

2.2 Monitoring and Mitigation of Impacts on Biological Diversity

2.2.1 Socio-economic Pressures and Their Impacts

Reducing or eliminating the current impacts on Brazilian diversity is a complex task. Brazilian Amazonia covers more than 3.7 million km², and the Cerrado biome, which has suffered worst from the expansion of agriculture and cattle-ranching in recent years, covers some 2 million km². The Atlantic forest extending from the north-east to the far south of Brazil has been reduced to a mere strip of remnants. The Brazilian coast extends for 7,408 km, and Brazilian oceanic waters cover 2 million km².

Brazilian biomes continue to suffer from the consequences of social and economic structures developed over the centuries and well before the advent of environmental awareness. The coastal area was where colonisation first took place and still has the highest population densities (Figures 2-9, 2-9a) and is where altered environments predominate (Figure 2-10).

Until 1985, government policy provided substantial incentives for mining and the expansion of the agricultural and cattle-ranching frontiers, with little regard to the environment. Tax incentives and subsidies were created to stimulate the occupation of enormous areas in the Amazon and the Cerrado, resulting in widespread deforestation and the degradation of the natural environments. Between 1970 and 1985, financial incentives and subsidised credits totalled US\$700 million, including 950 projects in the Amazon. Of these, 631 involved deforestation for cattle ranching.

The situation is similar in other regions of the country and with equally serious consequences. The destruction of the Atlantic forest is a tragic part of Brazil's history.

Apart from this, regional differences in income and social infrastructure have resulted in shifts in the human population, the occupation of new areas and the loss of biological diversity. According to the Report on Human Development in Brazil published by the United Nations Development Program - UNDP in 1996, the per capita GNP in the south and south-east is slightly over US\$5,000 per annum, whereas in the north-east it is US\$2,559, and US\$3,747 in the north. However, there are states in the

Table 2-12. Diversity of freshwater invertebrates in Brazil.

Phylum	Subphylum	Class	Subgroup	No. of genera	No. of species
Protozoa	Sarcodina	Sarcodina	Tecamebas	20	150
Porifera				21	44
Coelenterata				5	5
Platyhelminthes		Turbellaria		20	96
Nematomorpha				3	9
Annelida					73
Rotifera					457
Arthropoda	Crustacea	Branchiopoda	Cladocera		86
Arthropoda	Crustacea	Maxillopoda	Copepoda		273
Arthropoda	Crustacea	Malacostraca			75

Source: Rocha (1997).

north-east such as Piauí where the per capita GNP is only US\$1,339 per annum, and similar disparities occur when comparing municipalities within each of the Federal States.

Disparity of income and poor living standards, together with population increases, have resulted in a marked migration from rural to urban environments, as well as from poor areas to those offering employment and a better social infrastructure. Major migrations have also accompanied the expansion of the agricultural and cattle-ranching frontiers and the increase in mining, both industrial and open cast, placer-mining. It also resulted in the invasion of hitherto preserved Indigenous lands.

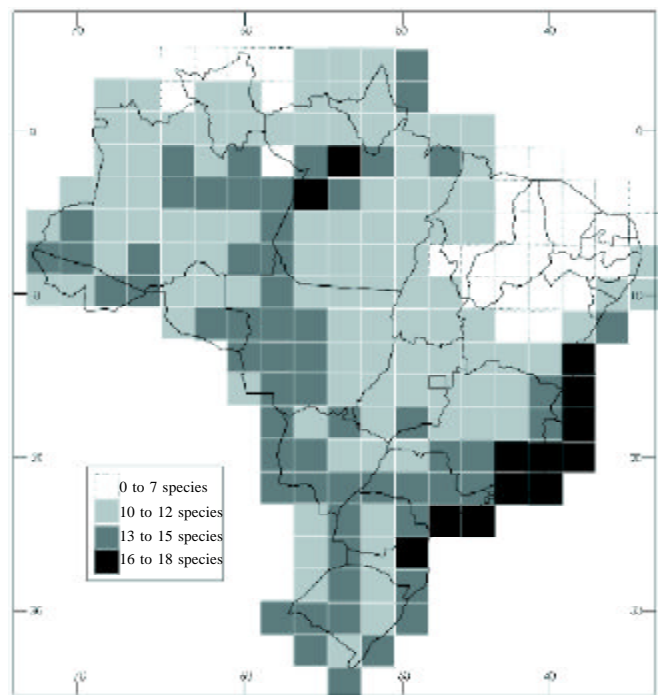


Figure 2-8. Distribution of threatened mammals in Brazil.

Source: Fonseca, Rylands, Costa, Machado, Leite (1994).

Table 2-13. The number of animal species threatened or presumed threatened in the states of Minas Gerais (MG) and São Paulo (SP).

Taxa	Threatened species								Species presumed threatened			
	Extinct		Critically endangered		Endangered		Vulnerable		Total			
	MG	SP	MG	SP	MG	SP	MG	SP	MG	SP	MG	SP
Mammals	5	1	13	9	12	8	10	22	40	40	25	25
Birds	4	21	12	47	27	37	40	59	83	164	64	25
Reptiles	0	1	3	0	2	10	5	13	10	24	15	40
Amphibians	0	0	-	0	1	3	10	1	11	4	17	26
Fish	0	0	1	3	0	2	2	29	3	34	32	29
Terrestrial invertebrates	3	1	4	8	13	12	11	22	31	43	12	40
Marines invertebrates	-	0	-	0	-	1	-	0	-	1		18
Total	12	24	33	67	55	73	78	146	178	310	165	203

Sources:

Minas Gerais State Government. COPAM Deliberation No. 041, 20th January 1995;
 São Paulo State Government. PROBIO-SP, State Decree No. 42,838, 4th February 1998.

As a result, the population of the nine states of the Northern region (Amazonia) has increased from 2 million inhabitants in 1950, to 4 million in 1970, 5.8 million in 1980 and 12 million in 1991. It now stands at about 18 million. The state of Rondônia has seen an increase in population from 36 thousand inhabitants in 1970 to 30 times this number in 1996. In Roraima, the population trebled between 1970 and 1991, and in Pará it has quadrupled in 50 years. The population of Manaus, the capital of the state of Amazonas, went from 633,000 inhabitants in 1980 to over 1 million in 1991.

Overall, the north of Brazil has increased its population from 7.8% of the country's total population in 1970 to 11.3% in 1991. Between 1980 and 1991, the population of the Amazon region increased at the rate of 1.8% a year for rural areas, compared to 5.4% a year for urban areas (Figures 2-11 and 2-12).

Population growth rates, however, have been declining over the last two decades. Health care and the use of contraceptives and voluntary sterilisation have been instrumental in causing a reduction in population growth from 3% a year in the 1950s, to 2.9% in the 1960s, and to 1.9% a year by the census of 1991. It is still decreasing. The birth rate has gone down by 37% over the last 15 years in the country as a whole, and by 20% in the north. Current statistics point to a growth rate of around 1.3% a year (Figure 2-13).

The 1996 Report on Human Development in Brazil by the UNDP concluded that the decline in the birth rate in Brazil is not a circumstantial phenomenon but an irreversible process within what, in demographic terminology, could be called a demographic transition. The report predicts that the population will stabilise at about 211 million inhabitants around the year 2020.

Over the past decades, social and economic expansion in the Central West and the Amazon has been stimulated by the opening up and paving of a major road network. The 'Polonoroeste' colonisation and development programme was begun in the 1970s, in parallel with the construction of BR 364 highway, linking central Brazil to the state of Rondônia.

The current situation in each of the biomes is as follows:

Amazonia. This is most well-preserved biome, with about 10% allocated to protected areas, and about 85% of the Brazilian Amazon still forested. Fires and forest destruction are generally associated with agriculture, cattle-ranching, and selective logging. Amazonia now provides 70% of the national and 2% of the international demand for timber, figures which will increase in the future. Mining is a serious

Table 2-14. Numbers and categories of threatened plant species in the states of Minas Gerais (MG) and Paraná (PR).

State	Category	No. of species
Minas Gerais ¹	Probably extinct	79
	Critically endangered	108
	Endangered	128
	Vulnerable	221
Paraná ²	Endangered	236
	Vulnerable	106
	Rare	251

Sources:

¹ Fundação Biodiversitas, Minas Gerais.
² Paraná State Government. State Secretariat for the Environment (SEMA) and the German Technical Co-operation Agency - GTZ. *Lista Vermelha de Plantas Ameaçadas de Extinção no Estado do Paraná*. Curitiba (1995).

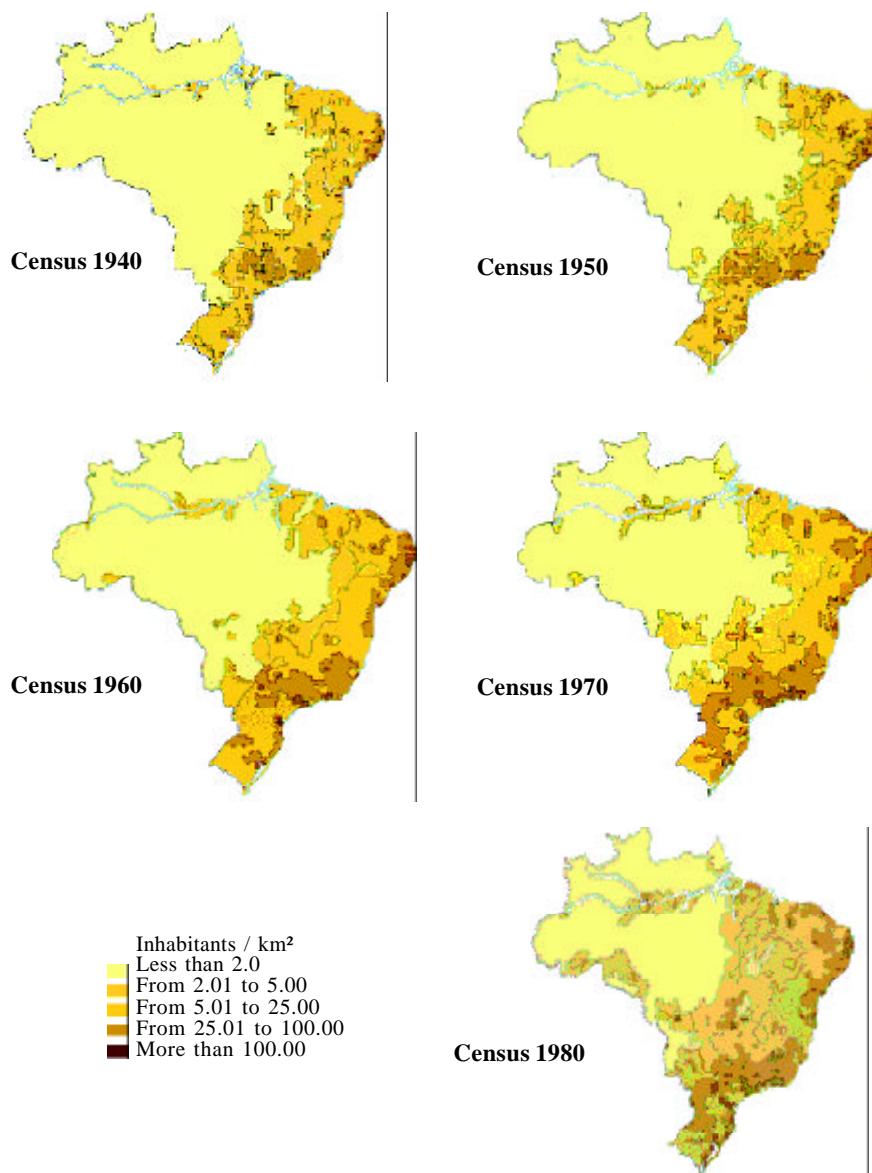


Figure 2-9. Evolution of human occupation of Brazilian territory - population density.
Source: IBGE (1992).

threat to many river systems, and overfishing has become a problem in some.

Cerrado. In terms of area, agriculture and cattle-ranching is increasing by 3% a year. Conversion of the Cerrado ecosystems for economic use involving the total loss of the original vegetation now totals 40% of the area, and more than 50% of the remaining natural ecosystems have been degraded. Burning, both for the maintenance and the creation of cattle pasture and for plantations is a common practice, and results in soil erosion as well as the loss of biological diversity.

Caatinga. The natural vegetation of this biome now covers less than 50% of the original area, and only less than 1% has

been designated as protected areas. Desertification is widespread. Extensive cattle-ranching, agriculture, extractivism, and subsistence farming have all had major impacts on this biome. Hunting for food is an important additional factor, especially in the dry season.

Atlantic forest. This is the most threatened of the Brazilian forest biomes, with less than 9% of the original area remaining. Around 80% of the forest is in private hands. Protected areas account for 2% of the original area. Deforestation is the main threat, for agriculture, for monocultural reforestation and for housing. Subsistence and commercial extractivism is also an important factor in the south of the state of Bahia as well as the southern states. The Araucaria Forest and the so-called Campos Sulinos (grasslands in the south), distinct ecosystems but considered part of the domain of the Atlantic forest, have been very severely affected by logging agriculture and cattle-ranching. Weakening of the soil is an ever-increasing problem. Only about 1% of the original area has been designated as protected areas.

Coastal Zone. Chief threats to the Brazilian coastal ecosystems include real estate speculation, and uncontrolled tourism, overfishing (industrial and subsistence), destruction and subsistence exploitation of mangrove swamps, and the pollution of estuaries (erosion inland, and industrial and urban pollution).

2.2.2 Monitoring Deforestation

From 1978 to 1996, the deforested area in the Amazon region is estimated to have increased from 78 to 501 thousand km²; 12.5% of the original forest area (Table 2-15). The yearly deforestation rates increased in the 1970s and 1980s. Between 1978 and 1988 they were as high as 0.54% of the total area, or 21,130 km² a year (Table 2-16).

Government measures in 1998, which included the suspension of tax incentives along with an economic recession, reduced the rate of deforestation. It dropped from

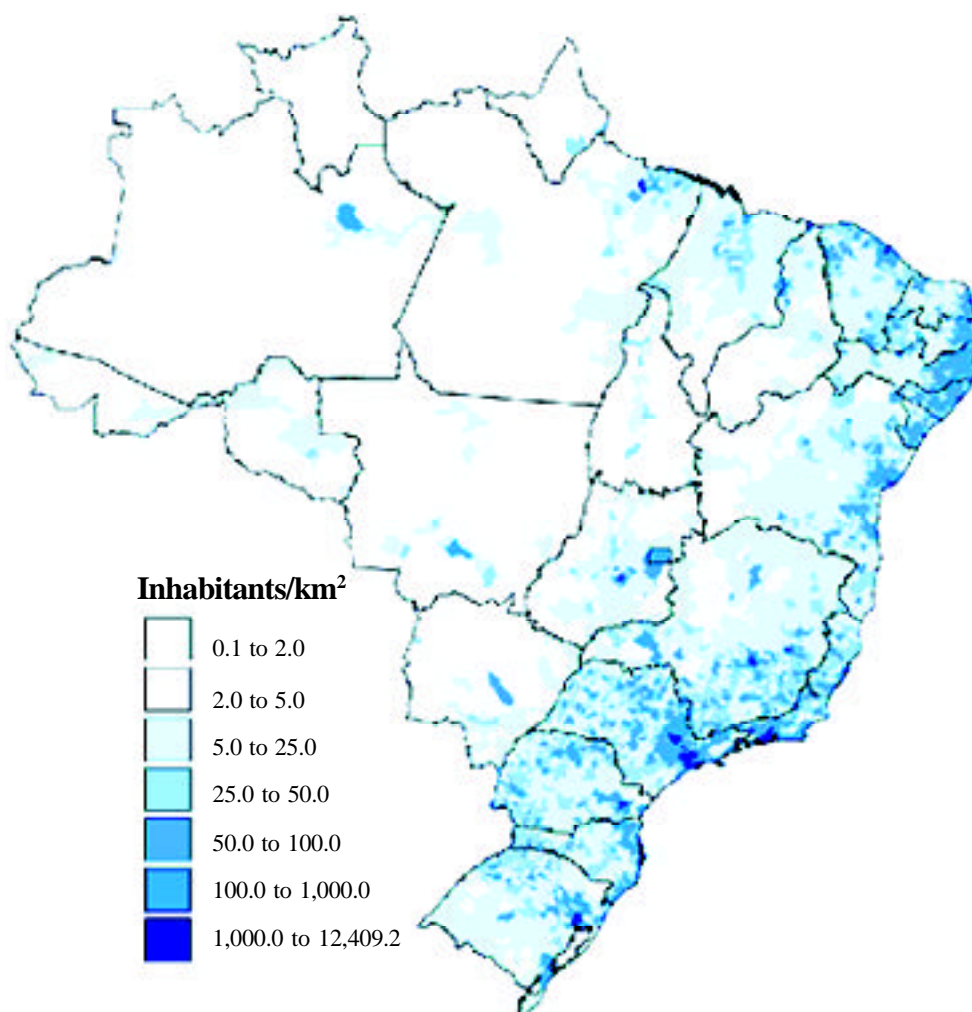


Figure 2-9a. Demographic densities - Brazil 1996.
Source: IBGE (1988).

0.48% in 1988/89, to 0.37% in 1989/90, and to 0.30% in 1990/91. As of 1991, however, deforestation increased again due to a more favourable economic climate, immigration, and the advance the agricultural and cattle-ranching frontier, going from 0.37% in 1991/92, to 0.40% for 1992/94, and peaking at 0.81% in 1994/1995. In 1995/1996, the deforestation rate dropped to 0.51% (Figure 2-14).

The Brazilian Government co-ordinates the world's biggest programme for routine monitoring of forest cover, through the National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais - INPE). The Project for Monitoring of Deforested Areas in the Amazon Region (Projeto de Monitoramento de Áreas Deflorestadas na Amazônia Legal - PRODES) has carried out routine yearly surveys since 1988. Different from those of a number of international agencies, this project does not involve merely sampling, but a complete annual census over the entire region, an area the size of Europe.

A report recently published by IBAMA and by INPE on deforestation shows that the prime cause in the region is the

conversion of forest into temporary pasture or land for agriculture. The greatest expansion in agricultural land has been concentrated in the states of Mato Grosso, Pará, Rondônia and Tocantins. According to this report, land holdings (less than 50 ha) having little access to technology or other resources account for 41% of the deforestation in the region (Figure 2-15). The worst hit vegetation types are the closed and open ombrophilous forests and their contact zones (Figure 2-16).

The impacts of logging are considerable, and indirectly lead to complete deforestation. The IBAMA/INPE report shows that the profits from selective logging (not registered in PRODES) revert eventually to projects involving clear-cutting, facilitated by the roads opened up for timber exploitation. Timber sales have grown in recent years, and now 90% of the internal market is supplied from the Amazon. Investigations by IBAMA have demonstrated that up to 80% of timber commerce in the Amazonia is illegal and predatory. Selective logging of just a few tree species is highly wasteful; up to 60%-70% of the trees felled are not marketed.

In December 1997, an External Commission of the Chamber of Deputies produced a report which reviewed the acquisition of timber companies, sawmills and large tracts of land in the Brazilian Amazon by Asian consortiums. It concluded that the presence of Asian timber businesses exposes the Amazon forest to a potentially high risk. Of the 13 transnational companies investigated, 12 had committed offences in terms of forest management, illegal purchase of timber; and the negotiation of timber from Indigenous Lands. Ten of them were deficient or illegal in their forest management plans, five had been fined for malpractice and four had been accused of violating the rights of indigenous people.

The Report made six recommendations: 1) A 10-year moratorium on deforestation; 2) An immediate stop to all man-made fires as from 1998; 3) That 10% of the entire Brazilian Amazon be given over to protected areas by the year 2000; 4) All Federal public land be converted into protected areas; 5) That approval of the law defining environmental crimes, already sanctioned by the Senate, be given priority in the Chamber of Deputies and; 6) The declaration of areas prohibited for logging. The Report went on to suggest a policy of incentives for forest conservation and for forestry exploitation under management, the establishment of an International Forestry Convention in the ambit of the United Nations, environmental auditing of all transnational enterprises, and the exclusion of

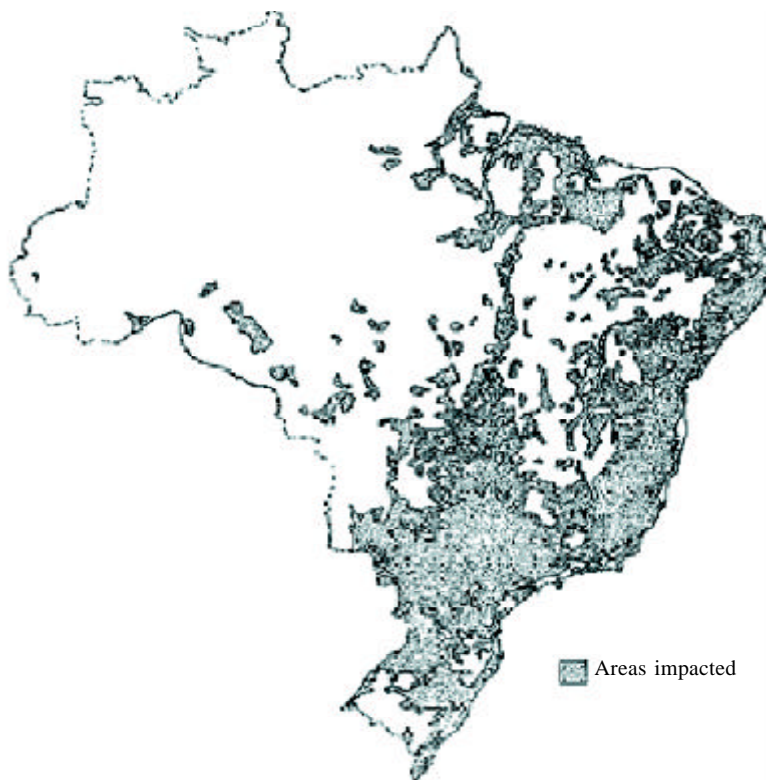


Figure 2-10. Areas suffering significant human impacts in Brazil.

Source: Brazão, Santos and Silva, IBGE (1993).

all areas of primary Amazon forest in any project for traditional agrarian reform.

The situation in the Cerrado and Caatinga regions is of even more concern insofar as 40% of the original vegetation in the Cerrado has been destroyed by human activities. As for the Caatinga, the remaining area of dry forest in the states of the North-East was reduced from 1,009,915 km² in 1984 to 727,695 km² in 1990, representing a loss of 47% over the original area (Table 2-17), the land having been cleared and put to other uses.

In the past, the Atlantic forest and its associated ecosystems covered some 1,130,000 km² in 17 Brazilian states. Human occupation of the region has resulted in a drastic reduction of the native vegetation in this biome, which is today only sparsely distributed along the Brazilian coast, in the interior of the south and south-east, and with some important isolated areas in Goiás, Mato Grosso do Sul and in the interior of the north-east.

In 1990, the INPE and an NGO, the SOS Atlantic Forest Foundation (Fundação SOS Mata Atlântica) concluded an 'Atlas of the Remnant Forests in the Atlantic Forest Domain,' on a scale of 1:1,000,000. It was published in 1993. A second

Tabela 2-15. Original and remaining (km²) forested areas of the Brazilian Amazon.

State	Area of State ¹	Original forested area ²	Remaining forested area in 1996 ³	% remaining in 1996
Acre	153,149	153,697	139,955	91.1
Amapá	143,453	137,532	135,570	98.7
Amazonas	1,577,820	1,481,902	1,454,468	98.1
Maranhão	333,365	165,848	66,510	40.1
Mato Grosso	906,806	481,442	362,301	75.3
Pará	1,253,164	1,144,858	984,503	86.0
Rondônia	238,512	215,245	166,597	77.4
Roraima	225,116	162,567	157,206	96.7
Tocantins	278,420	84,250	58,767	69.8
Brazilian Amazon	5,109,805	4,027,341	3,525,877	87.5

Sources: ¹ IBGE (1977). ² FAO. Brazil - Country Brief for Interim Forest Cover Assessment. São José dos Campos: INPE (1996); ³ INPE. *Desflorestamento 1995-1997 - Amazônia*. MCT/INPE. Brasília: MMA/IBAMA (1997).

edition, on a scale of 1:250,000, will cover 10 states (Bahia, Espírito Santo, Minas Gerais, Goiás, Mato Grosso do Sul, São Paulo, Rio de Janeiro, Paraná, Santa Catarina and Rio Grande do Sul), updating the information to 1995. In 1990 (Table 2-18), the remaining forest covered 9.02% of its original area, and the yearly rate of deforestation between 1990 and 1995 ranged from 3.62% to 13.13% in the different states, with an overall rate of 6.88% (Table 2-19).

The data for the state of Santa Catarina have already been analysed for the second edition of the atlas (period 1990-1995). Originally, forest covered 7,768,440 ha or 81.5% of the state, the rest being restinga (coastal vegetation on sand), mangroves and savannah. In 1995, the remaining forest covers 1,654,179 ha, 17.35% of the state, and 21.29% of the area of the forest that existed five hundred years ago (Tables 2-20 and 2-21). From 1990 to 1995, Santa Catarina lost 70,065 ha of forest, mostly Araucaria forest, which was 4.06% of the forest remaining in 1990. From 1990 to 1995, there was also a considerable loss of the restinga vegetation, with 10,013 ha being cleared, or 10.46% of the restinga present in 1990. Only 85,640 ha of restinga remain. A total of 155 ha of mangroves were also cleared during this period: 2.28% of the are remaining in 1990. There are now 6,621 ha of mangrove swamps in the state.

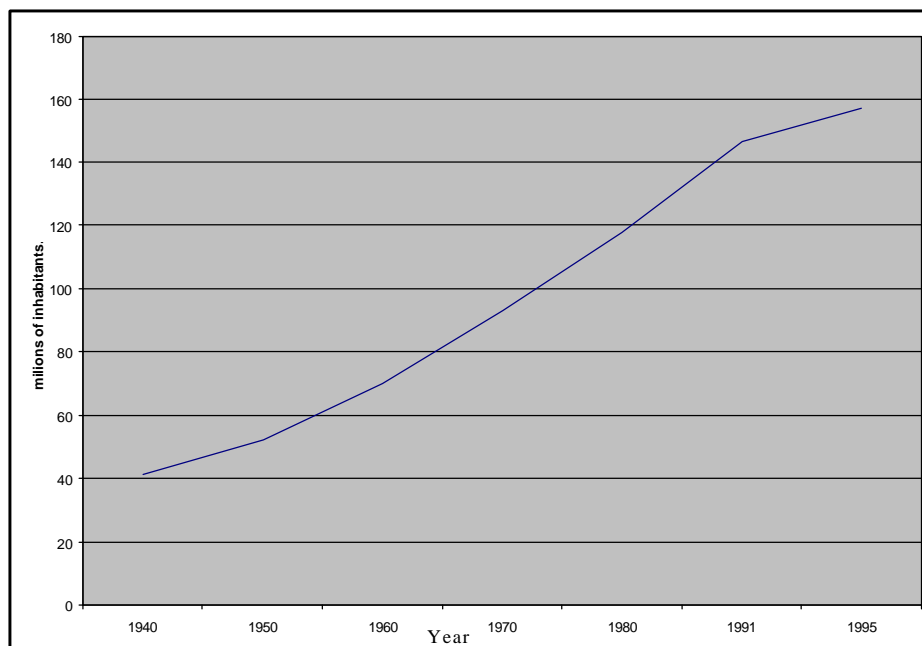


Figure 2-11. Population growth in Brazil, 1940-1996.

Source: IBGE (1997).

In the 10 years from 1985 to 1995, the state of Santa Catarina lost 167,851 ha (9.21%), of its remaining forest, and 11,802 ha (12.11%) of the remaining restinga vegetation. Summing the Atlantic forest, restinga and mangroves, the total loss of natural vegetation was 9.33%.

2.2.3 Combating Deforestation

The enormous problems and difficulties in combating deforestation in a country the size of Brazil require a major and complex infrastructure for planning, execution, monitoring

Table 2-16. Average annual deforestation in the Brazilian Amazon Region

State	78/89		87-88/89		89/90		90/91		91/92		92/94		94/95		95/96	
	km ² / year	%/ year	km ² / year	%/ year	km ² / year	%/ year	km ² / year	%/ year	km ² / year	%/ year	km ² / year	%/ year	km ² / year	%/ year	km ² / year	%/ year
Acre	620	0.42	540	0.39	550	0.39	380	0.28	400	0.29	482	0.35	1,208	0.86	433	0.31
Amapá	60	0.06	130	0.12	250	0.23	410	0.37	36	0.03			9	0.01		
Amazonas	1,510	0.10	1,180	0.08	520	0.04	980	0.07	799	0.06	370	0.03	2,114	0.14	1,023	0.07
Maranhão	2,450	1.79	1,420	1.30	1,100	1.03	670	0.63	1135	1.07	372	0.35	1,745	3.21	1,061	2.01
Mato Grosso	5,140	1.01	5,960	1.31	4,020	0.90	2,840	0.64	4,674	1.05	6,220	1.40	10,391	2.43	6,543	1.56
Pará	6,990	0.62	5,750	0.55	4,890	0.47	3,780	0.37	3,787	0.37	4,284	0.42	7,845	0.78	6,135	0.62
Rondônia	2,340	1.11	1,430	0.78	1,670	0.91	1,110	0.62	2,265	1.27	2,595	1.46	4,730	2.75	2,432	1.45
Roraima	290	0.18	630	0.39	150	0.10	420	0.27	281	0.18	240	0.15	220	0.14	214	0.14
Tocantins	1,650	2.67	730	2.00	580	1.61	440	1.26	409	1.17	333	0.95	797	2.29	320	0.94
Brazilian Amazon Region	211,300	0.54	17,860	0.48	13,810	0.37	11,130	0.30	13,786	0.37	14,896	0.40	29,059	0.81	18,161	0.51

Obs.: The absence of data for the state of Amapá in 1994 is due to the incidence of clouds.

Sources: INPE, IBAMA and MMA. *Desflorestamento* 1995-997.

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.

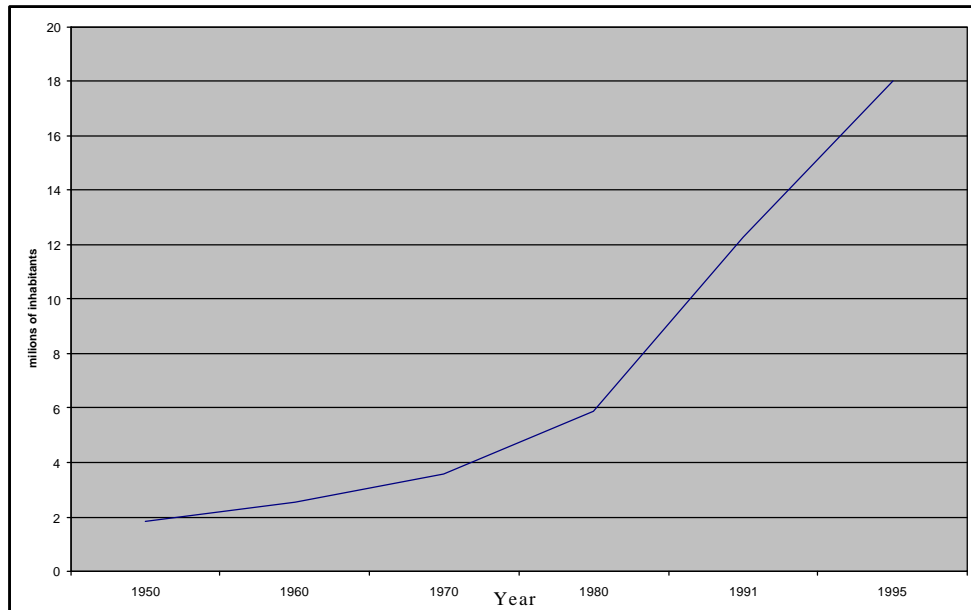


Figure 2-12. Population growth in the north of Brazil, 1950-1996.

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

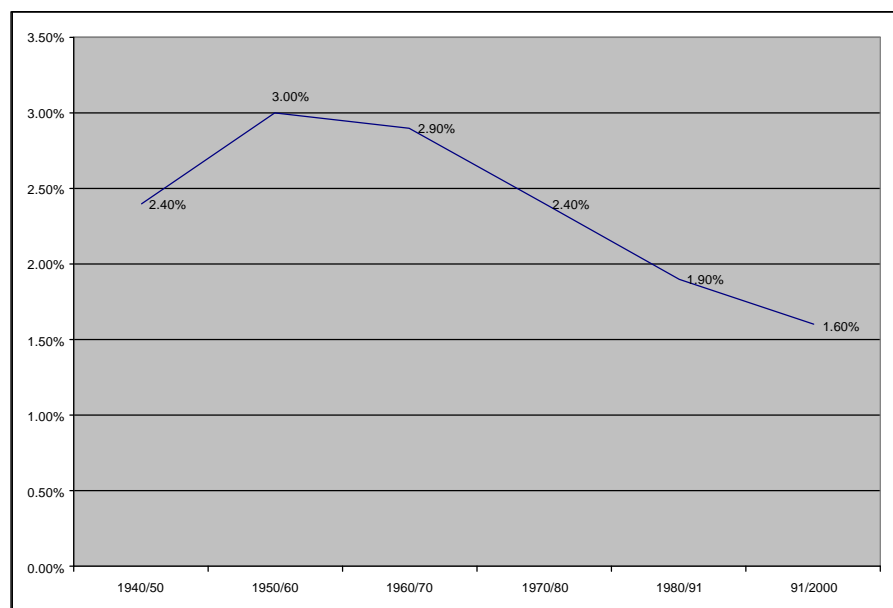


Figure 2-13. Population growth rates - Brazil 1940-2000.

Source: IBGE (1977).

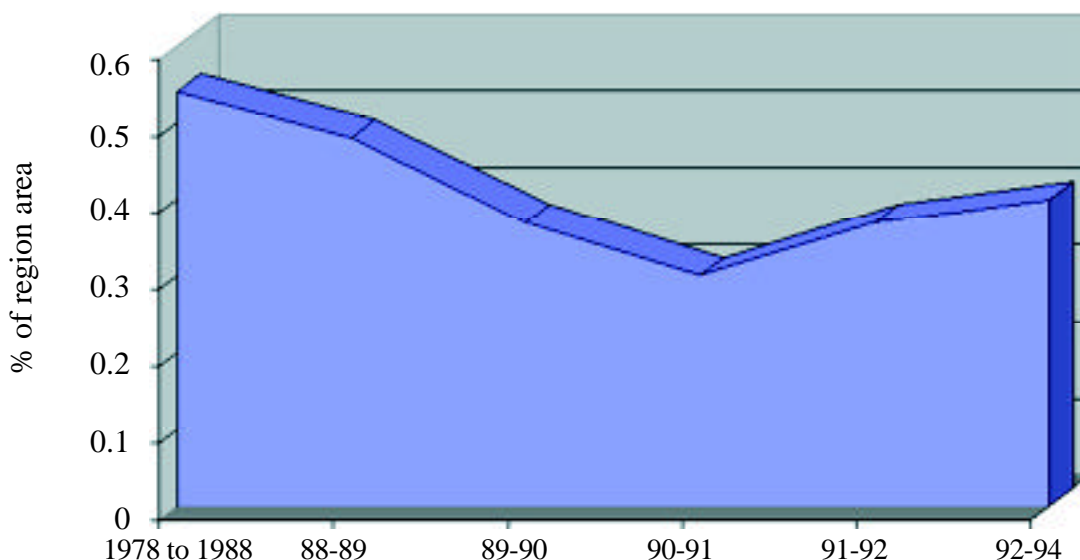


Figure 2-14. Changes in annual average deforestation rates in the Brazilian Amazon region.
Source: MMA (1997).

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 m³ 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

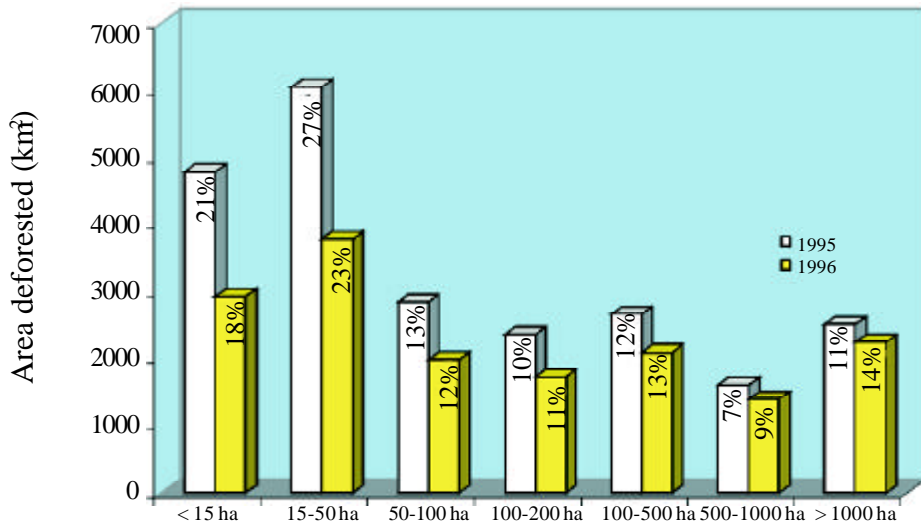


Figure 2-15. Deforested areas of different size classes in 1995 and 1996.
Sources: INPE-IBAMA (1995-1997), MCT/INPE, MMA/IBAMA (1997).

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.

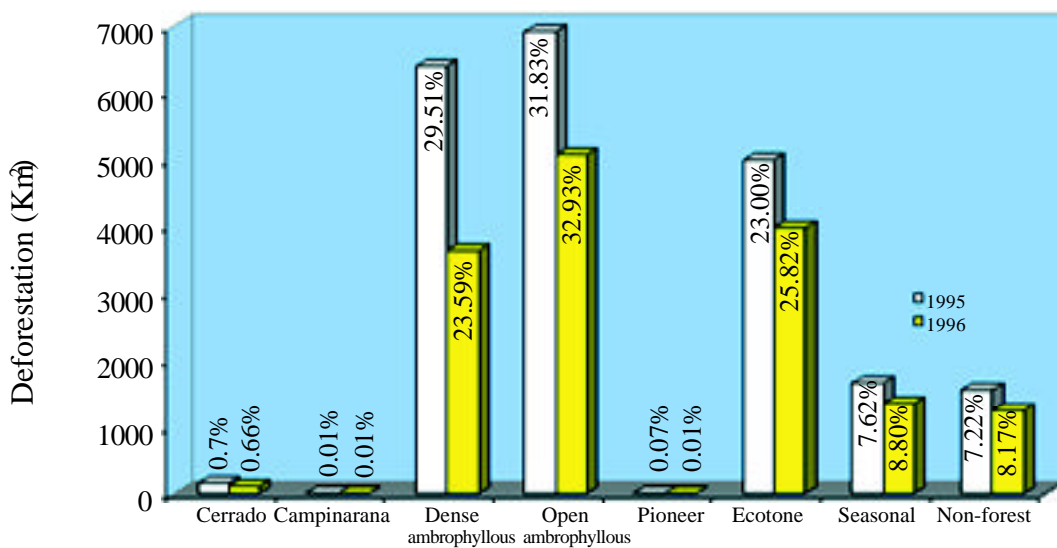


Figure 2-16. Annual total deforestation of different forest types.
Sources: INPE-IBAMA (1995-1997); MCT/INPE, MMA/IBAMA (1997).

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 (km²) 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 ¹	2,640	1,396	52.9	1,244	47.1
Total	1,548,672	545,754	35.2	1,002,915	64.8
Annual average		39,28	0.0025		

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

Obs: State names are in Figure 1-1.

n/a = data not available.

Sources:

¹ 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).

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

³ 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
Total	9,949,888	8,182,095	11,118.2	6.88

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 ¹		Remaining in 1990 ²		Remaining in 1995 ³		Deforestation 85-90 ⁴		Deforestation 90-95 ⁵	
	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.