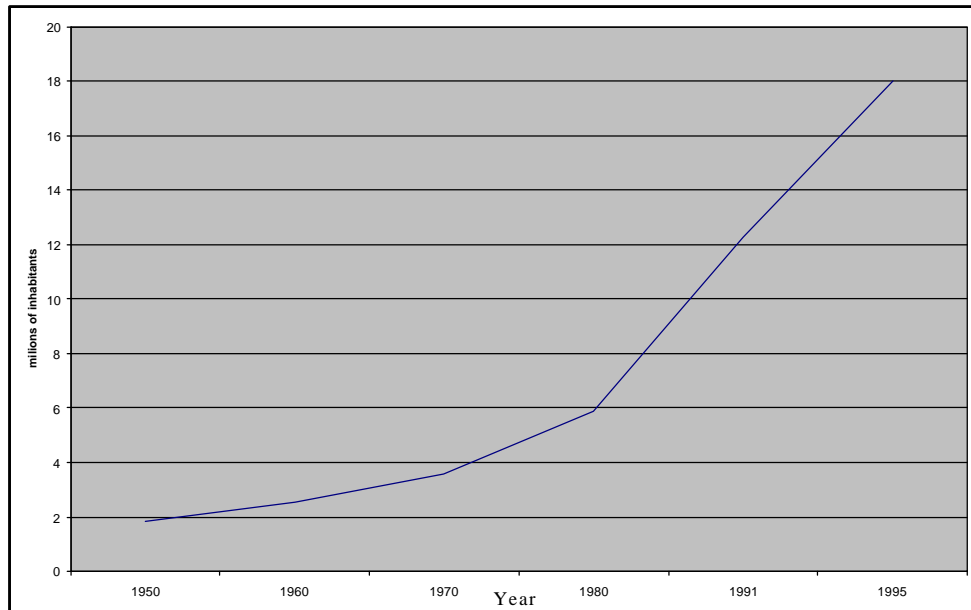


and control in situ. Although considerable progress has been made at the institutional and administrative level, the official Brazilian capacity for effective control are still far from adequate. The following single figure demonstrates this: the total number of IBAMA employees for inspection and control in the field is 1,263. For the entire Amazon the number is only 280, although forestry police complement the actions of IBAMA in this respect.



**Figure 2-12.** Population growth in the north of Brazil, 1950-1996.

**Source:** IBGE (1997).

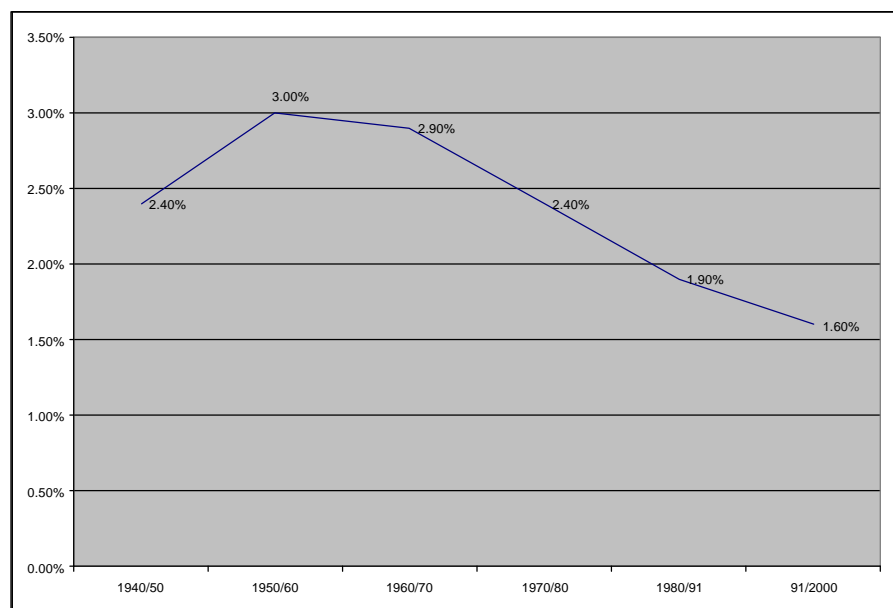
This situation has led the Federal Government to take certain steps. Due to the increase in the rate of Amazon deforestation in 1990/91 and 1992/94, a Presidential Provisional Measure (Medida Provisória) was issued, designating 80%, instead of 50%, as the obligatory portion of each property in which the forest must be maintained intact as a Legal Forest Reserve. This Provisional Measure also suspended the renewal of authorisations to cut two of the most exploited timber trees, mahogany and virola, and determined a review of all the current logging licences.

for areas of Legal Forest Reserves and Areas of Permanent Preservation (steep slopes, springs, gallery forest, etc., the preservation of which is already determined by law), as well as other areas which the State may declare as of interest for preservation.

In various states, the Government has obliged landowners to officially register their Areas of Permanent Preservation to guarantee their permanence, especially in the case of sale or the division of the property.

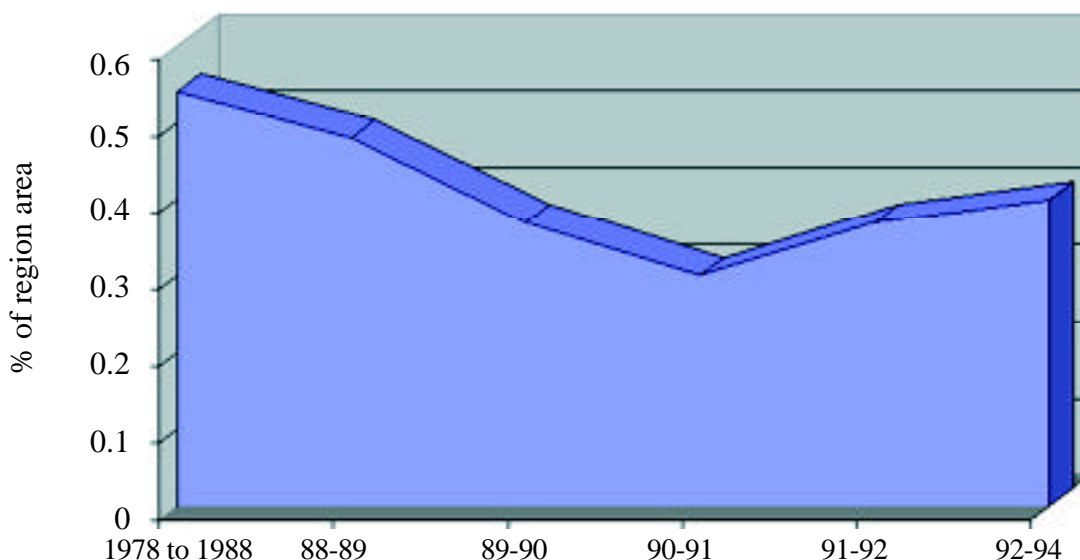
Another step taken to try to slow deforestation and promote sustainable management practices was the introduction of the so-called 'Green Protocol' (Protocolo Verde) programme. This programme benefits public or private financing agencies which make resources available only to the agricultural, cattle-ranching and forestry businesses which attend to the requirements of the maintenance of the Legal Forest Reserve (or which guarantee to meet them within the space of 30 years, as determined by Agricultural Policy Law).

A third measure promoting the conservation of biodiversity involved a change in the rural land tax (Imposto Territorial Rural - ITR) laws, which introduced exemption



**Figure 2-13.** Population growth rates - Brazil 1940-2000.

**Source:** IBGE (1977).



**Figure 2-14.** Changes in annual average deforestation rates in the Brazilian Amazon region.  
**Source:** MMA (1997).

A major advance will be made with the implementation of a monitoring and information system in Amazonia (Sistema de Informação e Vigilância da Amazônia- SIVAM), already approved in National Congress and contracted by the Executive. It involves funding of about US\$1,435 million which will be applied to data collection (US\$625 million), data processing (US\$151 million), telecommunications (US\$104 million), logistics (US\$228 million), integration and complementary services (US\$170 million), support to air traffic control (US\$7 million), and civil construction (US\$150 million).

In collaboration with the Army, the Air Force and the Federal Police, IBAMA carried out a major operation in the Amazon, 'Operation Macauá', during the drought in 1997, which resulted in the seizure of 533,000 m<sup>3</sup> of illegally logged timber. A similar operation is carried out every year during the dry season.

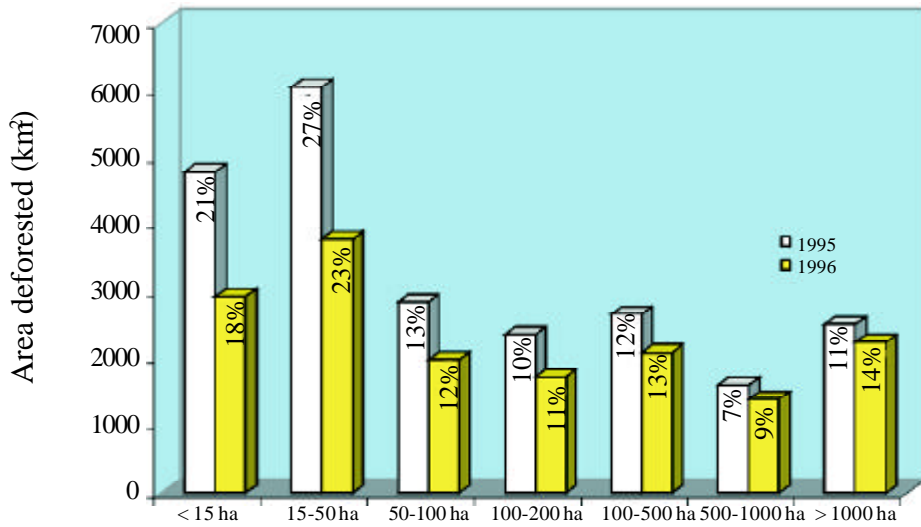
One of the means defined by IBAMA to rationalise and regulate the exploitation of timber resources is a project for opening-up concessions for logging and sustainable management in the National Forests (Projeto de Manejo Sustentável de Florestas Nacionais). There are currently 31 National Forests (FLONAs) in northern Brazil, covering an area of 16 million ha. This project also makes provision for an increase in the number of National Forests to cover 30 million ha. This would allow for the sustainable exploitation of 1.3

million ha/year, sufficient to meet demand for the next 20 years, besides allowing for the recovery of forests.

This project has achieved financial support from the International Tropical Timber Organization - ITTO, but has met with opposition from environmental sectors. The first published bidding, for an area of 5,000 ha of the 685,000 ha Tapajós National Forest, was suspended by the Federal Court of Pará and was later cancelled by IBAMA. A new public tender is being published to overcome the obstacles encountered in the first. Public tenders are also planned for the National Forests of Jamarí and Bom Futuro, both in Rondônia.

At present, Brazil contributes only 8.05% to the world trade in timber. With the depletion of forests in South-east Asia, however, international trade in tropical timber will tend to intensify in Brazil. This is already evidenced by the establishment in recent years of Asian Timber Company consortia in the Amazon.

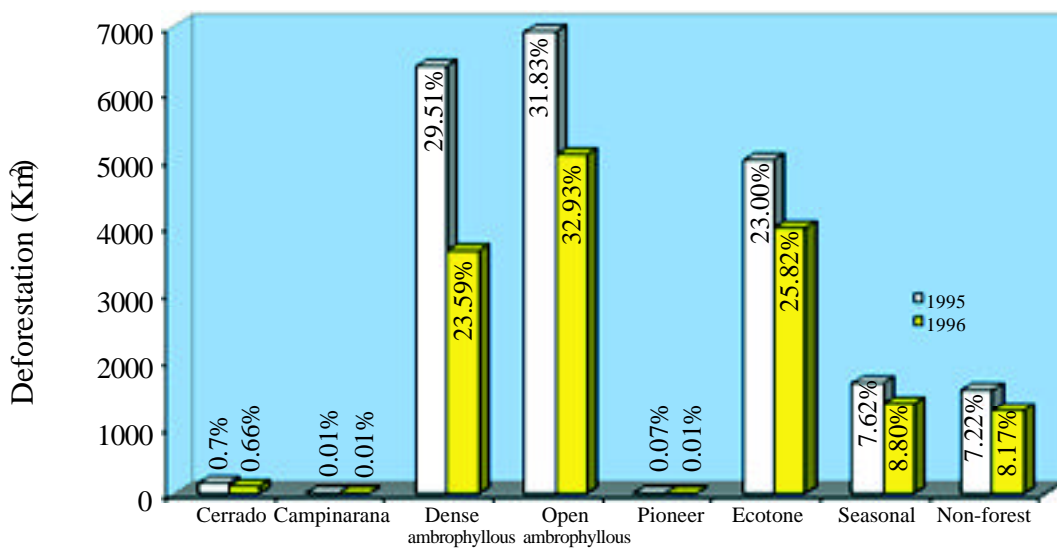
The Brazilian Government also hopes to make major changes in the direction of Amazonian development, based on a series of studies carried as part of the 'Environmental Diagnosis of the Amazon Region' (*Diagnóstico Ambiental da Amazônia*), carried out by the Brazilian Institute of Geography and Statistics (Fundação Instituto Brasileiro de



**Figure 2-15.** Deforested areas of different size classes in 1995 and 1996.  
**Sources:** INPE-IBAMA (1995-1997), MCT/INPE, MMA/IBAMA (1997).

Geografia e Estatística - IBGE) from 1991 to 1995, which resulted in the definition of 13 different biogeographic systems in the area, along with the 'Ecological and Economic Diagnosis' (*Diagnóstico Ecológico-Econômico*) carried out by the Secretariat for Strategic Affairs (Secretaria de Assuntos Estratégicos - SAE) of the Presidency of the Republic, over 2½ years. The latter report includes:

- A survey of the natural and social conditions of the region;
- A thematic analysis of ecological aspects, spatial organization and institutional policies;
- A report on environmental quality, combining all aspects.



**Figure 2-16.** Annual total deforestation of different forest types.  
**Sources:** INPE-IBAMA (1995-1997); MCT/INPE, MMA/IBAMA (1997).

This survey also resulted in the production of maps of the soils, geology, topography, climate, vegetation and water resources, on a scale of 1:2.500.000.

The final report of this diagnosis shows the progressive transfiguration of the landscape, with the formation of degraded areas especially at the interface of the Cerrado and the Amazon forest. It reinforces the view that land use systems which result in significant changes in the natural ecosystems are unsustainable.

Based on this survey, the Secretariat for Strategic Affairs - SAE has developed a model in which corridors for development in the most suitable areas alternate with corridors for conservation. One of the development strips already defined is a waterway along the Rio Madeira, a southern tributary of the Amazon, for the transport of grain produced in the north-west of Brazil. Another project is a transport corridor along the Rio das Mortes and the Rios Araguaia and Tocantins which, supplemented by road and rail systems, will terminate at Porto da Madeira in the state of Maranhão. This project, however, is still subject to an environmental impact study. A non governmental organization for indigenous interests has obtained a court ruling which has suspended the part of the project along the Rio das Mortes. Implementation of a third waterway, the Rio Teles Pires/ Tapajós, has also been suspended by the Federal Court of the state of Pará, also due to indigenous questions. The SAE model also includes the construction and paving of highways.

## 2.2.4 Monitoring Forest Fires

Fires occurring during the dry season (June to October) have been monitored daily by satellites NOAA 12 and 14 since 1987. This work is carried out by the National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais - INPE) of the Ministry of Science and Technology - MCT, in collaboration with IBAMA as part of the National System for the Prevention and Control of Forest Fires (Sistema Nacional de Prevenção e Controle aos Incêndios Florestais - PREVFOGO). Digital mapping of the data is carried out weekly by the Nucleus for Satellite Monitoring of the Environment and Natural Resources (Núcleo de Monitoramento Ambiental e de Recursos Naturais) of EMBRAPA. Analysis and spatial interpretation is done by ECOFORÇA and the results published by the newspaper *O Estado de São Paulo*. The satellite detects heat spots on the land surface with a resolution of approximately 1 km x 1 km. It

**Table 2-17.** The area (km<sup>2</sup>) occupied by human populations, and the extent of the remaining natural vegetation in the North-East of Brazil in 1990.

States	Total area	Area occupied 1990		Area of remaining vegetation 1990	
Alagoas	27,731	22,462	81.0	5,269	19.0
Bahia	561,026	294,370	52.5	266,656	47.5
Ceará	148,016	124,333	84.0	23,683	16.0
Maranhão	328,663	136,460	41.5	192,203	58.5
Paraíba	56,372	37,769	67.0	18,603	33.0
Pernambuco	98,281	51,106	52.0	47,175	48.0
Piauí	250,934	109,116	43.5	141,818	56.5
Rio Grande do Norte	53,015	30,059	56.7	22,956	43.3
Sergipe	21,994	13,636	62.0	8,358	38.0
In litigation PI/CE <sup>1</sup>	2,640	1,396	52.9	1,244	47.1
<b>Total</b>	<b>1,548,672</b>	<b>545,754</b>	<b>35.2</b>	<b>1,002,915</b>	<b>64.8</b>
<b>Annual average</b>		<b>39,28</b>	<b>0.0025</b>		

<sup>1</sup> PI = Piauí; CE = Ceará.

**Source:** Modified from Brazil, Presidency of the Republic, Inter-ministerial Commission for the Preparation of the United Nations Conference on Environment and Development. *O Desafio do Desenvolvimento Sustentável*. Brazilian Report to the United Nations Conference on Environment and Development (the Rio "Earth Summit.") Brasília: CIMA (1991).

is the world's biggest programme for remote monitoring of forest fires (Figure 2-17a-g).

For many years INPE used only the images from the satellite NOAA 14 (which passes over Brazil in the early afternoon) in order to monitor forest fires in the country. As of mid-August 1995, however, INPE started using NOAA 12 (which passes over in the evening) for the months August to November. According to EMBRAPA's Nucleus for Satellite Monitoring of the Environment and Natural Resources, this is because of problems of solar reflection which prevent the use of NOAA 14 images for the Amazon in this period. In other words, the use of NOAA 14 images from August to November could lead to overestimation in the number the fires counted.

The number of fires counted, using only NOAA 14 images, increased from 1992 to 1993, going from 290,446 in 1992 to 314,491 in 1993. In 1994 the number apparently dropped to 117,190, but this may also have been the result of the use of both NOAA 12 images as of mid August in that year (Tables 2-22). Caution should, therefore, be exercised when comparing the data before and after 1994. For 1995, however, NOAA 14 images up to the second week of August indicated 118,854 forest fires. Images from NOAA 12 as from mid August of that indicated 35,215. This gives a total of 151,069 heat spots for the year, an increase from the 1994 count.

The basis for comparison changed once again in 1996. Data from NOAA 14 images were analysed only for the months of June and July, when 58,601 fires were identified.

From August to November (inclusive), the data from NOAA 12 images identified 35,765 fires. Corresponding figures for 1997 were 36,314 and 56,403 (Table 2-22).

In summary, these data indicate the following:

- Data from NOAA 14 which allow for comparison of the period for June/July in 1995, 1996 and 1997, show an increase from 1995 (49,049 fires) to 1996 (58,601 fires), and a 38% decrease from 1996 to 1997 (36,314 fires);
- Data from NOAA 12 for the period mid-August to the end of November show little change from 1995 (35,215 fires) to 1996 (35,765 fires) and an increase of 54% from 1996 to 1997 (56,403 fires);
- Data from NOAA 12 in 1997 show a progressive increase each month during the year, but especially in September, October (the number fires nearly tripled), and November (an increase of 156%).

IBAMA is also developing a system for fire-detection, in collaboration with the United States Forestry Service - USDA/FS, using new air-transported thermal sensors.

A major project, 'The Large Scale Biosphere/Atmosphere Experiment in Amazonia - LBA' is being implemented in partnership with NASA. Conceived by INPE between 1992 and 1995, this project requires funding of US\$120 million, of which NASA is participating with US\$ 40 million. The project will study ecological, biogeochemical and hydrological aspects of the basin. When completed in 2003, the project will allow for the assessment of the effects that changes in the tropical forest have on the climate, both in Brazil and globally. At its present stage, the project is recruiting researchers and setting up a monitoring network. Climatological and hydrological studies will begin in 1998. Research in atmospheric chemistry will be initiated in 1999, and satellite monitors will be launched in 2000.

## 2.2.5 Combating Fires

In view of the disturbing facts shown up by satellite monitoring as of 1987, the National Commission for Prevention and Combat of Forest Fires (Comissão Nacional de Prevenção e Combate aos Incêndios Florestais - CONACIF) was established in August 1988 (IBDF Edict No.

**Table 2-18.** Absolute and relative values of the original and remaining areas (ha) of the Atlantic Forest in Brazil

State	Area of original forest	Remaining forest			
		1990		1995	
		Area	%	Area	%
AL	1,515,959 <sup>2</sup>	87,747 <sup>3</sup>	5.79	n/a	n/a
BA	8,540,086 <sup>1</sup>	1,267,478 <sup>1</sup>	14.84	n/a	n/a
ES	4,533,881 <sup>1</sup>	409,741 <sup>1</sup>	9.16	387,313	8.65
GO	1,424,522 <sup>1</sup>	7,119 <sup>1</sup>	0.23	6,471	0.21
MS	4,629,831 <sup>1</sup>	43,752 <sup>1</sup>	2.37	39,555	2.15
MG	20,838,778 <sup>1</sup>	1,214,059 <sup>1</sup>	4.50	1,125,108	4.19
PB	952,337 <sup>2</sup>	58,392 <sup>3</sup>	6.13	n/a	n/a
PR	19,285,419 <sup>1</sup>	1,185,137 <sup>1</sup>	9.47	1,730,528	8.90
PE	1,806,911 <sup>2</sup>	152,430 <sup>3</sup>	8.44	n/a	n/a
RN	259,003 <sup>2</sup>	63,965 <sup>3</sup>	24.70	n/a	n/a
RJ	4,320,496 <sup>1</sup>	1,069,230 <sup>1</sup>	25.01	928,858	21.85
RS	9,147,061 <sup>1</sup>	535,255 <sup>1</sup>	3.32	506,462	3.16
SC	8,152,273 <sup>1</sup>	1,729,160 <sup>1</sup>	18.57	1,666,241	18.46
SP	19,135,066 <sup>1</sup>	1,858,959 <sup>1</sup>	7.82	1,791,559	7.50
SE	1,196,015 <sup>2</sup>	4,200 <sup>3</sup>	0.35	n/a	n/a
<b>Total</b>	<b>105,531,636</b>	<b>10,682,412</b>		<b>8,182,095</b>	
<b>Average</b>			<b>9.38</b>		<b>9.02</b>

**Obs:** State names are in Figure 1-1.

n/a = data not available.

Sources:

<sup>1</sup> Fundação SOS Mata Atlântica, Instituto Nacional de Pesquisas Espaciais (1998). *Evolução dos Remanescentes Florestais e Ecossistemas Associados do Domínio da Mata Atlântica no Período 1990-1995*. Report. Sao Paulo (1998).

<sup>2</sup> Fundação Instituto Brasileiro de Geografia e Estatística - IBGE. *Mapa da Vegetação do Brasil*, scale of 1:5,000,000, 2<sup>nd</sup> edition. Rio de Janeiro (1993). (Data calculated from a map in digital format, using a system of geographic information).

<sup>3</sup> Conservation International, Fundação Biodiversitas, Sociedade Nordestina de Ecologia. *Áreas Prioritárias para Conservação da Diversidade Biológica da Mata Atlântica do Nordeste*. Campinas: Base de Dados Tropical - BDT (1995).

0254/88-P, 28th August 1988). It was the first national organization to be set up specifically to deal with the problem of forest and man-made fires.

Following an initial recommendation by CONACIF, in April 1989 the Federal Government established a National System for the Prevention and Combat of Forest Fires (Sistema Nacional de Prevenção e Combate aos Incêndios Florestais - PREVFOGO) (Decree No. 97.635, 10th April 1989), and attributed to IBAMA the co-ordination of measures necessary for the organization, implementation and carrying-out of programs concerned with education, research, prevention, and control and combat of forest and man-made fires.

According to this decree, IBAMA is responsible regulating the use of man-made fires. PREVFOGO is subordinated to the Directorate of Control and Inspection (Diretoria de Controle e Fiscalização - DIRCOF) of IBAMA.

In order to realise the objectives for which it was created, PREVFOGO has been concentrating its efforts in establishing a country-wide infrastructure capable of responding to the grave economic and environmental questions raised by forest and other man-made fires. Key issues are related to loss of biodiversity, the greenhouse effect, air pollution, road accidents and airport closures, besides the risk to human life and the loss of crops and possessions. Action by PREVFOGO includes programmes in the fields of prevention, control, combat, research and training, in public areas, protected areas, indigenous and/or undesignated land, as well as in private property, reforestation areas, in cities and in the country. Owing to the nature of the problem and the need to obtain results in the medium- to short-term, IBAMA adopted a management model for the implementation of PREVFOGO, involving more than a dozen public and private agencies (executive and consultant), with IBAMA being responsible for co-ordination and the provision of the means and resources.

A number of agreements, national and international, have already been signed and many others are in an advanced stage of negotiation. At the national level, IBAMA has already set-up partnerships with INPE, IBGE, the National Institute of Meteorology (Instituto Nacional de Meteorologia - INMET), IBGE, the Ceará Foundation for Meteorology (Fundação Cearense de Meteorologia - FUNCEME), the University of Brasília, the University of São Paulo, fire brigades and reforestation companies. The intention is to involve other

public and private organizations as well, including the Armed Forces (Estado Maior das Forças Armadas - EMFA), the Civil Defence (Defesa Civil), state environment agencies, state companies for technical assistance and rural extension (Empresa Estadual de Assistência Técnica e Extensão Rural - EMATER), EMBRAPA, municipal councils, and forestry police, amongst others.

In order to anticipate the solutions to some problems and, at the same time, to secure support and guidance in the implementation of PREVFOGO, IBAMA has established agreements for technical co-operation with countries which

**Table 2-19.** Loss of the Atlantic forest (ha) by state, between 1990 and 1995.

State	Forested area		Mean (1990-1995) deforestation per year	% (1990-1995) annual deforestation
	1990	1995		
Bahia	1,267,476	n/a	n/a	n/a
Espírito Santo	409,741	387,313	4,485.6	5.47
Goiás	7,119	6,471	129.6	9.10
Mato Grosso do Sul	43,752	39,555	839.4	9.59
Minas Gerais	1,214,059	1,125,108	17,790.2	7.32
Paraná	1,815,137	1,730,528	16,921.8	4.66
Rio de Janeiro	1,069,230	928,858	28,074.4	13.13
Rio Grande do Sul	535,255	506,462	5,758.6	5.38
Santa Catarina	1,729,160	1,666,241	12,583.8	3.64
São Paulo	1,858,959	1,791,559	13,480.0	3.62
<b>Total</b>	<b>9,949,888</b>	<b>8,182,095</b>	<b>11,118.2</b>	<b>6.88</b>

n/a = data not available.

**Source:** Modified from Fundação SOS Mata Atlântica, Instituto Nacional de Pesquisas Espaciais. *Evolução dos Remanescentes Florestais e Ecossistemas Associados do Domínio da Mata Atlântica no Período 1990-1995*. Report. Sao Paulo (1998).

**Table 2-20.** Forests, mangrove swamps and restinga in the Atlantic Forest region of the state of Santa Catarina and Deforestation.

Ecosystems	Remaining in 1985 <sup>1</sup>		Remaining in 1990 <sup>2</sup>		Remaining in 1995 <sup>3</sup>		Deforestation 85-90 <sup>4</sup>		Deforestation 90-95 <sup>5</sup>	
	ha	%*	ha	%**	ha	%*	ha	%**	ha	%***
Forest	1,822,030	19.11	1,724,244	18.08	1,654,179	17.35	97,786	5.36	70,065	4.06
Restinga	97,422	1.02	95,653	1.00	85,640	0.89	1,789	1.83	10,013	10.46
Mangrove	6,776	0.07	6,776	0.07	6,621	0.06	0	0	155	2.28

**Source:** Fundação SOS Mata Atlântica, Instituto Nacional de Pesquisas Espaciais. *Evolução dos Remanescentes Florestais e Ecossistemas Associados do Domínio da Mata Atlântica no Período 1985-1990*. Report. São Paulo, (1993).

1 98.95% of the area of the state was assessed (rest under cloud cover).

2 97.26% of the area of the state was assessed (rest under cloud cover).

3 93.58% of the area of the state was assessed (rest under cloud cover).

4 96.26% of the area of the state was assessed (rest under cloud cover).

5 90.87% of the area of the state was assessed (rest under cloud cover).

\* in relation to area of the state assessed.

\*\* in relation to remaining areas in 1985.

\*\*\*in relation to remaining areas in 1990.

have proven experience in the area of combat and prevention of forest fires. An example is the Memorandum of Understanding signed between IBAMA and the United States Department of Agriculture Forestry Service - USDA/FS involving technical and scientific exchange, which has proved to be extremely important for the assimilation of up-to-date technology in forest-fire prevention.

The implementation of this Memorandum is being carried out in accordance with the Operational Plan for Co-operation in Fire Management and Science (Plano Operacional de Co-operação em Ciências e Manejo de Fogo), which defines the extent and areas of co-operation, administrative mechanisms, and the duration of the accord. Since 12th September 1991 when the plan was made official, collaboration has already involved training, technical exchange and research programmes.

This collaboration has allowed IBAMA to assimilate and adapt the experience of the USDA/FS which participates in more than 100 programmes of prevention, control and combat of forest and man-made fires. Other North American agencies and institutions taking part in the programme include the National Aeronautics and Space Administration - NASA, the National Center for Atmospheric Research - NCAR, the National Parks Service - NPS, the Pacific Southwest Research Station, Arizona State University and Oregon State University.

The fundamental premise for this bilateral co-operation is the attainment of practical results for the partners involved, generating high-level research and not merely surveys and data collection on the ecosystems assessed. The IBAMA/PREVFOGO and USDA/FS collaboration has two basic objectives: 1) strategic assessment of environmental impacts caused by forest and man-made fires in the country and 2) the search for local solutions for control and monitoring.

Under the terms of the 1992 Convention on Climate Change, all signatories should present reports on their concrete contributions to controlling gas emission and the greenhouse effect, and inventories on the sources of these components. The executive organs of the Ministry of Environment - MMA and the Ministry of Science and Technology - MCT are responsible for carrying out and analysing these measurements. The MMA, through IBAMA, is also responsible for adoption of mitigating measures to reduce gas emission and its impacts. IBAMA, through its Directorate of Control and Inspection (Diretoria de Controle e Fiscalização - DIRCOF), has the mission to prevent, monitor and control forest and man-made fires in Brazil, while assessing their effect on ecosystems, public health and the atmosphere.

Three years after the creation of PREVFOGO, IBAMA recognised the need for a meeting of national and international specialists to debate the theme 'The State of

**Table 2-21.** Change in forest cover in state of Santa Catarina

Year	Area (ha)	% of natural forest cover in relation to the State
1500	7,768,440	81.50
1912	7,498,690	78.67
1959	2,859,550	30.00
1985	1,822,030	19.11
1990	1,724,244	18.08
1995	1,654,179	17.35

**Source:** Fundação SOS Mata Atlântica, Instituto Nacional de Pesquisas Espaciais. *Evolução dos Remanescentes Florestais e Ecossistemas Associados do Domínio da Mata Atlântica no Período 1985-1990*. Report. São Paulo, (1993).

the Art in Research, Prevention and Control of Forest and Man-made Fires in Brazil'. The seminar was held in Brasília in April 1995, and over 500 delegates from about 50 institutions took part. The complete proceedings of the seminar should be published in the first semester of 1998. It was centred on five major topics:

- Occurrence of forest fires;
- Causes and the use of burning in Brazil;
- Impacts of fires on the atmosphere and nutrient cycles;
- Impact of fire on ecosystems and biological communities;
- Prevention and control of forest fires.

Five main objectives have been established:

**a) Rural Extension and Dissemination**

- To organise prevention campaigns and prepare educational material for dissemination and distribution at the national level, in order to make the population aware of the dangers and damage caused by forest and man-made fires;
- To train technicians in rural extension to inform farmers and to teach them the necessary requisites and techniques in the use of fire in agriculture, as determined by Edict No. 231/P88 of IBAMA.

In the short-term, it is hoped there will be a decrease in the emission of gases and the quantities of particles produced by annual, uncontrolled man-made and forest fires, the effects of which have worsened the quality of the air and consequently public health, reduced visibility, resulting in the closure of airports and increasing the risk of car accidents, and contributed to the greenhouse effect.