



Fire Situation in Brazil

Fire environment, fire regimes and the ecological role of fire

As the ecosystems of Brazil vary from north to south, so, too, is there a great diversity of fire behaviour conditions as one moves from the tropical rain forest, to the caatinga in the northeast, to the cerrado, or savanna in the central part of the country, to the Mata Atlantica, or temperate rain forests along the coast in the east, to the forests of the south. The fire management system that evolves for Brazil must take into consideration the significant differences associated with these major ecosystems. There is a lot known about the fire relationships of the cerrado, less known about fire and the rain forest and even less knowledge available regarding the other ecosystems. The following discussion of fire in the cerrado has been adapted from Coutinho's (1982) paper on the "Ecological Effects of Fire in Brazilian Cerrado".

Cerrado. The cerrado is a complex of plant formations formed by grasslands, intermediate savanna and dry forests. The core zone of distribution of the cerrado is centred on the great plateau of central Brazil, covering 1,500,000 square kilometres. If the peripheral areas to the core zone are included, the total area for this vegetation complex may reach approximately 1,800,000 square kilometres. This enormous area covered with cerrado is a mosaic of different types determined primarily by the pattern and intensity of the fires and the soil types.

Fire is considered to be an important ecological factor in cerrado ecosystems. Charcoal fragments found in the soil of cerrado around Brasilia were carbon dated as being 1600 years old. Thus, fire was already present in this area at least 1200 years before the arrival of the Portuguese discoverers. Anthropological research has shown that people have inhabited central Brazil for more than 10,000 years. Indians undoubtedly used fire for many purposes at the time of colonization. The Caiapos Indians from central Brazil believed that fire was given to them in primeval eras by Bebgororoti, a mythological creature, who brought fire down from the sky during a violent storm. Although Coutinho stated that there are no known scientific records of natural fires in cerrado, others have reported lightning fires in places like Emas National Park. It has been estimated that each area of cerrado in long-settled regions is burned once every two years. This usually occurs during the colder and drier months of May to September. The greatest incidence of fire occurs during July and August. Fires can be widespread during these months throughout the cerrado. In 1991, for example, a prolonged drought contributed to the reported burning of one percent of the state of Mato Grosso. In 1994, 70 percent of Brasilia National Park burned, all of Emas National Park burned and all of the 562,000 hectares of Araguaia National Park burned. Araguaia National Park is located on Ilha Bananal in Tocantins State, the largest fluvial island in the world. All of this island burned as well in 1994. All of these areas are located in the cerrado. Such fires can impair ground and air transportation and cause many problems for people with respiratory diseases.

Tropical rain forest. Although the rain forest is generally believed to have little incidence of fire due to the moist environment, there is evidence that fires can occur under the right conditions. These fires are most often related to human activities, since tropical thunderstorms are accompanied by heavy rains that preclude the ignition of fires by lightning most of the time.

The abundance of charcoal of mid- to late-Holocene origin commonly found in rain forest soils of the upper Rio Negro in Venezuela indicates that fire has been a disturbance factor for a long time (Sanford and others 1985). The Rio Negro study concluded that episodes of fire disturbance have modified the forest during the mid- to late-Holocene, perhaps as a result of different climatic circumstances, perhaps as a result of human intervention alone, or possibly as a result of the interaction of human disturbance and climate.

Burning in the Amazon region today is primarily associated with the clearing of forests for agriculture, pastures, logging and other purposes. Fearnside (1990) reported that by 1988 approximately 400,000 square kilometres, or 8 percent of the Amazon region, had been cleared and the cleared area was increasing at about 35,000 square kilometres annually. In the Amazon region, most of the deforested areas are maintained in cattle pasture. The large ranchers account for about 75 percent of the clearing for pastures and small farmers account for the rest. Fearnside (1990) reported that pasture burns are done every 2-3 years in cattle pastures that are being maintained

for grazing. Uhl and Buschbacher (1985) have described the increased probability of fire spreading from cattle pastures into surrounding forests where selective logging has occurred.

Amazonian fires have been classified into three major types (Nepstad *et al* 1998):

- **"Deforestation fires"** are associated with forests that are burned following clearcutting to prepare the land for pastures, agriculture, or plantations.
- **"Forest surface fires"** occur when fires escape into standing primary or logged forests, burning surface fuels on the forest floor.
- **"Fires on deforested land"** refers to fires burning in pastures, secondary forests and other vegetation on lands that had once been forested.

Fires can be further divided into those fires ignited intentionally for pasture and land management purposes and those fires that accidentally escape into adjacent areas.

Of the three types of fires in the Amazon, the fires associated with deforestation have the greatest ecological impacts because they lead to the rapid replacement of rain forest species by more fire prone vegetation (Nepstad *et al.* 1998). This is a serious feedback cycle in which the flammability of Amazon vegetation increases over time.

Although the environment of the natural rain forest is not conducive to the ignition and propagation of fires, once the forest has been cut and allowed to dry for several weeks its flammability is greatly increased. Consumption rates of the biomass vary based on conditions at the time of burning. The 1982-1983 fires in East Kalimantan in Borneo demonstrated how serious fires can occur in tropical forests following severe drought and disturbance. Repeated burning in the Amazon region can lead to the dominance of the vegetation by fire resistant palm species and grass.

Forests of the Northeast. Ecosystems of the Caatinga Region and deciduous forests of the northeast are found in a hot, dry and thorny landscape (Ministry of Environment 1996). Temperatures here are very elevated, relative humidities are low and the climate is especially arid. Ecosystems of this region occupy an area of 939,391 square kilometres. Degradation of the natural vegetation has occurred primarily due to exploitation of forests for wood, conversions of vegetation to cattle pastures and the effects of fires.

The Atlantic Forest (Mata Atlantica). Although this ecosystem is also a rain forest, it is not an extension of the Amazon Forest but an entirely different plant formation (UNDP 1993). It contains an exceptional biological diversity. At the time of Brazil's discovery, the Atlantic Forest had an area of 1.5 million square kilometers which extended almost continuously along the Brazilian coastline. Due to its closeness to population centers with their demand for wood, presently there is only 10 percent left of its original extent. The remaining forest is highly fragmented and contains many threatened species of plants and animals. The Atlantic Forest is quite susceptible to fire and current policy calls for its direct protection from fire.

Forests of the South. The ecosystems of the pine forest region cover an area of 220,363 square kilometers (Ministry of Environment 1996). Elevations here are generally greater than 500 meters and it has a temperate climate without a pronounced dry season. This is the area of the Parana pine, a species with high economic and landscape values. The remaining native vegetation represents only 23 percent of the total area. Use of the land in this area is largely dedicated to agriculture.

In the extreme south of Brazil, south of the pine forest region, is an area of about 203,875 square kilometers that consisted in the past of seasonal forests. About 50 percent of the area is still covered by some form of native vegetation. Grassy areas, shrubs and planted forests are also found here.

Narrative summary of major wildfire impacts on people, property and natural resources that occurred historically

Wildfires in Brazil's diverse ecosystems have produced many adverse effects for all segments of society:

- Atmospheric pollution.
- Smoke effects on public health in critical areas.
- Disruption of air and ground transportation services by smoke, affecting private citizens, commercial and civil aviation and the Ministry of the Air Force.
- Potential contributions to global climate change through the production of "greenhouse gases".

- Reduction in water quality.
- Disruption of electric power transmission.
- Threats to life and property.
- Loss of biological diversity.
- Threats to commercial plantations of trees.

Narrative summary of major wildfire impacts on people, property and natural resources during the 1990s

Economic losses due to accidental fires, in some areas of the Arc, reached about R\$ 200.00/year to small owners, R\$ 500.00/year to middle ones and R\$ 9,000.00/year to big farmers. As far as public health is concerned it is estimated that the number of people hospitalized with breathing problems increases up to 3.2 percent during the burning period in Amazonia when it is compared to other months. This in turn causes troubles to the population and increases the expenditure in the health sector.

Forest fires have led to interruptions in the electrical energy supply. For example, in 1995, in the area of ELETRONORTE forty-seven interruptions took place that caused great losses to this company since the average value of each one is R\$ 43,360.00. These disruptions in energy supply also impose heavy losses to society as a whole. These fires produced a great quantity of smoke and caused huge problems to air traffic, even leading to the closure of airports during critical periods. For instance, in the late 1990s airports in Rio Branco, Porto Velho, Conceição do Araguaia, Carajás, Marabá and Imperatriz were closed for a total of 420 hours. This caused a total loss of about R\$ 3.15 million during the period. In addition to these monetary losses, there is a biodiversity loss as well.

The wildfires in the State of Roraima in 1998 can be used as an example of some of the fire management responses that would benefit from improvements in the future (Mutch, R. W. et al 1999). Bombeiros and others also called attention to the following issues that impeded a more successful response to the fires in Roraima:

1. Outside resources were not mobilized quickly enough to the fires to arrive early and keep the fires small. Many fires were burning in January, February and early March with only one Captain and 10 firefighters from Roraima available for fire suppression! The situation was overwhelming by the time bombeiros arrived from other States. Bombeiros worked hard under these difficult circumstances, but it was the arrival of rain later in March that kept the situation from becoming much worse.
2. There was not an integrated communication system on the fires, allowing all of the different organizations to talk to each other with a single radio with multiple channels to cover all frequencies. Each organization had its own internal communication system, but not a common system with each other. Also, there was not an effective communication link between the Area Command Center in Boa Vista and the field Command Centers.
3. Bombeiros did not have the right type of equipment for rain forest conditions; and there was not enough equipment.
4. There were not enough firefighters to be successful under the prevailing conditions in Roraima. There were maybe 700-1000 people engaged in the firefighting operations. Estimates ranged in the neighborhood of 10,000 or more firefighters needed by the time people showed up in mid-March. A smaller number of trained and well-equipped firefighters arriving in January and February could have greatly reduced the severity of the impacts and the costs.
5. Many more firefighters need to receive wildland fire training prior to the fire season, including bombeiros in the Amazon region whose training is more geared to structural firefighting. Volunteer brigades at the local level also need to be equipped and trained to serve as first responders to fire emergencies.
6. Air support was not continuously available to meet the needs of firefighters on the ground. The military diverted helicopters to missions other than the support of firefighters.
7. Farmers kept burning even during the burning ban when the fire danger was so high. It took the threat of arrest to convince the farmers to stop burning. (Note: The Yanomani tribe, on the other hand, said they would not burn until told by the bombeiros that it was okay to burn again).
8. The Command Center in Boa Vista tried to produce daily plans, but the planning process was more on the order of reporting what had occurred rather than directing priorities for future operations to guide field commanders. More experience and training in the ICS process would help to overcome this shortcoming. People should fill the ICS positions within Command Centers based on knowledge of firefighting operations and not on military rank.

9. There was not a process in place for the daily evaluation of the performance of firefighters on the various fires. Evaluations should be conducted to ensure that firefighters are meeting incident objectives.

These lessons learned from Roraima in Brazil are somewhat indicative of strengths and problems experienced on the fires in Mexico and Central America. Public policies should be developed to build on the strengths of the Roraima response and minimize the negative features. Of course, policies that serve as incentives for the local people to invest more in fire prevention and sustainable land use practices are critically important as well.

Fire management organization

The numerous adverse effects of uncontrolled fires led to the creation of PREVFOGO (A National System for Wildland Fire Prevention and Suppression) through the Federal Government's Law Decree No. 97,635, dated April 10, 1989. In a Document signed by IBAMA President Tania Munhoz in November 1990 the objective for PREVFOGO was defined as:

"...systematizing, in an integrated and objective way, the interesting information, including the prioritization of affected areas, the ways of identification of fire and burning focuses in real time, the material and human resources to be mobilized and the integrated communication system. It also envisions the implementation of an appropriate prevention programme, thus guaranteeing the effective reduction of forest fires and burnings in Brazil and their consequences; and disciplining the use of fire through controlled burning based on appropriate technical and scientific knowledge."

What this objective calls for is the development of a systematic fire protection programme for Brazil with all of the essential elements in place to provide future benefits to the diverse sectors of society. Achieving this important goal is a difficult and challenging task, but it is a task that must be accomplished with skill, motivation and continuity of effort. The antithesis of this goal is surely something that no one wants. As Jose de Paiva Netto stated, "the destruction of nature is the extinction of the human race."

The PREVFOGO strategy to produce a systematic programme of fire protection was designed around a network that included:

- A National Center at IBAMA headquarters in Brasilia. The National Center would work in an integrated manner with all public and private organizations involved with firefighting and controlled fires.
- State Centers located at the State Superintendencies of IBAMA or other agencies through agreements. The State Centers would be responsible for implementing fire policies and implementing fire programmes for the States. The effective firefighting actions in the States would be assigned to the Fire Departments, who would be provided with the resources needed to purchase appropriate equipment. Firefighting personnel also would be provided by IBAMA staff and trained volunteer brigades.
- Regional and Municipal Centers would be responsible for firefighting and executive actions in cooperation with the Bombeiros and existing forestry companies in their respective areas.

PREVFOGO is concentrating on five priority areas (Cornacchia and Pedreira 1998):

- Administer rural extension and education programmes with the farmers to reduce the number of wildfires that arise from agricultural burning.
- Develop fire management plans for IBAMA's Conservation Units to use suppression and prescribed fire to minimize adverse impacts on ecosystems.
- Monitor "hot spots" by satellite to provide information on problem areas.
- Provide training in fire prevention and firefighting, aerial firefighting methods for pilots and fire cause determination
- Prepare brigades to carry out actions to prevent and fight wildfires in Conservation Units; and work with enforcement authorities to ensure that regulations are being met.

Individual states in Brazil also have developed plans for the protection of forests from fire (Government of Parana State 1998; Cavalcanti 1998).

PREVFOGO is located within IBAMA's Directorate of Control and Supervision.

Use of prescribed fire to achieve resource management objectives

Prescribed burning is an agricultural or forestry practice that uses controlled fire in order to initiate agricultural activities, or to manage fire-adapted ecosystems. The burning must be done using controlled fire within the natural or planted vegetation under prescribed environmental conditions that allow the fire to be kept within a restricted area, with heat intensity and fire spread that meet management objectives. The burning must be authorized by IBAMA, or by the responsible state agency; and training on proper burning methods is being provided to farmers in the Amazon through PROARCO.

Public policies affecting wildfires and fire management

The Roraima fires underscored the growing realization that forests in the Amazon were becoming increasingly vulnerable to fires in drought years. Fire risk was especially acute in the "Arc of Deforestation" in the southern Amazon where timber harvest, agriculture and other land management practices have greatly increased the flammability of vegetation. This continuous arc is about 3000 kilometers long and 600 kilometers wide. The response of the government of Brazil to this problem was to request a loan from The World Bank in support of a project called PROARCO, a program for the prevention and control of burning and forest fires in the Deforestation Arc. Planning for the project began in the spring of 1998 and The World Bank approved a loan for US\$ 15 million on September 10, 1998, to prevent and control large-scale wildfires in the southern part of the Brazilian Amazon. The programme is jointly administered by IBAMA, the Brazilian Government's official Environment Agency and the Ministry for the Environment, Water Resources and the Amazon Region.

PROARCO was designed around the following components (Ministry for the Environment and IBAMA 1998):

- Monitoring agricultural burning and forest fires (including the monitoring of fire risk).
- Enforcing regulations regarding the use of fire in land management.
- Preventing forest fires (including the training of farmers to burn using appropriate precautions and safeguards).
- Combating of forest fires.
- Establishing a strategic task force (providing overall coordination).

Benefits of the PROARCO effort could include a reduced occurrence of large scale, damaging fires through fire prevention and fire suppression; more sustainable land use practices; improved partnerships among federal, state, municipal and non-governmental organizations and agencies; de-centralization of actions to the local level; and better protection of the Amazon rain forest.

Sustainable land use practices used to reduce wildfire hazards and wildfire risks

Brazil has a structure to organize sustainable forest management practices that are fundamental in supplying the internal and external markets for natural resources. In this regard, a public network is being organized under a concession system, effective administration system and a monitoring system. Brazil also has established a network of preserved areas to assure the perpetuation of biodiversity as well as assure their use by traditional peoples. In these areas it is possible to start a program of sustainable eco-tourism which will attract people to the Amazon and other areas who can learn more about the importance of the conservation of nature.

Since agricultural practices of fire use in tropical countries can degrade forest resources over time, there is a compelling need to enlist the small farmer as part of the solution in developing a conservation ethic. Some countries have used incentives effectively in this regard to gain the commitment of farmers towards more sustainable land use methods. Efforts to change the model of natural resource uses from their current extensive exploitation in the Amazon to a more sustainable model will require the better integration of public policies aimed at promoting economic development and settlement with those designed to conserve natural resources (Nepstad et al.1998). The authors called for policies that provide for increased agricultural productivity on deforested lands while at the same time providing disincentives for reckless uses of forested lands.

Finally, Brazil invests in a major forest vigilance system known as SIVAM. SIVAM will be a fundamental tool to obtain information on the region and actually monitor logging and illegal deforestation. It will allow real time observation and monitoring in order to properly take care of the forests.

Community involvement in fire management activities

The main response to improve fire prevention efforts should come from society, particularly from rural areas. Training farmers in more careful fire use can result in better protection for individual farms and neighbouring farms. PROARCO is providing leadership in the Amazon to provide such training to improve the use of fire in agriculture; and reduce the negative fire impacts on agricultural lands and on natural resources.

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