating and Technical Council, made up of several institutions with differing responsibilities:

- National Institute of Forest (INAB) executes forest policy. It is autonomous, decentralized with its own resources.
- National Council of Protected Areas (CONAP) conserves, manages, protects natural resources, and is responsible for the Guatemalan System of Protected Areas (SIGAP).
- Additionally, there are the Ministry of Agriculture, Livestock and Food (MAGA); Environment and Natural Resources Ministry (MARN); National Security Ministry (MDN); Presidential Secretariat for Executive Coordination (SCEP) and the National Coordinator for Disaster Reduction (CONRED).

During the dry season, at periods of high risk, Centres for Forest Fire Emergency Operations (COEIF) are established and form a network. There are also urban centres. A range of other government institutions support SIPECIF's work, such as The National Peace Fund (FONAPAZ), Ministry of Health, voluntary and urban firefighters, the National Civil Police (PNC), and the Environment Protection Service (SEPRONA). An Urban and Rural Development Board (CODEDUR) is responsible for involving local populations, and forms Departmental Environmental Working Commissions (CODEMA) that act as a forum for all involved parties to discuss plans and actions.

In support of these institutions, there are many laws, regulations and declarations that cover fire in relation to forest, environmental protection and protected areas. Application of the law is a constraint.

There are two main government sources of funding – operational and emergency funds. NGOs also provide funds. There are two funding constraints: funding sources to contract, train and equip a competent organization, and being able to predict and increase budget before periods of high risk.

Management

Fires are detected by land inspection and communication with citizens, institutions, and using air transportation companies. There are eight observation towers located in strategic areas. The National Commission for the Knowledge and Use of Biodiversity of Mexico (CONABIO) provides information about critical spots.

Once a fire is detected, operations are planned using set reporting procedures, with central control exercised by the COEIF. Fire fighters are organized in groups of 10, trained in basic fire control, supervised and directed by a forest technician.

Control is either direct, using backpack pumps and shovels; or indirect, involving fire line construction. Prescribed fires, taking into account weather, firebreaks, topographical direction and wind, are occasionally used to reduce fuel load. Although improving, there are insufficient protocols and trained personnel to carry them out extensively. In some areas, procedures have been established for agricultural controlled fires (e.g. preparing land for crops), but implementation is constrained due to lack of supervision. Fire permits are helping planning and supervision, but can be bureaucratic. Fire calendars are being used to determine the ideal time for burning, particularly for prescribed fires. Large-scale burning protocols for cattle pasture require further study.

Integrated forest fire management systems are being developed, where land-use is designed to reduce the spread or intensity of wildfires, e.g. by fire breaks maintained by agricultural, pastoral or recreational activities; or the use of alternatives to the traditional use of fire for land clearing or maintenance.

In areas important for cultural heritage, such as Parque Tikal and Tiger Lagoon, proper land management is being encouraged. Thirty-six forest management plans have been developed for nearly 14 000 ha, and there are 496 plans for replanting trees over nearly 19 000 ha. Additionally, there are approximately 50 000 ha under forest management.

Specific recommendations given by Schindler *et al.* (2002) for Guatemala are to strengthen the legal framework and improve the application of the law against illegal use of fire, and to train brigade leaders in the organization, tactics, strategies and control of large-scale fires.

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HONDURAS

Extent, causes and effects

Honduras covers 111 890 km², of which 5 million ha are forested. Broadleaved forest covers 2.6 million ha and pine forest/savanna 2.4 million ha. The pine forest, located in the central and western areas (and extending into neighbouring countries) is a fire climax. Exclusion of fire leads to broadleaves, whereas excessive fires lead to grassland. Fires have been made worse by the introduction of African pasture grasses. About 80-100 000 ha of forest are lost annually, mainly due to agricultural conversion and unsustainable exploitation. Fires are normally of low intensity, but periods without fire quickly lead to hazardous fuel build-up. In contrast to Guatemala and Nicaragua, lightning is a regular cause of ignition, most abundant in the Mosquitia (northeast).

There has been a long history of fires. There are about 2 300 fires annually, affecting more than a million ha of forest during the last 25 years. The resulting forest degradation impacts on quantity and quality of water (flooding and sedimentation), destruction of infrastructure, desertification and general reduction of living standards. The main areas affected are in the centre and the Mosquitia.

The climatic effects of *El Niño* and Hurricane Mitch (1998) caused severe, widespread damage to forests and land, and led to marked increases in fire occurrence. There is a close relation between fires and landslides, and the problem of the pine bark weevil (*Dendroctonus frontalis*) is widespread.

Fires recorded in Honduras (1980-2002)

Year	No of fires	Total area burned (ha)	Mean area per fire (ha)
1980	3 581	85 000	24
1981	3 555	32 000	9
1982	3 629	84 600	23
1983	3 775	108 400	29
1984	2 374	49 200	21
1985	2 704	33 800	12
1986	2 795	67 600	24
1987	2 398	137 100	57
1988	1 658	52 600	32
1989	2 172	42 000	19
1990	1 648	21 000	13
1991	2 674	70 000	26
1992	1 631	32 600	20
1993	1 463	31 000	21
1994	1 444	98 085	68
1995	1 109	91 000	82
1996	1 145	47 921	42
1997	1 941	183 638	95
1998	2 260	96 623	43
1999	1 820	54 986	0.2
2000	2 279	63 593	28
2001	2 336	82 356	35
2002	1 884	53 485	28
TOTAL	52 275	1 618 587	31
Mean	2 272	70 373	

Fires are mainly started intentionally, primarily by “*incendiaros*” – particularly in the frontier areas - and also as a result of negligence during land clearance for agriculture, to improve pasture, to aid to hunting, and while collecting fuelwood and honey. Small-scale, fragmented land use and shifting agriculture makes fire control difficult. Degradation of soil is a major problem, resulting from poor cultivation techniques, excessive use of fire, and overgrazing. Underlying all these immediate causes is the socio-economic situation of the country, including issues such as distribution and tenure of land suitable for cultivation, lack of credit, poor market information, and poor transport.

Causes of fires in Honduras (1994-2001)

Year	No. of fires	“Incendiaros” ” %”	Pasture %	Agricultural fires	“Caminantes nocturnas”	Others
1994	1 444	57	16	11	4	12
1995	1 109	58	12	8	5	17
1996	1 145	56	12	8	5	19
1997	1 850	54	16	10	4	16
1998	2 260	59	9	9	4	19
1999	1 820	54	13	9	4	20
2000	2 259	53	17	12	5	13
2001	2 336	57	1	12	4	26
TOTAL	14 223	64	14	11	5	20

Planning and management

At the national level, the main institutions involved in the agricultural sector (which includes forestry) are the Secretariat of Natural Resources and the Environment (SERNA); the National Agrarian Institute (INA); the Honduran Institute for Agricultural Marketing (IHMA), the National Bank for Agricultural Development (BANADESA), the Coffee Institute (IHCAFE) and the State Forestry Administration of the Honduras Forest Development Corporation (AFE-COHEDFOR). The activities of these institutions are coordinated by an Agricultural Development Board (CODA), making it ideal for forest fire coordination.

Protected areas and wildlife are the responsibility of the Agriculture and Livestock Board (SAG). SERNA is responsible for policy formulation, and the National Forest Service (SEFONAC) for implementation. AFE-COHEDFOR is perceived by the public to be the only entity concerned with forest conservation, and the main agency responsible for fire prevention and control. There is also the *Comisión Permanente de Contingencias* (COPECO) that coordinates all agencies in case of national disaster, in particular the Armed Forces.

At municipality level, there is the Municipal Development Board (CODEM) and the Community Development Board (CODECO).

The National School of Forest Sciences (ESNACIFOR) has provided training in forest fire prevention and control for many decades, both at national level and within the Central American region.

There are two main sources of finance – the regular budget of AFE-COHEDFOR, and national emergency funds. As with other countries, Honduras needs a financing programme that is sensitive to long-term fire predictions. In general there is a lack of funding sources.

There is a national plan for forest protection. The perception of local communities and forestry cooperatives is that the participation/support of an external agency is necessary. Basic training in fire management is adequate, but despite advances, prevention still needs improvement, as well as large-scale fire control. The use of prescribed fires was introduced several decades ago and has been extensively tried, but practice and knowledge needs to be maintained. Issue of forest permits has been successful. More use needs to be made of fire calendars.

Future proposals

Schindler *et al.* (2002) have made specific recommendations for Honduras:

- A major challenge is to strengthen the institutional framework, linking community-based organizations with national agencies (such as AFE-COHEDFOR and COPECO).
- It is also essential to strengthen the legal framework and improve its application, not only by providing adequate support to officials involved, but also by providing incentives to local people to protect the forest (in the form of forest goods and services), and to collaborate with the authorities.
- Training of fire-brigade leaders in organization, strategic/tactical planning, and command of large-scale fires is essential.

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NICARAGUA

Extent, causes and effects

Nicaragua covers an area of 121 400 km², of which 5.5 million ha are forest, predominantly broadleaved (88%). The remainder is pine forest adapted to fire (the southernmost extension in the region of this forest type). Fire intensity is generally low. However, build up of the fuel load can result in serious fires, and *El Niño* has allowed fires to occur even in broadleaved forest.

Ignition sources are mainly human, and 90% of forest fires result from uncontrolled use, mostly near the boundary with agriculture. Underlying causes include traditional agriculture, social and economic needs, as well as lack of education about forest resource protection. Immediate causes include establishment of settlements, agriculture (to clear land and crop residues), cattle raising (to remove weeds and improve pasture), hunting, honey gathering, pyromania, timber and fuelwood extraction, charcoal-making, road cleaning, negligence by people passing through the forest, and settlement of personal grudges.

The effects of fire have been quite serious. There is a link between poverty distribution and loss of forest cover (i.e. social vs. ecological vulnerability) and fires put at risk the well-being of present and future generations. Over the last ten years, some 5 million ha of forest have been affected. The main impact is on the hydrological cycle, leading to environmental deterioration (e.g. contaminated water). In 1998, as a result of *El Niño*, 7% of the country was affected. An average of 5 764 fires/yr. is estimated to affect cropland and forests, resulting in economic losses calculated at several million US dollars. The incidence of fires from 1998-2002 was reduced by 65%.

Number and extent of fires in Nicaragua (1993-2002)

Year	No. of fires	Agricultural Area affected (ha)	Forest Area affected (ha)	Total (ha)
1993	2 529	140 876	41 102	181 978
1994	2 161	102 031	26 756	128 787
1995	1 511	58 311	24 467	82 778
1996	9 593	150 691	103 777	254 469
1997	9 442	148 320	102 144	250 464
1998	15 196	234 778	161 685	396 463
1999	2 523	39 632	25 227	4 859
2000	4 765	158 511	92 424	250 935
2001	4 654	36 086	24 318	60 405
2002	5 266	38 501	26 146	64 647
TOTAL	57 640	1 107 739	628 047	1 735 787
Av. per year	5 764	110 774	62 804	173 578

Planning and management

Responsibilities are shared between state entities and administrative divisions. The Ministry of the Environment and Natural Resources (MARENA) is responsible for the general environment and setting standards. It has specific responsibility for protected areas, but otherwise shares responsibilities with (among others) the Ministry of Agriculture and Forestry (MAGFOR). The National Forestry Institute (INAFOR) operates under MAGFOR and is responsible for prevention, mitigation and control of forest fires, helped by MARENA for protected areas. There is a National Forestry Commission (CONAFOR) comprised of representatives of some 10 related agencies. In contrast to Guatemala and Honduras, INAFOR has defined 14 forest districts as an intermediate level of organisation. In total there are four operational levels: community, municipality, forest district and national.

There is no national emergency agency (in contrast to Guatemala and Honduras) but under the national plan for the prevention, control and management of fires, INAFOR establishes national/municipality emergency commissions at the beginning of the dry season involving all institutions, with the power to make decisions regarding planning and implementation of fire control and implementation. This level of decentralization and involvement of some 15 institutions has led to some fragmentation of responsibilities concerning fire management, which makes coordination and communication difficult. There are 400 field technicians, but insufficient intermediate staff.

With regard to finance, there are many sources of funds. The most important is the National Fund for Forestry Development (FONADEFO) that is managed by MAGFOR. The financial situation of INAFOR has been a constraint – its funds come from tax on sale of timber and fines, and many forest owners exploit the forest illegally to avoid paying tax, and levy of fines is inefficient.

An Environmental Law and associated regulations cover most aspects concerning fire, but are inefficient, and efforts are being made to rationalize the laws, as well as analysing underlying causes. Current situation is far from what the law intends. An Environmental Action Plan was initiated in 1993, but not enforced due to weak institutions and lack of strategy. More recently a revised national environmental plan for 2001-2005 was established (*Plan Ambiental de Nicaragua - PANIC*). This plan does not guarantee funding.

Although the prevention and control of fires is recognized as one of the most important and wide ranging aspects of forest protection, nevertheless activities have been limited in the past to a few specific projects. Controlled fires are recognized as an efficient tool for management of fuel load, with certain forest species (e.g. pine) requiring fire if they are to be properly managed. However, prescribed fires have not been used widely, although there has been training in standard techniques, and issue of permits and preparation of burning calendars are being used more extensively. There is a need to perfect large-scale prescribed burning in support of cattle-raisers who elect to burn hundreds or thousands of hectares. Sanitary measures of cutting and leaving, as in the case of the pine bark weevil *Dendroctonus*, increase likelihood of damage due to fuel build-up and increased risk of fire.

Fires are detected and monitored by the NOAA satellite system, which allows fire statistics to be made at national level, as a result of two passes of the satellite per day.

A strategic plan for a fire prevention and control campaign has three components:

- Awareness creation and provision of information, using radio spots, leaflets, and formal and informal education.
- Training, carried out at two levels - one for technicians with a certain academic level and another course in practical fire fighting. Approximately 33 courses are carried out each year. Methodology includes interactive lessons, demonstrations, and practical exercises.
- Capacity building of brigades and equipment. There are no permanent fire brigades - volunteers come together at the beginning of the dry season in the areas of greatest risk. There is no specialized equipment to combat fires, and conventional agricultural equipment is mainly used – which has been scarce and lacking in maintenance.

Future proposals

Specific recommendations for Nicaragua given by Schindler *et al.* (2002) are as follows:

- Strengthen the legal framework and application of the law with regard to illegal use of fire.
- Strengthen the linkages between communities and agencies.
- Consolidate responsibilities among government agencies, where there has been fragmentation rather than decentralization.
- Establish and promote a national system for emergency management.
- Develop intermediate levels and reform the financial system of INAFOR.
- Train brigade leaders in organization, tactics, strategies and command of large-scale incidents.

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THE GUATEMALA, HONDURAS, NICARAGUA SUB-REGION

The foregoing notes on Guatemala, Honduras and Nicaragua are based on a sub-regional study carried out by Schindler *et al.* (2002). The authors also draw several important sub-regional conclusions and recommendations, as follows:

Sub-regional conclusions:

- Forest fire prevention and control strategies lack an essential element – how to improve the underlying social conditions that cause public indifference to forest fires, and/or hostility towards forests.

- Statistics only about fires are insufficient – it is necessary to analyse the socio-cultural factors and propose preventative measures, not just to mitigate impact in critical areas, but to remove the causes.
- A lot of information lacks credibility and needs to be verified.
- Forest degradation and destruction by fire is a political problem that requires political decisions.
- Solving the forest fire problem depends on local communities adequately benefiting from the forest (whether state, communal or private).
- The pressure on society has not yet reached a level to force fundamental changes in the use of the forest.
- There is a lack of long-term vision on how to overcome structural weaknesses in the field, transforming public awareness and paving the way for co-responsibility for fire management.
- The concept of fire prevention should be understood as part of human development.
- Access to forest resource is a key issue that requires clarification of the rights of resource users.
- It is very important to apply the principal of subsidiarity in developing an appropriate prevention and control strategy. The process of gradual decentralization must clearly define municipal responsibilities, community rights, and benefits of management.
- The municipality is the ideal focus for promoting participation of communities in democratic management.
- It is essential to develop policies, regulations and supporting legislation in support of participatory approaches.
- Financial insecurity is a constraint to implementing planning and implementation of programmes.
- Consideration should be given to policies that positively encourage conservation and rehabilitation of degraded areas.

Based on these conclusions, the following recommendations were made for the sub-region:

Suggestions for government ministries

These include promoting community participation in co-management; strengthening grass-roots organizations; developing strategies based on social requirements; providing long-term support to successful NGO projects; separating government from implementing agencies; continuing work on land tenure issues; exploring incentives to use fire responsibly; allocating funds based on climate forecasting; and reforming legislation to clarify use of timber from burned areas.

Suggestions for implementing agencies

These include revising educational and prevention programmes for both rural and urban people; strengthening application of the law; revising institutional policies at national level to reflect the value of goods and services protected from fire; and redefining the indicators of success in fire management programmes.

Training proposals

These include training technicians and agricultural extension agents in planning and implementation of prescribed fires, as well as management of large fires; establishing and strengthening national fire-fighter training standards; and promoting training courses for new municipal leaders, making them aware of their rights and responsibilities regarding fire, natural resources, and the agencies involved.

Technical proposals

These include improving the availability and use of daily meteorological data in support of fire-fighters' safety and capacity to carry out prescribed fires; incorporating the best available technology to develop fire calendars; using information available on the internet; and introducing a Fire Danger Rating System is to help control issue of burning permits.

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COSTA RICA

Extent, causes and effects

Costa Rica covers an area of 51 060 km². The forest types are almost all broadleaved. There is no occurrence of the Central America fire-climax pine forest. Many protected areas to conserve biodiversity have been established. Fire and slash-and-burn practices are common, affecting the country's biological diversity and people's livelihoods, especially in rural areas. Officials and private individuals dedicated to protecting, conserving, and developing natural resources, have been concerned about this for some time.

Wildland Fires by Conservation Area in Costa Rica (1998-2004)

Conservation Area	1998 (ha)	1999 (ha)	2000 (ha)	2001 (ha)	2002 (ha)	2003 (ha)	2004 (ha)	mean area (ha)	(%)
Arenal Tempisque	0.00	52.00	205.00	1 046.00	729.50	8 727.75	11 343.99	3 157.75	7.65
Tempisque	35 225.00	6 723.00	12 616.50	29 754.40	32 141.50	9 488.00	9 341.00	19 327.06	46.84
La Amistad Pacífico	203.00	312.00	967.00	4 958.00	3 200.00	33.00	7 528.02	2 457.29	5.95
Guanacaste	6 877.00	2 332.00	15 162.30	10 875.00	7 239.00	4 157.78	3 862.60	7 215.10	17.49
Pacífico Central	3 332.95	909.00	7 518.50	9 755.00	6 587.00	2 735.02	2 810.00	4 806.78	11.65
Arenal Huetar Norte	17 951.00	470.00	427.00	1 115.00	436.00	7 570.00	156.50	4 017.93	9.74
Osa	1 300.00	385.00	0.00	0.00	3.00	0.00	116.00	257.71	0.62
Cordillera Volcánica Central	4.50	8.50	0.00	8.00	1.00	71.00	70.20	23.31	0.06
TOTAL	64 893.45	11 191.50	36 896.30	57 511.40	50 337.00	32 782.55	35 228.31	41 262.93	100.00

Source: MINAE/SINAC (2005)

Wildland Fires by Vegetation Type in Costa Rica (1998-2004)

Vegetation Type	1998 (ha)	1999 (ha)	2000 (ha)	2001 (ha)	2002 (ha)	2003 (ha)	2004 (ha)	mean area (ha)	(%)
Forest	7 818.00	2 003.00	3 500.50	5 741.50	7 375.90	976.27	5 445.01	4 694.31	11.38
Plantation	881.00	158.00	168.30	541.00	311.00	123.00	785.00	423.90	1.03
Tacotal	10 422.50	2 088.00	4 079.00	7 812.00	1 355.50	1 390.50	556.00	3 957.64	9.60
Charral	6 263.00	1 589.50	6 123.50	12 372.00	13 017.50	5 922.25	5 041.25	7 189.86	17.42
Pastos	18 871.25	2 611.00	17 870.00	21 816.80	6 162.30	17 086.91	20 065.90	14 926.31	36.17
Pastos y Charral	12 597.00	2 332.00	360.00	0.00	1 173.00	977.30	493.81	2 561.87	6.21
Yolillal	3 730.00	410.00	28.00	151.00	4.00	1 281.50	97.41	814.56	1.97
Pastos y Typha	0.00	0.00	0.00	0.00	14 027.00	0.00	0.00	2 003.86	4.85
Otros	4 310.70	0.00	4 767.00	9 077.10	6 910.80	5 024.82	2 743.93	4 690.62	11.37
TOTAL	64 893.45	11 191.50	36 896.30	57 511.40	50 337.00	32 782.55	35 228.31	41 262.93	100.00

Source: MINAE/SINAC (2005)

Planning and management

In 1997, Costa Rica initiated a National Fire Management Strategy that provides guidelines for establishing institutional programmes to reduce the number of forest fires and use of fires in agriculture. Supporting legislation states that the prevention and control of fires is a public matter that must be supported by the relevant authorities. The law requires establishment of forest fire brigades and regional commissions, and encourages participation of civil society. The Costa Rican Presidency has set up a National Commission on Forest Fires (CONIFOR), as part of the National System of Conservation Areas (SINAC) of the Ministry of the Environment and Energy (MINA E), and is represented by several national public and private institutions as well as civil society. The Commission is now the forum where participants can develop, discuss, support, coordinate, and follow up implementation of the National Fire Management Plan.

A National Technical Committee (COTENA) comprises managers or coordinators of the Fire Management Plan for each conservation area in the country, and provides technical support for SINAC's decision-making, as well as coordinating the fire reduction efforts of all conservation areas, according to their own plans or programmes. An annual National Fire Management Action Plan ensures that all projects developed by National Commission institutions are integrated and given official backing of the Environment Minister and President.

The fire prevention and control programme has an official mascot called Toño Pizote, a *coatimundi* animal cartoon character that is used as a symbol for national and regional publicity and awareness creation. The International Strategy for Disaster Reduction (ISDR) uses Toño in its current campaign. Children's brigades have been set up to help primary school pupils understand the need for changing attitudes towards fires, and learn about the environment, the effect of fire, and the measures for prevention and control.

SINAC officials are supported by Volunteer Forest Firefighters, which indicate the commitment of civil society to the reduction of fires in forest or on farms. The strategy appears to be working, since the area affected by fires has fallen significantly, helping to conserve, rehabilitate, and restore the forests and its environment.

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PANAMA

Extent, causes and effects

Panama covers an area of 74 430 km². The forest types are varied, some with high biodiversity, since the isthmus forms a bridge with South American flora and fauna. The watershed around the Panama Canal is of critical importance to its functioning. Areas affected by fire include forest plantations, natural forest, clearings and grasslands. The areas with low and medium occurrence of fires are in the north of the country, the west of Panama Province, and in other zones of the interior. The forested areas with most problems lie in the north in Coclé Province, Donoso area, and the west of Panamá Province. These are critical areas for the future enlargement of the Panama Canal.

Causes of fires include: burning for agriculture and pasture; burning of rubbish, recreation activities (barbeques, bonfires, smokers); hunters, fishing, use of explosives, protests against exclusion from protected areas; revenge and vandalism; and changes in soil use.

Number of forest fires in Panama

Year	No. of fires
1996	513
1997	399
1998	2 974
1999	563
Total	4 449

Area affected by forest fires in Panama

Year	Area affected (ha)
2000	2 204
2001	3 344
2002	7 129

Planning and management

The national environmental law of 1998 states that it is the responsibility of the State and civil society to take the necessary measures against disasters and environmental emergencies. To ensure planning, coordination and implementation of such measures by relevant agencies, the National Authority for the Environment (ANAM) was created. In 2000, The Ministry of Economy and Finance established the National Directorate for Natural Patrimony, and within this the National Service for Forest Development and Administration.

The functions of the forest service are to administer the restoration, utilization and improvement for state forest resources, and to draw up and support the implementation of forest fire prevention programmes, in coordination with the competent agencies.

In 1994, the environmental law established state forest legislation that covers forest fires. In the section on forest protection, it was stated that ANAM (at that time IRENARE) should develop means to prevent and control fires, by elaborating a national plan in coordination with relevant agencies. To achieve this, brigades of volunteers to control fire would be created, coordinated by the Fire Service (CBP), the National System for Civil Protection (SINAPROC), and ANAM, supported by the National Police, Red Cross and Civil Aviation. With regard to land clearance and fires, ANAM ensures these are carried out in strict accordance with permits. Fires are strictly prohibited in primary forests.

These agencies are currently constituted as the National Commission for the Prevention, Control and Management of Forest Fires (CONPRECMAIF), whose general objectives are to make available an inter-institutional arrangement for consultation, advice and coordination to prevent, control and manage forest fires. Specific objectives are to reduce the number of fires caused by people; to control and extinguish fires as soon as possible; and to understand the underlying causes of fires.

CONPRECMAIF's functions are to:

- promote the development of inter-institutional programmes that strengthen forest fire prevention campaigns;
- establish means of coordination to join forces in the search for human, financial and material resources required;
- strengthen activities that allow the participation, organization and training of civil society;
- promote and manage the development of training courses on fire for all level;
- control forest fires;
- plan and implement restoration programmes;
- handle infringements of the law;
- contribute to the monitoring of area most at risk from fire;
- channel international help in support of the strategies and annual fire action plans;
- establish fire brigades with staff and volunteers, providing them with training.

The Operational Plan against forest fires is concerned with: communication, raising alarm and extinction of fires; investigation of causes, evaluation of damage, and recuperation of damaged area; and management of public information and forestry statistics system.

Data have been obtained using NOAA/AVHRR satellites with receivers installed in the Ministry of Natural Resources in Managua, Nicaragua.

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