United Nations Environment Programme – UNEP

Latin America and the Caribbean Regional Office

Ministry of the Environment - MMA

Brazilian Institute of the Environment and Natural Renewable Resources - IBAMA

# GEO BRAZIL 2002

## Brazil Environment Outlook

Edições IBAMA

Brasília
2002

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# GEO BRAZIL 2002

**Brazil Environment Outlook**

**IBAMA** – Brazilian Institute of the Environment


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# presentation of the Minister of State for the Environment

Having worked for so many years with environmental issues at both the state and federal levels, it is with undeniable satisfaction, and even immense pleasure, that I see the successful conclusion of this broad coordination effort of the Brazilian Institute for Environment and Renewable Natural Resources – IBAMA, resulting in the "Report on the Perspectives for the Environment in Brazil - GEO-Brasil"

I must admit that, given the enormous challenge of portraying the country's environmental state as a whole, and given the time constraints – the document began effectively to be prepared in May 2001 and had to be concluded before the Johannesburg World Summit on Sustainable Development (August 26 - September 4, 2002), I was concerned with the enormity of the work before them. Nevertheless, I have always trusted the staff and the joint partnership work that was developed to execute this project.

GEO-Brasil is one more persuasive example of the fact that in environmental management, the dedication, creativity and solidarity that were translated into the effort, enthusiasm and collaboration of countless partner institutions, in addition to the unrestricted support of the Ministry of Environment, can lead us to produce major progress in terms of quality that reaffirms, both domestically and abroad, our unconditional commitment to the cause of sustainable development.

From a thematic point of view, GEO-Brasil is quite comprehensive as it covers not only socioeconomic and cultural aspects, uses of land and subsoil, forests, biodiversity, water resources, coastal and marine environments, fishing resources, atmosphere, urban and industrial areas, environmental disasters, health and environment, public policies, but it also includes assessments on the challenges and opportunities for the Brazilian environment.

With this document, which is to be updated every two years, we are taking another important step to better equip environmental management in Brazil, since its data are essential inputs for decision making by our authorities. Furthermore it represents an extremely useful compendium of information for all Brazilians.

I should thus like to congratulate my collaborators, the public and private institutions and the non-governmental organizations that worked so hard to make GEO Brazil a reality.

I must also express my thanks to the essential support given by the United Nations Environment Programme – UNEP in providing the methodology to carry out this work, which places us at the forefront in development of information, according to international standards, prepared on the environment on a global scale. We are thus in harmony with the advanced methodologies and procedures that are currently being employed in the *Global Environment Outlook*, that is, the Global GEO.

GEO-Brasil comes, therefore, to fill a significant gap in Brazilian environmental management and crowns all the efforts of our federal administration that, under the leadership of President Fernando Henrique Cardoso, has always enthusiastically and boldly defended the path of sustainable development as vital for the permanent progress of the country and its people.

**José Carlos Carvalho**
**Minister of State for the Environment**

# presentation of the president of IBAMA

In 1997 **IBAMA - The Brazilian Institute of the Environment and Renewable Natural Resources -** was evaluated and given credentials by PNUMA *as a Brazilian technical-scientific institution with a large network of human resources in Research and Environmental Development in the country and enormous territorial and interinstitutional connectivity with federal, state and municipal government agencies, universities and civil society organisations.* With these credentials, IBAMA became one of the international *Collaboration Centres* of the GEO programme. Since this time, we have been organising our databases and investing in new technology and refining methodologies in Strategic Information Management.

This publication represents IBAMA's great efforts in data collection, systemisation and environmental analysis. It also represents multisector and interdisciplinary efforts. The material here was developed through an intense and voluminous process of institutional links aiming at broad and consistent participation of the involved socio-political-cultural-environmental participants in the Brazilian nation. This also includes specialists from the academic community with in-depth experience with each of the themes and chapters.

The innovative process of change in the institutional paradigm co-ordinated by **IBAMA** allowed for an extremely rich exchange of experiences and a democratic sharing of ecological data and information. This resulted in the consolidation of institutional partners in Technical Co-operation Agreements. It also resulted in the development and spread of methodology for "Integrated Environmental Evaluation". This has become one of the major national efforts for the production of Environmental Information.

**IBAMA,** in carrying out its institutional mandate of offering support to the forming of political policies for sustainable development, is extremely proud and honoured to present the first **GEO BRAZIL.** This publication represents regimented principles in developing an Information System for the management of fauna, fish and forest resources as well as carrying out an evaluation of the environmental impacts on the national territory. **GEO BRAZIL** is edited and published by IBAMA Editions.

**IBAMA** is making **GEO BRAZIL-1** available to Brazilian society and to the international community at Johannesburg-2002. Directors, co-ordinators, managers, centre chiefs and researchers all feel extremely grateful for the relationships of mutual trust that have developed over the past months. We are also extremely pleased with the continuity in the process of integration of partner institutions. We are certain that there will be many more in the near future and that the continual permanent process of interinstitutional co-operation has only just begun.

**Rômulo José Fernandes Barreto Mello**
**President of IBAMA**

# UNEP Presentation

## Introduction to Environment Outlook - Brazil

Since the United Nations Summit on the Human Environment in Stockholm in 1972 and the Earth Summit in Rio de Janeiro that took place 20 years later, the environment has become more and more important for world development. Today, in the expectations surrounding the World Summit on Sustainable Development to be held in Johannesburg, we recognise that many of the victories that were reached in Rio were not followed through. Although the Earth Summit made a crucial impression on the debate for sustainable development, it did not represent a decisive moment in the hoped for change for a new model of sustainable development.

Innovative political policies are necessary to reverse the tendencies that are damaging to the environment, fully incorporating it into economic development. Such policies should be based on reliable current information on environmental tendencies and should take efficiency into account. This information represents a base for decision making and appropriate environmental management. GEO-Brazil is a valuable tool in this sense.

GEO-Brazil integrates the set of evaluations of the Global Environment Outlook (GEO). These include those that register the progress reached in the area of sustainable development on the global, regional and national levels. The report was developed by the Brazilian government under IBAMA co-ordination using UNEP evaluation methodology. Dozens of partner institutions participated in the process contributing with technical knowledge on all areas related to the environment, accomplishing an integrated evaluation. In addition, GEO – Brazil clearly demonstrates the importance of GEO as a process where hundreds of individuals and organisations participated in the elaboration and publication of the report and contributed to the implementation of a national network of current information on the environment in order to provide information for the developers of political policies as well as the general public. This report is only the first in a series that will be broadened and refined periodically over the next few years.

The United Nations Environment (UNEP) is proud to have sponsored GEO-Brazil. The development of a GEO report about a country with the size and the abundance of resources and ecosystems that Brazil has presented an enormous challenge. Like similar initiatives, this project reveals the priority given by PNUMA and Director Dr. Kalus Toepfer to collaboration with Brazil, currently one of the principal partners of UNEP in the region. GEO Brazil also serves the proposals of the Forum of Ministers of the Environment of Latin America and the Caribbean, whose presidency is actually exercised in Brazil, soliciting UNEP support for national and regional initiatives of GEO in Latin America and the Caribbean.

We hope that GEO Brazil contributes in a significant way to the environmental debate in Brazil and stimulates progress towards sustainable development in a country that harbours so many of the natural resources of Latin America and the Caribbean and the world. The sustainable use of these resources will serve as an inspiration to other countries in their efforts towards the search for a new model for sustainable development for the future.

**Ricardo Sanchez Sosa**
**Director**

**Regional Office of the United Nations Environment Programme for Latin America**

# presentation of the Coordination and editing Team

GEO Brazil was developed by IBAMA in partnership with a wide variety of public institutions, universities and non-governmental organisations. It represents the enormous effort of all those involved directly or indirectly in the production of this report. This publication provides a picture of the Brazilian environmental situation in its many aspects and focuses on the causes and consequences of pressures and impacts and the corresponding political solutions. GEO Brazil provides possible scenarios based on the observed tendencies related to these elements. The report is based on methodology adopted in the development of the Global Environment Outlook – GEO of the United Nations Environment Programme – UNEP, with IBAMA serving as the Collaboration Centre for Latin America and the Caribbean since 1997.

The conclusion of GEO Brazil and its launching coincide with the World Summit on Sustainable Development (Rio+10), to be held in Johannesburg in August and September of 2002. The presence of the publication at this important world event on the environment essentially aims at showing the Brazilian environmental situation to the world. It also aims at demonstrating the advances, the problems and the outlooks for the various environmental, social and economic tendencies dealt with in GEO Brazil. At the same time, this document is a document oriented towards action, expressing recommendations on effective methods that can contribute to the consolidation of sustainable development in the country and the implantation of the basic frameworks described in the recently announced Brazilian Agenda 21.

With GEO Brazil and the Brazilian Agenda 21 in Brazil, the Brazilian government and society have shown themselves to have an effective commitment to sustainable development. This is especially true in terms of the commitments that were made during UNCED 92, known as Rio 92. At this International Summit Brazil was often the protagonist of leadership and initiative in building consensus, negotiations and partnerships in a wide variety of countries, institutions and representatives of the global community in order to design and consolidate commitments for sustainable development.

The development of GEO Brazil was an effort that reproduced this integrated, participatory, consulting and constructive process on a smaller scale. This document was developed with consensus and was technically as consistent and valid as its authors and institutional partners. The result is a document that will be of great value to all of Brazilian society in its various organised sectors, specially the government and non-governmental institutions, universities and learning centres, the private sector, civil society, legislators, government representatives, mayors, and countless others including the common citizen who is interested in environmental themes.

One of the by-products of the development of GEO Brazil was that it provided the opportunity for the beginning of a consolidation process in terms of a national environment information system. Previously, information that had been collected and stored in the various partnership institutions was found in a broken up form. This process brought about the need for a revision of omissions, gaps, inconsistencies and duplicities. It also brought about the search for a solution to these problems. As a consequence this has been helping the country improve its environmental statistics and its institutional ability to develop environmental reports using international standards.

The strengthening of the institutional ability for environmental evaluation and spreading of this information as part of a global project can be added as another positive by-product of GEO Brazil. This also occurred for the development of productive global exchange partnerships and through the training of IBAMA specialists and those from other institutions in adopting the methodology of GEO/UNEP. In addition, another positive by-product of GEO Brazil was the increase in the institutional capacity for obtaining funds for environmental research. This element was supported by the recognition UNEP expressed for this project.

These are aspects that provide motivation for the continuity of the GEO Brazil process in the form of providing impetus for a historical series that will allow for comparative analyses of the evolution of sustainable development and the implantation of the Brazilian Agenda 21. This will depend on periodic information that is capable of assisting in guiding and forming political policies on the use and occupation of Brazilian territory as well as guiding the consolidation of the Ecological-Economic Zoning in Brazil and integrated environmental management under the strategic co-ordination of the Ministry of the Environment.

Finally, we would like to stress the enthusiasm, the persistence, the dedication and the perseverance of Mr. Hamilton Nobre Casara, former IBAMA's president, Mr. Donizetti Aurelio do Carmo, IBAMA's Licensing and Environmental Quality Director and the entire team of specialists and staff members at IBAMA and the partnership institutions as well as the consultants. All of these individuals made the publication of GEO Brazil possible.

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**IBAMA**
**National Co-ordination of GEO Brazil 2002-08-17**

**Brasília**
**August, 2002**

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chapter I

# introduction

# introduction

## 1. IDENTITY AND TERRITORY, APPROACH AND PERSPECTIVES

### 1.1. Territory and Identity

The Brazilian territory is one of the country's foundations and symbols of national identity, and its grand scale and natural diversity are key distinctive features. To a great extent, these factors embody both real and potential opportunities of development and relatively autonomous insertion in today's globalised world.

The Brazilian territorial configuration is subject to two different dynamics. On one side, there is continuous pressure exerted by economic interests on the environmental heridage as a driving force for the ever-increasing generation of wealth. This threatens many areas in the country as its natural resources are exhausted. As a result, local populations are impoverished, with apparent impacts on the present and especially on the future. At the same time, the configuration is characterised by fragile, always incomplete links among the various levels and spheres of our reality. These are in a constant state of reconstruction and are therefore fragmented and uneven. Their components are extremely unequal. These components include historical backgrounds and interactions among social groups and, to a greater or lesser degree of inequality, impacts on both the domestic and international communities.

Hence, our multiple and transitory conceptions of territory and identity are "ongoing", and are subject to the whim of diversely paced interactions between social groups from different backgrounds and cultures, between ourselves and the environment we live in, the resulting achievements and conflicts, and impacts on the domestic and international communities (Almeida and Cruvinel, 2001).

Therefore, the country's territory can be perceived as a converging point of natural and social developments that both cluster together and act as links in a single chain with multiple meanings. This ensemble is composed of various past and present sector-specific public policies. Other elements include their creators and managers. They also include us, the users and the recipients of the economic, social, environmental and geopolitical consequences discussed here (Carvalho, 2001).

In this sense, the territory is viewed as an element of the social structure where natural, human, technological and financial resources interact. This concept derives from a system of regulations and flows. The increasing territory-globalisation interrelations can be observed through the transformations undergone by participants and the roles they perform. It can also be seen in the need to interconnect spaces, in the growing expansion of the flow of people, information and goods. The country's perspective for territorial development as described in the Avança Brasil ("Move Forward Brazil") Programme illustrates the point: it both provides for mechanisms to foster progress in the country's backlands and stresses the need to gear efforts towards areas and segments that can generate more substantial effects on the rest of the economy. This is done a view towards integrating the country into the international economy.

This political guideline tends, however, to favour those areas with comparative advantages. this widens inter- and intra-regional gaps as investments, activities and overexploitation of resources occur in the most developed and, consequently, more densely populated regions. In this sense, urbanisation represents not only a factor of demographic concentration, but also a prerequisite for the creation of development opportunities. This must take place above a subsistence level, taking advantage of agglomeration economies, which are key for the badly desired boost in small businesses. Cumulative and growing interactions between the environment and the supply of services in densely populated areas have adverse effects both on the environment and on the quality of the service supply, which leads to bottlenecks and shortages.

When and where territorial management is not implemented in a co-ordinated and effective fashion, many clashes take place, as mentioned earlier. When this happens, all stakeholders end up in a lose-lose situation. In this sense, the implementation of integrated territorial management in Brazil can help suppress or reduce different types of environmental aggressions that still occur in several Brazilian biomes.

## 1.2. GEO – A Brief Background

The "life-friendly environment quality" can be seen as the guiding principle of the National Environment Programme – PNMA (Law 6,938 of 31/08/1981), around which all other principles and goals revolve. In order to ensure that its goals will be achieved, this policy establishes the Report on the Quality of the Environment – RQMA (article 9, item X of Law 6,938 of 31/08/1981, added to the original text by means of Law 7,804 of 18/07/1989). For as long as the National Environment Programme has been around, a document in the form of a Report on the Quality of the Environment was only published in 1984 with a view towards informing society about the real conditions of the environment in Brazil and its main problems and achievements.

When the United Nations Conference on Environment and Development – UNCED, also know as Rio-92 was held, the Brazilian Government published a report called "Challenge of Sustainable Development: the Brazilian Report for the United Nations Conference on Environment and Development". The document was jointly developed by consultants, the government and several civil society organisations in order to map the state of the environment in Brazil to serve as input for the discussion of the stances adopted by Brazil with regard to environmental issues at Rio-92.

Ever since, many efforts have been made by the government and civil society entities towards including the principles and goals of the Conference's Agenda 21 into the Brazilian environmental programme. Based on the need to develop a broader view of the conditions of the environment in Brazil – focusing on the correlation between environment and the various production segments in particular – the Brazilian Ministry of the Environment published "Brazilian Ecosystems and the Main Development Macro-Vectors" in 1985. This is a manual for the development of environmental management policies. The primary goal of this document was to provide the main entities involved with the various facets of territorial management in the country – especially at federal and state levels – with a more integrated view in terms of space. This is true with regard to the most significant development vectors, including a description of their characteristics, dynamics and trends.

The underlying principle guiding the project was one that could produce adequate tools for the implementation of environmental management policies within the Brazilian territory. In this sense, a space-orientated view of what was going on in the country with regard to the conditions of the environment was an indispensable task set out by this study. To this end, the work considered that a space-orientated approach by the various production sectors would by represented by "development macro-vectors". These refer to the most important interventions in the space/territory. For the examination of such macro-vectors, the ecosystems they affect were taken into consideration and the following indicators were used: pollution; waste; protection and sustainable use of natural resources.

As a follow-up to the advancement of an integrated environmental management in Brazil with the involvement of civil society and an inter-institutional coalition of distinct public policies, the Ministry of the Environment published "Diagnosis of Environmental Management in Brazil" in 2001. The purpose of this report was to present the institutional, administrative, technical and legal frameworks dealing with environmental management in all Brazilian states and the Federal District.

When the Brazilian Agenda 21 is launched in July 2002, the government enters a new phase towards sustainable development. In 1997 the Comission for Sustainable Development Polices (CPDS – Comissão de Políticas de Desenvolvimento Sustentável) was established for the formulation of Agenda 21. The commission was co-ordinated by the Ministry of the Environment and lit comprised 10 members of the civil society and government. For the elaboration of the Brazilian Agenda 21, six topics were assigned priority level: sustainable agriculture; sustainable cities; regional infrastructure and integration; natural resource management; reduction of social inequalities; and science and technology for sustainable development.

## 1.3. Building Interaction

The document called Global Environment Outlook - 1 or GEO 1 was developed in response to the recommendations of "Agenda 21", in accordance with a decision made by the United Nations Environment Programme - UNEP's Governing Council at its 18th session in May 1995. It was designed to build a consensual environmental database on global environmental problems, to establish priorities within the realm of current concerns and particularly to identify the concerns that the international community must address. Published in January 1997 by the United Nations Environment Programme, the GEO-1 report was the first of a biannual series of documents aimed at examining the environment's global state and assessing the current efforts towards making the environment more sustainable.

GEO-1 was elaborated according to a participatory and region-specific approach. The data used were collected by UN Agencies, several experts and organisations from the various continents, who were designated as Collaborative Centres. For the formulation of GEO-2, UNEP adopted the concept of Collaborative Centre as a "regional multidisciplinary institution that fosters interactions between science and policy-making". Each Collaborative Centre conducted studies in order to keep the environment's state at regional and global level under examination. The Centres also worked to support scientific guidance for the development of regional and international policies, in addition to planning actions towards sustainable development.

The strategy used by UNEP for the design of GEO-1 – the generation of basic reports of GEO-1's chapters and its later submission to the Collaborative Centres for review – was reconsidered. In this sense, GEO-2's strategy was to develop approaches in conjunction with the *Collaborative Centres* and to assign them tasks such as data collection and analysis and the formulation of chapter reports, thus ensuring greater participation of regional institutions in each continent and therefore validation of results.

In January 1997, IBAMA - the Brazilian Institute for the Environment and Natural Renewable Resources was invited by UNEP to join the GEO Process as a *Collaborative Centre*. IBAMA was chosen because it was a national-level, environment-minded institution with experience in environmental analyses, research, control and environmental management. IBAMA's scope within GEO-2 was defined as Latin America and the Caribbean, to work in conjunction with the University of Chile through its Centre for the Analysis of Public Policies, and the University of Costa Rica, through its Development Thinktank. IBAMA has been involved in the elaboration of GEO Reports ever since. GEO-2 (GEO-2000) was published in November 1999. In 2000, GEO-2000 for Latin America and the Caribbean – GEO-LAC was published. GEO Juvenile for Latin America and the Caribbean was issued in 2001 and in July 2002 GEO-3 was published. Also in 2002 GEO-LAC is to be issued. In this period UNEP supported the publication of national level GEO reports in Panama, Costa Rica, Barbados, Peru, Argentina and recently GEO Brazil.

IBAMA's participation in the formulation of GEO reports gave it the expertise necessary to undertake national strategic interconnections with a view towards developing the Environment Outlook Report of Brazil – GEO Brazil. Its objective is equivalent to that of the Quality of the Environment – RQMA stipulated by the Brazilian environment legislation.

The organisations below have been invited to contribute with the thematic diagnoses:

- **IBGE** – Brazilian Institute for Geography and Statistics;
- **IPEA -** Institute for Applied Economics Research;
- **EMBRAPA** – Brazilian Agricultural Research Corporation;
- **CPRM** – Brazilian Geological Survey;
- **IBAMA/DIREN** – Directorate for Renewable Natural Resources;
- **BIODIVERSITAS FOUNDATION;**
- **MMA/SRH** – Ministry of the Environment & Secretariat for water Resources;
- **IEAPM** – Admiral Paulo Moreira Sea Research Institute;
- **IBAMA/DEPAQ**;
- **COOPE** – Fundation for Project Co-ordination, Research and technological Studies & **UFRJ** – Federal University of Rio de Janeiro;
- **IBAM** – Brazilian institute for Municipal Administration & PARC;
- **CEPED -** University Centre for Disaster Study and Research & **UFSC -** Federal University of Santa Catarina;
- **FIOCRUZ -** Oswaldo Cruz Foundation;
- **MMA -** Ministry of the Environment;
- **IPAM -** Institute of Environmental Research for the Amazon.

The involvement of other equally important organisations with regard to the topics approached in the report was restricted by reason of the required time of institutional engagement. Funding restrictions and red tape problems in the establishment of institutional co-operations also occurred, and such problems will be minimised during the elaboration of GEO Brazil 2. The organisations participating in GEO - Brazil mentioned above were in charge of consulting with other institutions dealing with each topic in order to have a broad range of opinions and views and also to make the data and information collected more cohesive.

## 1.4. Report's Structure and Contents

This report's structure comprises five chapters (see below). Each chapter was developed based on input from different collaborators/authors. Technical credits are listed collectively and entirely in the beginning of this report.

### Chapter 1 - INTRODUCTION:

This chapter lays out GEO's elaboration method, this publication's composition, the approach, its purposes and backgrounds, with special attention to some points and questions raised as the chapter was being elaborated. The approach suggested by IBAMA to collaborating organisations for the development of their respective input was the one UNEP has been using to create global GEOs. It favours assessments of state-pressure-impact-response - SPIR in a given moment. Its proper application in Brazil would require, however, access to time series of environmental data in order identify trends and the development of scenarios for all listed topics. These are unavailable today. From all points raised as input to the GEO process, this chapter focuses on some of the requirements for integrated environmental management in Brazil.

**Chapter 2 - THE STATE OF THE ENVIRONMENT:**

This chapter addresses the state of the environment in Brazil, taking into account the main pressure-exerting factors and their impact according to topics originally stipulated by the United Nations Environment Programme - UNEP in GEO reports. These topics include: soils, forests, biodiversity, water, coastal and sea environments, atmosphere, urban and industrial environments. Due to the country's diversity, these seven original topics were broken into sub-soils, fishery, environmental disasters and health and the environment. The two latter elements link all the others. The multi-institutional approach in place shows significant differences in approach identified within these institutions, which will be explained throughout the report.

**Chapter 3 – POLICY RESPONSES:**

Analysing sector-specific policies that have an impact on the current territorial dynamics, its trends, conflicts and challenges requires a background characterisation of the efforts made by Brazil and of the broad range of new participants in society. These elements often develop their actions independently and in a vacuum in response to the key conflicts and demands laid out in the two previous chapters of this report. That said, the main purpose of this chapter is to show the different views of the various collaborative institutions with regard to the actions considered as responses to problems that were identified earlier, with a view towards helping improve system of territorial management and management currently in place in the country.

**Chapter 4 – SCENARIOS:**

The development of scenarios is based on the identification of the main pressure factors that act on Brazil's major biomes: the Amazon, Caatinga, Cerrado, Pantanal, the Atlantic Forest, Southern Fields and Coastal Zones. The relevant pressures were those that imposed substantial changes to the environment and thus helped worsen the standard of living and undermine the continuation of local economic activities and the survival of indigenous cultures. As biomes are large territorial units for analysis purposes, they were considered as space units for the diagnosis and analysis of trends. To this end, the main vectors and their impacts were identified for the construction of trend scenarios and desired scenarios for the individual biomes.

**Chapter 5 – RECOMMENDATIONS:**

This chapter addresses the necessary recommendations for a significant change of behaviour to tackle the two critical challenges. The first challenge is to improve the standard of living in occupied areas, particularly in large urban agglomerations, which have been extensively degraded in terms of overexploitation of natural resources (e.g. water) so that the infrastructure essential to life in all its aspects, such as basic sanitation, can be furnished. The second challenge is to ensure both proper preservation and exploitation of the remaining natural resources through sustainable management of these resources. This is necessary so that the areas that are now poorly populated can be occupied in a more adequate fashion.

The **ANNEXES** in the end of this report contain sets of environmental, economic and financial indicators provided by IBGE and IPEA. These indicators are based on corresponding statistical databases, biomes and selected fauna species and the voluminous bibliography used. The annex section ends with a collection of the main regulations on the use and preservation of the environment in Brazil. Such data were gathered in order to provide input to potential studies.

The harmonious participation of public agencies, research institutions, universities and non-governmental organisations – which were selected among the most distinguished in the country – fulfilled a key requirement for the process to continue, i.e., the simultaneous involvement of these participants that work with the environment. The original goal was to produce an "agreement document on the state of the environment in Brazil". In order to achieve this goal, however, inter-institutional co-operations were geared towards integrated territorial management, which is in its early stages in the country.

The outcome of the presented undertakings provide major contributions to this approach being adopted in the future. This is true insofar as it fosters the development of discussion, confrontation and negotiation groups, though temporary, to deal with the substantial differences in approach and views regarding the mechanics of Brazilian land use and occupation. Reaching an agreement about the state of the environment requires gradual work. For the time being, this report brings together the various views of the many guest institutions, by sector. As a result, there are foreseeable discrepancies in statistical data provided by the various institutions to support their distinctive stances with regard to the state of the environment in the country.

## 1.5. The SPIR Approach

The approach used in developing the essential documents that comprise GEO Brazil is the same as that employed by the United Nations Environment Programme (UNEP) for the elaboration of the GEO series. Basically, it consists of a State-Pressure-Impact-Response Integrated Environmental Assessment with regard to human activities that affect the environment.

The UNEP and the International Institute for Sustainable Development – IISD have developed a manual that is part of GEO's training programme. Its purpose is to prepare participants and collaborators for the generation of GEO reports and other documents related to the environment. The goal is to generate accurate assessments of the state of the environment and of the consequences from policies relative to the decision-making process towards effective sustainable development.

### 1.5.1. Integrated Environmental Assessment (IEA)

IEA is an approach for the production, analysis and sharing of information on issues related to the natural environment and the society, which are relevant in terms of public policy-making. IEA addresses four basic questions:

- What is going on with the Environment?
- Why is this so?
- What are we doing about it (Policies)?
- What will happen if we do not take prompt action?

### 1.5.2. SPIR's. Structure

Human interference in the environment affects the state of its components and generates a response, whether immediate or not, to its quantity and quality. As is the case with all complex systems, the impact caused when a component is altered induces changes to the extent of the pressure exerted on it. Such cause-effect interactions can be better viewed when one is able to arrange the states of the environmental components according to their respective pressure factors. This is a simple way of assessing environmental impacts based on the pressures that generated them and therefore on the potential responses from policies that could minimise them or even suppress them. The Integrated Environmental Assessment revolved around three categories Pressure-State-Response (PSR). Based on the PSR structure's rationale, some more detailed alternatives have been developed, such as SPIR, where the Pressure Impact on the environment has been included.

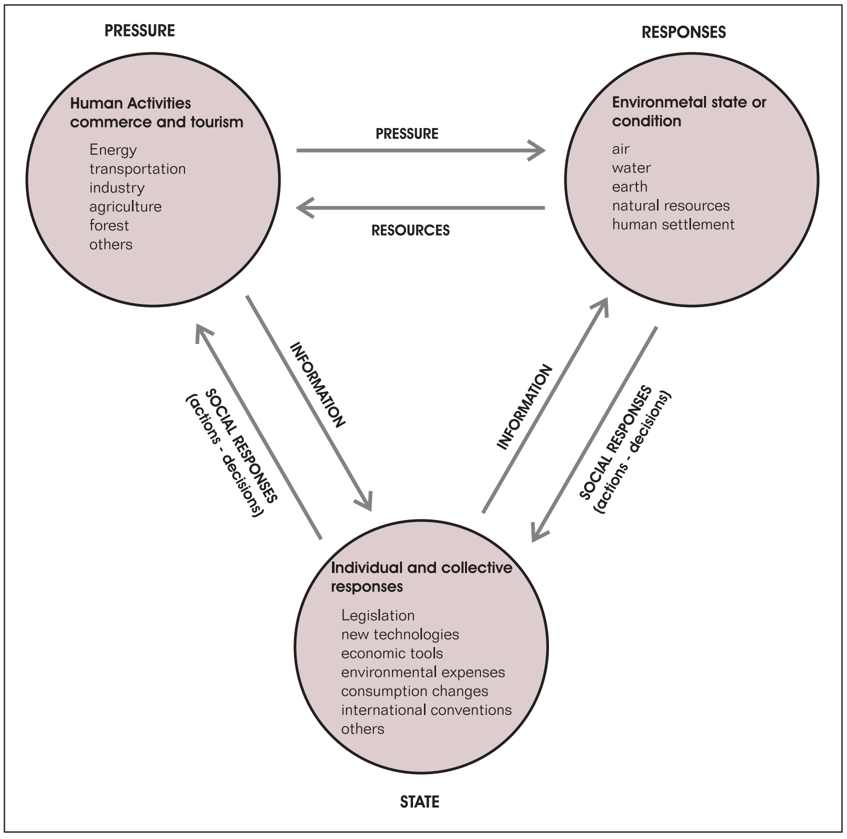
Depending on the relationships in point, some terms may appear in more than one of those categories. The SPIR structure can be used more as an approach for analysis than as a rigid category.

The following descriptions may be useful:

**a) STATE:**

This refers to environmental conditions, such as: air quality against air pollution levels; deforestation rate; level of water contaminants etc. The state of the environment affects human health as well as socio-economic elements. For example, increased soil degradation can have impacts on: decreased food production; expanded food importation; increased use of chemical fertilisers; under-nourishment and so on. Being knowledgeable about the state of the environment, as well as its indirect effects, is a critical requirement for decision-makers and public policy makers alike.

**Figure 1 - SPIR Structure**




**b) PRESSURES:**

These are frequently classed as actions imposed by human beings on the environment: activities and processes that influence the environment and cause changes (usually considered as primary causes and driving forces); demographic growth, industrial expansion, consumption patterns, inequalities etc.

**c) IMPACT of this pressure on the environment:**

This refers to the health and well-being or condition of the population, economy, ecosystems etc.: high levels of nutrients in coastal waters (state) can lead to higher algae levels and increased poisoning by toxic substances produced by sea species in coastal communities (impact).

**d) RESPONSE by the society:**

Actions taken in order to diminish or prevent environmental impacts, to offset environmental degradation or to preserve natural resources. Such actions may include: national regulations and laws; economic instruments; regional/international conventions and agreements etc.

## 2. Current Status and Perspectives of Environmental Management in Brazil

One of the first environmental problems that was identified in the 1960's – even before the governments of developed countries started to declare a substantial amount of regulations and specific laws, before they put new institutions in place and before they adopted measures on environmental effects – was the fragmentation of the existing policies, especially those related to the use and protection of environmental resources. The American policy for the environment was promulgated in 1970[1], and was an instance of legislation whose primary objective was to foster integration of different government agencies that developed actions that were either directly or indirectly associated to the environment.

### 2.1. Causes and consequences of fragmented approaches to develop and implement environmental policies

Even though fragmentation was identified and diagnosed over the course of the three past decades as a relevant issue for effective implementation of environmental policies, very few effective actions have been taken up to now in order to do away with fragmentation of policies, whether for the environment or not. On the contrary, the various regulations, agencies, plans and programmes and other instruments created during the period only helped increase this multiplicity.

Many factors can account for the fragmentation of actions regarding environmental policies. One of them refers to the approach according to which the environment is viewed as comprised by distinctive and separate resources, settings and systems – air, water, energy, soil, plants etc.

Another factor can appear in the decision-making process, i.e., in the domain of reasoning. Human capacity is limited in dealing with complexities and problems in an integrated fashion. The most frequently used method to overcome such limitation is the division and creation of specific areas of reasoning and responsibility. In the administrative domain, and most notably in the context of an administrative state, this division is expressed by the creation of different agencies and institutions in charge of different areas/sectors so as to make their administration "manageable".

### 2.2. An alternative to overcome fragmentation: the integrated environmental management

As a proposal to overcome fragmentation in dealing with complex and uncertain systems such as the environment, an initiative being developed is the redesign of planning procedures and, more specifically, of environmental management. In this context, environmental management has been increasingly understood as a set of activities/ procedures, the objective of which is to guarantee that a given area (biome, ecosystem) and/or resource (fauna, flora) is used in a way that makes its sustainability be the main requirement to be pursued.

In order to achieve this, it is important to consider that the management process includes in its stages the activities and practices of forecasting, assessment and follow-up. These elements start from the most general level and arrive at the most detailed level. This means that activities and practices that start during the planning stage and extend to the monitoring of different projects. Graphically speaking:

**PLANNING ⇒ CONTROL ⇒ MONITORING**

It is important to note that, since the environmental impact studies (EIS) arose, different instruments have been developed with the objective of providing a more comprehensive and effective perspective to the environmental management process. For example, this is the case of the Strategic Environmental Assessment – SEA, the main objective of which is to assess implications of policies, plans and programmes in the context of economic, environmental and social dimensions. Another example is the adaptive management process, which aims to establish more efficient monitoring procedures. This process is not what is being carried out at the moment.

Today Brazil seeks the integration of these different instruments (new and already known ones). In combination, they may promote progress in the environment management practices carried out today. It was decided to give the title Integrated Environmental Management to this new perspective, considering that it integrates the different environment management instruments developed and available today. This should occur so that the environment also be considered in an integrated way.

[1] National Environmental Policy Act - NEPA

Each of the Integrated Environmental Management stages will be discussed briefly below, and the development of actions will be explained, which aim to put in practice this environmental management process perspective at federal government level – specially at the level of the Ministry of the Environment.

## 3. Integrated Environmental Management Planning

### 3.1. Strategic Environmental Assessment

A simple idea of Strategic Environmental Assessment – SEA – is that it represents a process of environmental assessment of policies, plans and programmes – PPPs. Probably, due to the fact that it is a new concept, there are few definitions that have been attributed to the SEA process. However, an appropriate definition is used by Sadler and Verheem (1996):

"SEA is a systematic process to assess the environmental consequences of policies, plans and programmes, in a way to ensure that these consequences are included and appropriately considered in the initial stage of the decision-making process, together with the economic and social aspects."

In accordance with the literature on the SEA process and also with the analysis of the main experiences related to the practice of this process at national, regional and local levels, three main types of action may be submitted to a SEA process:

**a)** sector PPPs (such as power and transportation);

**b)** PPPs related to territory use, covering all activities to be implemented in a determined area and;

**c)** policies or actions not necessarily implemented through projects, but that may have significant environmental impacts (for example, incentive or credit policy).

The main problem concerning this triple context of the SEA process application is the integrated nature of these three types of actions. It is impossible to discuss a sector policy, plan or programme without relating them to the territory where they will be implemented or the political and ideological context in which the policy, the plan and the programme were designed and approved.

The same argument is true for the geographic dimension issue. It is impossible to consider the use of a determined territory without pondering the sector activities that will be developed within (and also out of) its boundaries. Althoug this separation is convenient to simplify the analysis to be developed in a SEA process, it brings consistent problems to the execution of the final results of the proceedings. This factor must be considered in SEA conclusions.

In order to overcome this issue in the context of SEA, the proposed proceeding is management by ecosystem/ biome. Because it is new perspective, like SEA, the establishment of a precise concept of what management per ecosystem/ biome is not in an easy task. Nevertheless, it is important to point out that the concept has two dimensions: one is structural/ functional and the other is political.

In relation to the first dimension, it is important to consider that in the definition of what an ecosystem/ biome is, it is necessary to understand that this is a term applied to a wide variety of spatial scales. Functionally, as well as spatially, ecosystems and biomes exist in a hierarchic structure. The higher level contains and is composed of different components in a lower level. Thus, the boundaries of an ecosystem/ biome can be both structural and functional. If the differences identified on both sides of the boundary are significant, then the boundary is real or natural; if the differences are not significant, then the boundary is artificial and cannot define different ecosystems/ biomes. However, even considering this aspect, defining an ecosystem/ biome is still a very complex task. In order to make some progress towards this definition, climate has been considered a relevant element for the establishment of boundaries of an ecosystem/ biome. Climate controls the patterns of ecosystems/ biomes on different scales. As a result, the boundaries of an ecosystem/ biome are based on climate, which allows the identification of permanent boundaries.

Another system for the definition of ecosystems/ biomes takes water into consideration. Thus, climate and water are the two most important factors, as they present more precisely the real boundaries of relevant ecological processes.

An interesting system to define possible work ecosystems/ biomes within the Brazilian context was proposed by Egler (2001), who redesigned the national territory with the use of landscapes demarcations and administrative limits (municipalities). **Figure 1 in Chapter 4** presents this proposal.

As indicated, the definition of management by ecosystem/ biome has a policy, in addition to a functional structural dimension.

> "...management per ecosystem is much more related to population than anything else... the success or failure of the management by ecosystem in protecting environments, revamping the economy or restoring communities' health, starts and ends with the population and their choices – not with nature preservation, databases, ecological classifications, or any other technological instruments that are only mere useful means for desired purposes." (Salwasser 1994, apud Crober 1999)

At last, it is important to indicate that the management by ecosystem/ biome requires a deeper understanding of social and economic systems and their interactions with biophysical systems.

> "... we need much more accurate knowledge on what public attitudes are and how they vary in accordance with socio-economic factors, such as: age, education, income and social classes... and most importantly, we need to know why certain attitudes are kept and what the commitments between cultural attitudes for the protection of the environment and the economic gains from the use of natural resources are." (Marcin 1995, apud Crober 1999)

Another important aspect of considering the SEA process refers to the reasons that have justified the need to adopt and implement it. There are two main reasons to insert SEA in the present political and environmental agenda.

The first reason is the potential capacity of this process to overcome technical deficiencies identified in the Environmental Impact Study – EIS – process, specially in relation to the reactive, rather than the proactive nature of this process. Therefore, issues such as the consideration of different alternatives (for example, scale, place, time, technology) and the mitigating measures are understood and considered and already decided upon at the project level (the EIS process application level). This limits possibilities for modification. In addition to that, the project EISs are regularly limited to the consideration of the direct impacts caused by the activity, without considering several other possible impacts, which are usually called cumulative impacts.

The second reason that justifies the adoption of SEA procedures is the role this process may play in the promotion of development sustainability. Thus, if sustainable development is a practice to be achieved, together with other measures[1] , through the integration of environmental, social and economic dimensions in the decision-making process, SEA may perform a decisive role for such integration, by acting as a co-ordination procedure within the different levels of governmental planning activities.

The first reason will be discussed in the next item, when the control stage of the Integrated Environmental Management process is considered. It will indicate the problems that must be overcome, and also the solutions that have been proposed. Wider discussion of the second reason, sustainability promotion, is necessary. Other aspects important to the effective implementation of a SEA process must also be taken into consideration.

An issue already considered to be relevant is the need to overcome the fragmented treatment given to the environment, for proposals like sustainable development to be viable. Nevertheless, it is important to observe that this practice has not been limited to the environment only. It has extended to other activities such as planning and formulation of local, sector, regional and national policies.

The SEA process can be described as analysis and assessment of both environmental impacts and social and economic effects of policies, plans and programmes established in a determined context (national, regional, local or sector).

[1] The other defended measures to achieve sustainable development are: (1) the establishment of environmental quality goals and/or emission rates that make the achievement of these goals viable; (2) the institutional strengthening to promote the combined achievement of environmental quality and economic development goals; and (3) the intensive use of economic instruments to guide the economy to ways that enable effective sustainable development.

The application of this process may ease the development and implementation of co-ordination procedures, in a way to avoid inconsistencies and conflicts among the objectives, the goals and the participants of these PPPs.

By triggering an interaction exercise and the harmony of different policies, plans and programmes, SEA can perform a mechanism for the co-ordination practice to be fortified. This can take place at the planning level. In addition to inserting the environmental variable and value in the context of different PPPs, the use of strategic assessment procedures goes beyond this dimension and also influences the planning activity itself. This occurs while the necessity of interaction between different policies, plans and programmes is established. This is not done in the sense of imposing centralisation/ control, but with the purpose of seeking coherence and legitimacy for policies, plans and programmes when public participation in the planning process is stimulated.

In what considers the implementation of a strategic assessment exercise, the identification of the topics that must be considered and included in the study to be developed is a relevant aspect. The following factors influence the choice of the topics to be included in SEA:

**a)** environmental laws, regulations and patterns;
**b)** objectives of environmental, social and economic policies;
**c)** public consultation; and
**d)** former decisions or the opinion of relevant groups.

Different topics must be appropriate for different planning scales – what is applied to a policy is not always applied to plans or programmes. The topics may adopt only a biophysical (narrow) view of the environment, or they may take a wider view, including socio-economic aspects.

The topics may be guided by sector subjects (e.g. power, transportation, culture) disciplinary subjects (e.g. demography, biology or geography), or they may be cross cutting, in order to include a more comprehensive outlook in the assessment. For example, the following topics are some to be considered in a strategic assessment of a development policy, plan or programme:

**a)** natural resources are used efficiently and residues are minimised by closed cycles;
**b)** pollution is limited to levels at which natural systems can withstand without harm;
**c)** nature diversity is valued and protected;
**d)** local needs are met locally;
**e)** everyone has access to quality food, water, shelter and fuel, at acceptable and affordable costs;
**f)** everyone has job opportunities in a diversified economy;
**g)** the population's health is protected, through the creation of a safe, clean and pleasant environment, and through health care services;
**h)** people live without fear of violence, crime or persecution;
**i)** everyone has access to the necessary instruments, knowledge and information, in order to be able to fully participate in society;
**j)** the community can take part in the decision-making process;
**k)** culture, fun and recreation opportunities are available to everyone; and
**l)** places, spaces and objects combine sense and beauty with usefulness. The settlements are "human" in scale and form. Local diversity and identity are valued and protected.

In order to have a measurement of the impacts related to different topics/ activities to be assessed by SEA, environmental or sustainability (including economic and social aspects) indicators are used. It is possible to measure and forecast all impacts of a PPP and indicators are used to represent the status of and the impacts on different aspects of the environment. For example, they can be used to measure the conditions of the initial environment (with no interventions) and forecast impacts. They can also be used to compare alternatives and monitor the implementation of the PPP.

Some relevant aspects rise in the indicator-choosing process:

- **a) first:** there is no "agreement" related to which acceptable indicators are. Different organisations adopt different indicators.
- **b) second**: the indicators can be of three types: ***pressure***, which describe pressures on the environment – e.g. pollutant discharge; ***state***, which describe the environmental conditions – e.g. pollution levels of a determined water body; and ***response***, which measure the responses to environmental pressures – e.g. percentage of vehicles with catalytic converters.
- **c) third:** the number of indicators is important. The more indicators that are used, the more "complete" SEA will be. Likewise, the necessary length of time and volume of resources for SEA to be carried out will be larger.
- **d) fourth**: some indicators can be easily measured, while others cannot.

In order to have appropriate indicators, it is necessary to have trustworthy numeric data from monitoring processes. On the other hand, the data from a monitoring process need to be processed, so they can be better understood (and more relevant) in the elaboration of answers and the implementation of policies. These data are compared, as much as possible, to patterns defined in previous studies to be assessed.

Concerning the implementation of SEA in Brazil, two moments may be identified as expressive. The first one marked the elaboration of a SEA manual, requested by the Brazilian Ministry of the Environment. The objective was to identify the procedures that characterise the strategic assessment to check which actions are necessary so its implementation is feasible in the context of national planning structure. The next step will be the establishment of procedures and mechanisms that will enable the use of the SEA as an assessment procedure of policies, plans and programmes at sector, national, regional and local levels.

The second moment, starting now, marks the beginning of the SEA development within the Brazilian Ministry of Planning, Management and Budget – MP. It is about carrying out SEA for the PPPs related to the North and Midwest regions of the Avança Brasil programme.

## 4. Control in Integrated Environmental Management

Although the environmental impact study (EIS) process is expressively used in Brazil, it has still been triggering several discussions, which is evidence of its relevance and application.

### 4.1. Advantages and Limitations of Environmental Impact Studies

These discussions are related to different aspects of the process. One of them is of a technical nature, referring to suggestions for the improvement of methodologies and the forecast techniques used. Another is related to the procedures adopted in the EIS process or the legal and institutional arrangements used for its introduction and implementation – procedural, legal and institutional issues. Finally, there is discussion on the political and structural nature of the process, where the main issue considered is an assessment of its effectiveness, in respect to the dimension with which EIS results are taken into consideration, and how the process changes or improves the consideration of environmental and social issues in the decision-making process concerning development actions.

A crucial issue to be solved in the context of this discussion is the decision on which of the above aspects are important. This is an important issue, due to the fact that different specialists in this assessment process are insistent on any problem related to EIS inadequate or ineffective use as due to one of these aspects. They go on to point out that process improvement can be achieved through changes in the impact forecasting methodology, or in the adopted procedures, or the legal and institutional aspects.

On the other hand, other specialists state that the problem can be found in variables located outside of the strict dimensions of the EIS process, which makes the decision on how to optimise the process more complex.

The EIS process has been receiving strong criticism in relation to its effectiveness and efficiency – mainly from important non-governmental environment organisations. This certainly jeopardises its role as an important instrument in the decision-making process.

The Environment Impact Study is known as a forecasting process of the possible effects/ impacts that a development action can cause on the natural or human-modified environment.

However, this simple definition is not enough to describe how this process is implemented. The purpose of EIS is different, depending on **when** and **by whom** it is defined. Nevertheless, there are three purposes that are widely acknowledged as EIS characteristics. The first is that it works as an information instrument for the decision-making process. For the decision-makers – for example, a local government – the EIS process can provide a systematic assessment of the environmental implications of a development action. On some occasions, it can assess possible alternatives to this action before a decision is made. The EIS and the Environmental Impact Report – EIR, are not the only document to be considered in a decision-making process. Nonetheless, unlike the other analyses used to make a decision such as a cost/ benefit study, the EIS is usually more comprehensive and less quantitative.

The second purpose attributed to the EIS is that it works as a negotiation and mediation instrument. When putting together representatives of businesses, the government (acting as a planner) and groups of organised civil society, the EIS can work as an instrument to provide balance in reaching agreements among the different interests involved in a negotiation.

Finally, the EIS represents a support instrument for the formulation of development projects and actions. The EIS indicates areas/ aspects where projects can be modified in a way to minimise or eliminate adverse effects on the environment (forecasting action). Thus, when used by businesses in the initial planning stage of a development action, the EIS can lead to a better consideration of the social and physical environments and, consequently, to a financial return of the costs incurred in the study itself.

According to assessments developed by the Ministry of the Environment, three issues have been considered crucial to the EIS practice being effectively developed in Brazil. These issues/ problems must be discussed, aiming to identify possible solutions that can make the EIS viable as a helping instrument to the decision-making process.

## 4.2. The Public's Participation

The public's participation is a stage of EIA process that has been considered as essential, but also problematic. Perhaps, one of EIA's strengths has been openness for public involvement in the decision-making process traditionally carried out in the governmental sphere. This event was true both for the United States in 1970, with the approval of the American Environmental Policy, and for Brazil, in August 1981, with the approval of the National Environmental Policy (Law 6938).

As for this stage in EIA's process, the discussion on possible improvements focuses on two aspects. The first concerns when the public should take part. The second refers to how to transform the public's participation into effective participation in the decision-making process on development actions.

Usually, the public's participation takes place during the Environmental Impact Study review, and this is how it is carried out in almost every EIA system adopted globally. However, this has been gradually changed so as to comply with different assessments showing the importance of the public's participation from the outset of an EIA process. There is a proposal to introduce public participation from EIA's outset with the objective of promoting the development of a study with a higher quality and legitimacy. The main argument supporting this proposal is the fact that the population which will be affected (directly or indirectly) by a development action and is in a better position to know how this action will impact on and/ or change their lives. The issue here refers to the improvement of the quantity and quality of information to be made available for an EIA. This is essential to avoid future reactions to the projects being implemented from a population which was neglected and/ or left out of the decision-making process.

What has been proposed as a mechanism to allow the public's involvement from the environmental assessment's inception is for the environmental agency in charge of reviewing the environmental impact study to carry out a consultation both in person and by mail. As previously observed, participation at this stage of the process allows the public to indicate aspects to be included in the assessment. The public then has the opportunity to use as a reference the knowledge that the communities have of the characteristics, dynamics and specificities of the areas they inhabit.

The second instance has that already been anticipated in the legislation on EIA in Brazil, at the conclusion of the assessment study, during its final review by the government's environmental agency. However, the analysis already carried out on this participation process has indicated that improvements are necessary. The main question to be solved in this context is how to promote effective and specially informed participation by the public in reviewing an EIA. The problem here is the existing imbalance between financial and technical resources made available to the entrepreneur, the governmental agency in charge of reviewing EIA and the public's participation. It is clear that the most fragile party here is the public which, in most cases, do not have the necessary expertise to effectively take part in the discussions on the possible benefits or consequences – social, economic and environmental – of the project to be implemented.

A solution for this matter, which has been considered by the Ministry of the Environment, is to enable a financial mechanism aimed at facilitating the public's participation in EIAs. This would be done by financing advising services, consultancies and studies, among others. The National Environment Fund (FNMA – *Fundo Nacional do Meio Ambiente*) has been financing this type of demand already, but the objective is to encourage more frequent use of it.

### 4.3. The Need for Geo-referenced Information Systems

The second issue in need of corrective measures within EIA refers to the necessity for setting up information systems which allow the organisation and availability of fundamental data for the development of assessment studies. Actually, this is an issue whose scope transcends EIA's realm, also being relevant to SEA.

In Brazil, the need to develop a system aimed at systemising, treating, storing and making environmental data and information available dates back to the beginning of the 1980s, when the National Environmental programme established the Environmental Information System (SINIMA – *Sistema Nacional de Informações sobre o Meio Ambiente*) as one of its implementation mechanisms. However, it never became feasible, mainly due to institutional reasons. The prime reason is that the different agencies sectorially responsible for the collection and storage of environmental information and data (soil, vegetation, mineral resources, among others) did not want to make them available for fear, on the one hand, of losing control over the information and, on the other, of the responsibility for its management.

At the beginning of the 1990s, the establishment of the Ecological and Economic Zoning (ZEE – *Zoneamento Ecológico Econômico*) brought back this issue of structuring an information system, though with a larger scope, including social and economic components too. Although ZEE has advanced significantly in terms of structuring databases with fundamental information for environmental management, this initiative was only possible in some states, basically those included in the Brazilian Legal Amazon. Except for these initiatives, whose scope and dimension were limited to the state level, zoning has not been systematically implemented in the other states of the Brazilian Federation, being mostly restricted to small fragmented areas in the country.

Following its purpose to establish a more effective environmental licensing system in the country, *the National Environment system (SISNAMA – Sistema Nacional de Meio Ambiente)* included the information issue as a priority in actions aimed at strengthening the EIAs. Assuming that one of the main demands in carrying out an environmental impact study is the availability of geo-referenced data, the proposal under implementation is to strengthen the environmental information systems at the state level.

The third and last issue which has been faced by SISNAMA in the realm of the EIAs refers to the sustainability of the process. This issue includes both the establishment of a reparation system for expenses with study reviews carried out by environmental agencies (federal, state and municipal) and actions aimed at promoting the institutional strengthening of these environmental agencies. These actions consist of the capacity-building of the agencies' human resources – with training and recycling programmes – and the establishment of a higher institutional autonomy by implementing more independent management practices and proceedings, whether at the staff level or budgetary and extra-budgetary resources level.

Box 1 - Zee - Brasil

**ECOLOGICAL AND ECONOMIC ZONING IN BRAZIL**

**According to data by the Ministry of the Environment, during ten years of ZEE's execution in the country, 811,000 $km^2$ were surveyed, in the scale of 1:250,000, which corresponds to 10 per cent of the national territory.**

**Aggregating the zoning carried out in the scale of 1:100,000 or larger to these figures, the previous percentage totals 11 per cent of the national territory.**

**In terms of continuous areas, the largest one zoned up to the moment are the Upper Paraguay Basin, with 361,660 $km^2$ and the State of Rondônia, with 238,513 $km^2$.**

**The prevailing work scale has been of 1:250,000, although the scale of 1:1,000,000 has been used at the beginning of ZEE's work for the macro-zoning of the Amazon.**

Fonte: Ministry of the Environment

This institutional reform includes legal, conceptual and organisational aspects. This issue will be examined more thoroughly later on, while discussing the institutional aspects involved in the implementation of Integrated Environmental Management.

Although the implementation of the environmental impact study presents different degrees of difficulty, mainly dependent on the political context where it is carried out, it is also important to consider that the EIA has not yet been replaced for another process which could adequately perform the three functions considered above – i.e., an information, negotiation and anticipation tool – in the decision-making related to development actions (projects). For that reason, it is important for EIA to be assessed for its efficiency and efficacy, seeking to use this assessment to identify and correct the problems which currently impede its effective implementation.

## 5. Monitoring in the Integrated Environmental Management

Usually, EIA's literature considers post-decision monitoring and auditing as the two last stages in the environmental assessment process. However, given the importance of these stages for the Integrated Environmental Management process, they will be discussed separately in this document.

### 5.1. Monitoring Stages

Monitoring can be divided in two activities: monitoring of the implementation and monitoring of the impacts. The first corresponds to assessing if the action under evaluation (usually a development project) was implemented (built) according to what was approved, and that the mitigating[1] measures were carried out as specified in the SEA or in the EIA.

The second involves comparing the outcomes of the action's implementation and of its impacts, in view of the anticipations and engagements made previously in the SEA and EIA processes. So, monitoring's main function is to test and improve the effectiveness of the techniques and proceedings (aimed at anticipating and assessing the impacts), with the primary purpose of improving future practices.

### 5.2. Obstacles to the Monitoring Activity

To the detriment of integrated management, monitoring and planning activities are the stages most in need of improvement and conformity. Three reasons can be pointed out to explain the shortcomings. The first is legal, once management proceedings do not consider monitoring as mandatory. In the absence of a legal obligation, it is very difficult to convince an entrepreneur to carry out an expensive activity that from another perspective does not bring him any direct benefit.

1 Mitigating measures are the actions proposed by an Environmental Impact Study, in order to avoid or minimise possible impacts which will be take place with the construction and operation of the development action.

The second reason is the short term attention devoted by the public to the projects which will be implemented near their dwellings. Generally, when it exists, this interest in discussing the social and environmental impacts of a project is focused on the approval stage, and does not extend to the implementation and operation stage. This stage is when the impacts and consequences will actually arise.

Finally, there is what can be called the 'budget factor'. EIA's process is considered by most entrepreneurs as a passing test for their projects or development actions during the project's construction stage. Many efforts and activities are developed in a short period of time. These include project planning, EIA execution, the discussion of this study with the government and in some cases with the public, approval and, finally, project construction. This includes the implementation of mitigation actions indicated in the EIA. All of these stages are included in the budget, during project construction stage.

When construction is complete and the project enters the operational stage, there is another budget to be considered (operation-related budget). There are few anticipations made for environmental and/or social-related matters in this budget, especially due to the lack of a legal measure demanding this provision. Since budgets are highly rigid documents, demanding considerable conformity and allowing little flexibility for changes, it is quite difficult to alter them in order to accommodate unexpected events – even environmental or social-related events. This aspect is more evident in development actions and projects conducted by the government than by the private initiative, since a private budget is more flexible than a governmental one.

A matter which reinforces the need for effective monitoring of intervention/development actions is the existing certainty that the knowledge of ecosystems/ biomes is limited and imperfect and, therefore, the management process entails considerable uncertainties.

## 6. Adaptative Management

Adaptative management has been proposed as a way of overcoming the problems derived from the uncertainties rooted in the management practices of ecosystems/biomes.

"adaptative management is an approach that applies the concept of experimentation to the design and implementation of policies for natural and environmental resources. An adaptative management is one that is designed to clearly test formulated hypotheses about the behaviour of an ecosystem under the influence of man's action (...) if the policy works, the hypothesis is validated. If it fails, however, an adaptative design still provides lessons so that future decisions can build on a better knowledge base." (Lee and Dancey, 1993)

The adaptative management approach is a necessary element for successful management of ecosystems/ biomes. It offers the best opportunity for the selection of the best management approach. Inadequate decisions are made on a daily basis. However, when system management is as complex as the ecosystems/biomes, risks of making wrong or inadequate decisions increase. Through adaptative management, these mistakes can be detected and grasped in a learning process so that future decisions can be made more smoothly.

If, on the one hand, the adaptative management approach proves to be an extremely promising tool for the management of environmental and natural resources policies, it is important, on the other hand, to be alert to its potential risks as experimentations can bring unexpected results. Nevertheless, if the management of ecosystems/ biomes is recognised in advance, and if it is regarded as an inherently uncertain activity, unexpected results can turn into learning opportunities instead of being weaknesses to be anticipated and corrected.

## 7. Institutional Aspects for the Implementation of the Integrated Environmental Management Approach

In addition to the aspects related to planning, control and monitoring that have been identified here, another challenge for the implementation of the Integrated Environmental Management is the institutional aspect.

One important aspect to start with is the method through which institutions were structured to address the environment. As was noted earlier with regard to fragmented policies, the same approach was also adopted to deal with institutions.

This event can be easily identified by analysing the organisational structure of governments at federal, state and local level. At federal level, for instance, the various sector-specific ministries and the agencies that usually operate under such ministries demonstrate how fragmented public administration is.

Also, with regard to the institutional side, interagency co-operation is another critical point. If it is about time that the society exerts more pressure on government agencies – though greater financial, human and infrastructure resources will not be made available for them in turn – an aggregation of competencies and resources is a necessary step in order to boost the response ability of such agencies. The actual picture of interagency co-operation, however, is a clear-cut, inflexible outline of institutional frontiers, as if this approach could ensure survival of the institutions.

As was identified in the discussion about the Integrated Environmental Management approach, its effective implementation depends on restoring a practice of government planning as a mechanism of concerted action and integration of policies. Furthermore, when a need for planning is identified, a key element in this sense is the development of co-ordination procedures that cannot lead, as was noted earlier, to the establishment of controls and power centralisation in one or a few institutions. Much to the contrary, by co-ordination we mean an approach towards negotiation, accommodating different viewpoints and acknowledging that participation and transparency are indispensable elements for a successful planning. **Chart 1** contains the main differences between the Traditional Management approach and the Integrated Management approach.

**Quadro 1 - Diferenças entre a Gestão Tradicional e a Gestão Integrada.**

| GESTÃO TRADICIONAL | GESTÃO INTEGRADA |
|---|---|
| Tomada de decisão 'TOP DOWN' | Participação de diferentes níveis |
| Centralizada, Linear | Descentralizada, com retro-alimentação |
| Aversa a riscos | Admite riscos |
| Decisões finalistas | Aceita revisar/revisitar e admite erros |
| Visão impositiva | Visões compartilhadas |
| Dentro dos limites administrativos | Através dos limites administrativos |
| Ator individual | Parcerias |

Fonte: Crober - 1999

With regard to the major difficulties for the implementation of this new system of environmental management, it is important to point out the items below:

**a)** development of approaches that adequately address the high levels of uncertainty that environmental systems involve;

**b)** intra- and interagency changes in the government in order to meet requirements of increased co-operation and partnership work;

**c)** design of new institutional capacities able to meet adaptative management requirements, especially with regard to public participation in the decision-making process; and the need to adopt a more interdisciplinary scientific approach.

A redesign of the institutional structure towards resuming a planning approach in the government requires not only a mandate for this role to be played, but also a political proposal that this activity be developed in accordance with democratic principles.

Another challenge to be addressed at institutional level is a need to change the way institutions, most notably public institutions, are traditionally perceived. Several studies have tried to demonstrate that institutions should be considered as independent variables, and not as a mere reflex of a given reality. They should also be viewed as entities that dialectically shape and are shaped by the individuals in them. Most importantly from this perspective is that an institution is not only a locus where individuals make arrangements to perform roles established by successive new decision-makers through structures and flowcharts developed according to principles that are limited to a good administration.

Much more than that, institutions play essential roles, namely by transforming individuals into citizens so that they can operate in accordance with appropriate rules of conduct, and also by raising awareness of moral and intellectual virtues of politics. A citizen knows the institutional reasons for specific conduct, and can justify this conduct under the requirements of an established order. This order is not to be understood as inflexible, backward, and immutable rules. It is important to point out that the concept of institution adopted here encompasses elements such as cultures, religions, laws and regulations. It also includes a more limited and specific level, namely that of an organisation or company.

## 8. Some Preliminary Considerations

Considering this perspective, an organisation must not be subject to permanent changes and alterations. This is due not only to the fact that constant changes result in a breakdown in the structure of functioning rules and routines, leading to a loss of institutional identity. It is also due to the fact that the immediate result of any organisational change is an inefficiency element in its operation, regardless of the type or nature of the occurring change.

In view of that, there is a crucial task to be pursued. That task is the search for institutional stability, aiming to capacitate public institutions to perform their roles and functions more efficiently. This stability refers not only to the organisational aspect, but also to the redemption of individuals in these institutions who make them the locus of formulation and implementation of public policies.

Finally, another challenge in the institutional context refers to the design of institutional arrangements. These make possible the participation of large segments of society in the decision-making process. On the other hand, they make possible the organisation of forums that allow for consideration of opinions from different participants and spokespersons at the same level of importance and consideration.

The architecture of these arrangements also performs a crucial role for the implementation of the adaptive management procedure, as its working characteristic assumes that different participants can express their ideas and opinions on the development of policies, plans, programmes and specially projects in advance.

This can be done aiming at the correction of possible problems/ impacts that were not identified during the elaboration process of these documents.

In this issue, it is essential to overcome the prejudice imposed by the idea that only educated people have the capacity of including knowledge in the decision-making process. This view does not allow the consideration that consultation with relevant social participants brings into the decision-making and assessment process information from the populations and the individuals who live where the policies, plans, programmes and projects will be implemented. This is significant knowledge from these individuals' lives that has the property of aggregating different dimensions that translate regional and local socio-economic and environmental behaviour and dynamics. Although many think that traditional knowledge does not seem to contain a scientific basis to be accredited, it can integrate the different dimensions of the environment in such a way that short-term limited researches of disciplinary nature cannot.

As seen before, Integrated Management represents the combination of different management and assessment procedures that have been developed since the early 1970s. Adaptive management, management of ecosystems/ biomes and strategic environmental assessment are all instruments that have been created as a way to solve problems identified in the implementation process of environmental management instruments in use, specially the environmental impact study.

The main mark of progress promoted by this new management perspective, is the use of ecosystems/biomes focus. This establishes new territory for intervention planning purposes. This new territory encompasses uncertainties and risks as elements that must be managed and not avoided in the planning and management processes, as conventionally understood. Finally, another significant highlight of this progress is the effective inclusion of the public, in such a way to provide a social context to decisions on the use of resources.

chapter 2

# the state of the environment in Brazil

# the state of the environment

## 1. The Geopolitical Context of Brazilian Territorial Configuration

With an area of around 8,500,000 km$^2$, Brazil covers almost half of South America. To the north, it borders Venezuela, Guyana, Suriname, French Guyana and the Atlantic Ocean. To the south, it borders Uruguay. To the west, it borders Argentina, Paraguay, Bolivia and Peru. The Atlantic Ocean bathes the east coast. There are several volcanic islands, among which are Fernando de Noronha, Abrolhos and Trindade. The country borders all nations of South America, with the exception of Chile and Ecuador.

The Brazilian territory is singularly located on both external and internal level. The former is related to the fact that the world sees the country as a “traditional” natural resource reserve and as the holder of biodiversity in the largest tropical forest on the planet. This includes having control over its genetic bank, whose potential is still unknown. This element is internally linked to the technical, economic and political incorporation of the territory, demanded by the productive expansion of the national space.

Considering both its latitude (between the 5°16’20”N and 33°45’03”S parallels) and its longitude (between the 34°47’30” and 73°59’32”W meridians), the vast Brazilian territory holds an extraordinary mosaic of ecosystems. This mosaic is produced not only by great climatic diversity but also by a great topographic diversity.

The position of the Brazilian territory, to the west of the Atlantic Ocean, and its topographic variations imprint different qualities on atmospheric macrosystems, be they continental or oceanic. This creates a wide variety of climatic areas that range from equatorial to subtropical areas, with degrees of types and subtypes. These areas are produced by geoecologic variability in the country.

Throughout history, these characteristics divided into sections the several forms in which society occupied and used the spaces shaped by tropical and subtropical nature in the country into sections. Generally speaking, this made up five large geographic regions: the North, the Northeast, the Southeast, the South and the MidWest.

## 2. Territory and Water

Brazil is the fifth largest country in terms of territorial extension on the planet. It physically shares its largest water basins (**Map 1 Water Basins**) - the Amazon Basin and the Prata Basin - with the other South American countries. In addition to economic leadership in the continent, this gives the country a natural platform to lead the process of regional economic integration and to strengthen itself in the face of hegemonic blocks, whether they are linked to the United States, Europe or Asia.

The Amazon River is predominantly a plain river in the national territory. Its headwater streams are located in the Peruvian region of the Andes. This makes its use and, more importantly, the management of its use a process shared by the countries that make up the South American Amazon. It should be noted that the Amazon River makes up the world’s largest water basin, with an area of 5,846,100 km$^2$. About 3,836,520 km$^2$ are located within the Brazilian territory.
It may be affirmed that one of the central matters to be faced by the Brazilian society and State will be related to the planned and shared use of the large water basins and significant water resources located in the East of South America, where the perimeters of the Brazilian territory

**Map 1 - Water Basins**


Source: IBAMA

extend.

The shared use of the Prata Basin was a pioneer experience in the consolidation of practices and effective regulations for the shared management of resources in the South Cone countries. The Prata Basin covers an area of about 3,100,00 km. Its geopolitical importance is a result not only of its demographic and economic importance but also of the cultural identity it has historically built in the South American continent. Two international treaties – The Prata Basin Treaty (1969) and the Paraná River Treaty (Itaipu, 1973) created the external cooperation bases necessary for the discussion regarding shared use of this Basin. Regarding the Amazon Basin, the Amazon Cooperation Treaty – TCA (1978) is the legal means for international regulation of water resources. In the realm of the Amazon Cooperation Treaty, new mechanisms can be created for adjusting and improving shared water resource management in that part of the South American continent. It should also be noted that, in addition to the Itaipu hydroelectric plant, the Tietê and the Paraná-Paraguay waterways are located in this water basin.

## 3. Brazil: Economic Context of the Territorial Configuration

Historically, economic activities developed in Brazil have been closely related to the exploitation of its resources and, therefore, of its territory's natural potential. Internally, this territory has never hindered national development. It has always provided the resource base necessary for expanding the economic frontier whenever that was asked of it. This happened at times when the growth process accelerated and, more recently, during the consolidation of the internal market.

The implementation of various types of exportation activities at different times in history explains not only the form in which Brazil was populated but also how regional differences appeared. The implementation of these activities took place as the international market demanded products whose advantages and possibilities for exploitation were concrete, and Brazil offered differentiated geographic spaces.

Until the 1950s, Brazil was made up of economically dense "islands" isolated from one another and concerned with the international market. This revealed a spatial feature that resulted from the process of occupation of the country, which made differentiated marks on the vast national territory as the several economic cycles aiming at exportation unfolded. This happened with great discontinuity, both in terms of geography and time. They include the gold cycle, which at its time was the most notable experience for fostering the process of connecting the interior of the country and affirming Brazilian nationality.

The location of the great plateaus and plains are scattered and, above all, the manner in which the different types of topography in Brazil are limited **(Map 2 - Hypsometry)** explain the fact that demographic settlement and density first occurred in the area along the coastal line. The existence of Brazilian plateau cliffs close to the sea along large parts of the southeastern coast was a natural barrier to reaching the interior of the country in the past.

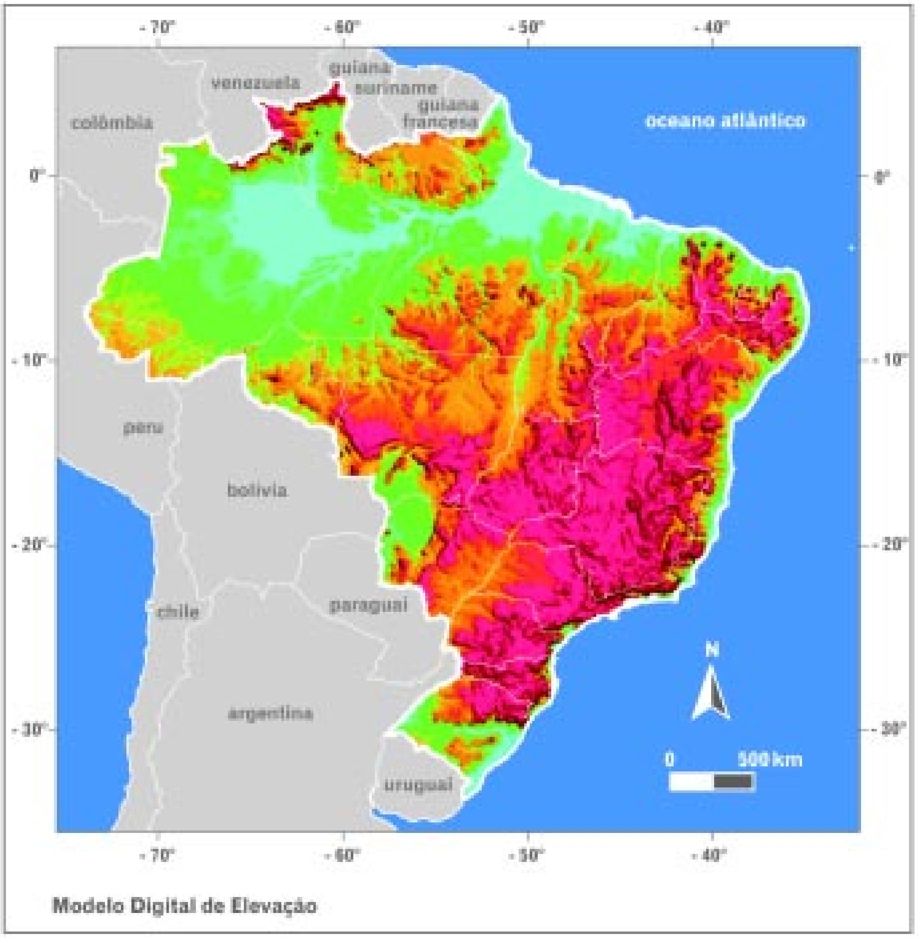
Tenuous economic activity had been a characteristic of the extractivist activity that takes place in the enormous Amazon plain covered by humid tropical forests. It had also been a characteristic of the cattle industry, which is the main activity in the Cerrado of the Brazilian central plateau, in the Caatinga of the semi-arid areas in the northeast and in the subtropical fields in the south. This trend only ceased when coffee culture and other agricultural activities induced by its growth were introduced in the interior in the west of São Paulo.

In this context, rivers were the "natural ways" for reaching the interior of the country. This created a traditional branching out pattern in the occupation of the Brazilian territory, modelled by the distribution of urban centres along riverbanks. Densely used agricultural areas followed the same model.

As a result of the nature of topography in Brazil, plateau rivers are predominant. Even though they pose difficulties for navigation due to sudden declivity, they have served as networks for promoting population distribution in the interior since colonial times. Plateau rivers include the São Francisco and the Paraíba do Sul.

The way in which coffee plantations moved through the Paraíba Valley until they reached the São Paulo plateau represented not only the first great clear cutting movement toward the interior of the country but also the first regional difference in Brazil that went beyond mere exploitation of the territory's natural potential. This happened despite the exceptional temperature, rain and soil conditions.

**Map 2 - Hypsometry**




Source: CPRM

Once the Serra do Mar barrier was crossed, the growth of coffee culture in the São Paulo plateau became one of the vectors in the urbanisation/industrialisation process São Paulo went through in the mid-19th century. This happened through the successful introduction of various other agricultural and non-agricultural activities and caused coffee culture to depend on the growth of the internal market and on the modernisation of the production process. These were necessary for the reproduction of the complex economy and interests that resulted from commercial coffee activity.

The consolidation of the commercial coffee production served as the basis for the centralisation of power in the country. This changed its political, social and spatial nature as it moved the economic centre from the "north" to the "south". This change validate political supremacy and economic control, thus ending a long process of adjustment regarding the geographic location of the centre of power. The new centre served as the basis for restructuring political and economic relations in Brazil.

Political agreements regarding interests increasingly related to activities in the financial and industrial areas were strengthened by the economic hegemony that resulted from commercial coffee activity. The expansion of this activity at this point assumed the creation of an internal market and intense use of natural resources on a national scale.

The movement for the integration of the country's geographic space was necessary for the establishment and growth of the internal market. It was made possible by the creation of a technical network aiming at the construction of highways and at energy generation and distribution. This started during the second half of the 1950s and became more intense in the 1970s, when tax and credit incentives, necessary for the increase in productive projects outside more developed areas, also grew.

The construction of Brasília during this period changed the political map of the country. It also redesigned the national traffic network, which from then on was increasingly dependent on the growth of the internal market. It also served as a platform for reaching the Amazon in accordance with the geopolitical development and security policy used to incorporate remote resource frontiers. This had a direct impact on its fragile forest ecosystems.

The talk of national integration was the basis of the process of National Developmentalism and took on elaborate form and aggressive political action in the 1970s. This was when the acceleration of the urbanisation/industrialisation process started radically altering the pace and the way in which the national territory was connected and used.

The incorporation of natural resources was the primary condition for the growth of the economic frontier in the country after the desired level of industrial and financial concentration was attained in the *São Paulo´s* centre. According to different rationales and the differentiated moments for growth/insertion in the internal and external markets, both the peripheral regions close to the Araucarias Plateau in the west of Paraná and those further from central plateau Cerrados, as well as the Northeast and the Amazon, were incorporated to the country's resource frontier.

In spatial terms, this movement occurred as a consequence of the horizontal growth of vast modernised agricultural borders, as was the case in the west of Paraná and in the MidWest and, more recently, in tablelands in the west of Bahia and in the South of Maranhão and Piauí. It also happened due to the holes and damaged spots left on the landscape by mineral extraction and by irrigation agriculture projects in the semi-arid region in the northeast.

In this context, tourism growth and intensification in the northeast coast has become a powerful vector for the transformation of this regional space. This will bring about new risks and new opportunities to society and to the environment in the northeast.

An urbanisation and industrialisation process was associated to this movement for the incorporation of areas to the national economic sphere. This meant simultaneous economic and demographic decentralisation toward the interior of the country. This resulted in growth and density in the national urban network. Large cities and numerous medium cities outside the coastal centre where occupation of the Brazilian territory historically took place. Were added to the network.

Brazil reaches the year 2000 with thirteen cities whose populations are over 1,000,000 inhabitants. In addition, there are two national metropolises, São Paulo and Rio de Janeiro, whose populations are over 5,000,000 inhabitants and 11 other regional metropolises that are mostly the political-administrative capitals of the most highly populated states of the federation. Except for Brasilia and Guarulhos, these cities comprise the nucleus of the nine metropolitan regions defined by the Brazilian Institute of Geography and Statistics (IBGE – *Instituto Brasileiro de Geografia e Estatística*) in the 1970s.

The cities of Salvador, Belo Horizonte, Fortaleza and Brasília, whose populations are over 2,000,000 inhabitants, are included in this group. The other ones are Curitiba, Recife, Manaus, Porto Alegre, Belém, Goiânia and Gurarulhos. With a population of 34,389,320 inhabitants, these large cities held about 20 percent of the 169,799,170 inhabitants in the country in the year 2000.
In the same year, however, medium cities – those with

200 - 500 inhabitants – which in 1980 held 9.3 percent of the country's total population in 37 urban centres reached the year 2000 with 13.7 percent of this population scattered around 76 cities. Larger cities – 500 to 1,000,000 inhabitants – jumped from 8 to 18 urban centres, during the same period of time, holding, respectively, 3.4 percent and 7.4 percent of the country's total population.

The urbanisation process occurs clearly in areas in the MidWest and in the Amazon where demographic density is lower. It occurs as a dynamic force and results from the redistribution of population and their activities. The growth of modernised farming and cattle-raising in the MidWest is the branch of the ongoing agroindustrial reorganisation process which has advanced the most. This process has resulted in businesses moving from the São Paulo Metropolitan region to the interior and also to the closer southern states.

Therefore, there are currently risks and opportunities for an organized use of the Brazilian territory that is more adequate to sustainable economic, political and environmental development in terms of allocating investment and activities toward the great arch of penetration in the areas of the Amazon Forest that are still preserved.

Brazilian states and their internal subdivisions are the result of a settlement process whose basis for political domination was growth and spontaneous ownership of territory. The area comprised by their territory is thus extremely differentiated. This includes states such as Amazonas, with an area of 1,577,820 km$^2$, which corresponds to about 18 percent of the national territory, and others such as Segipe, with an area of 22,050 km$^2$.

In general it should be noted that the current territorial configuration of Brazilian states was based, on transformations of the garly Captaincies, whose sizes were limited only by designations provided by the coastal line.

Territorial expansion grew toward the interior of the country according to the captaincy owners capacity for exploration. In 1997, Rodrigo stated: "the captaincies were a twisted territorial division. After the division process, some were vast desert lands; others, small were gores of land."

During the Imperial era, Brazil was a Unitarian State whose government and administration were held by the central power. It held all provincial authority. Therefore, this territorial imbalance was not harmful and did not cause great disturbance or inequality in public administration since the Provinces were territorial divisions of the central State and not parts of this state. It was the Nation that was made up of Provinces.

However, in the republican federation, this difference in territory size among the member states would somehow reinforce accentuated inequality in economic and administrative conditions, first at state and now also at municipal level.

From the political point of view, in the 80s there was generalized distension. This somehow legitimised the process of decentralisation of the economic sphere and of occupation of the interior of the country. This was revealed by the different levels of demographic density (**Map 3 Demographic Density chapter 4**) that converge toward the formation of new local realities, in contrast to some general tendencies seen in economy and in post-war Brazil. The consolidation of democracy was the starting point that resulted


in the promulgation of the Federal Constitution of 1988. From then on, the principle of power decentralisation was established, making it possible for legal mechanisms to be used for the consolidation of the federative division of the national territory.

Currently, federative entities are no longer limited to 26 States and one Federal District. This was a consequence of the political-administrative division that history outlined in the national territory. In addition, there are 5,561 municipalities that are relatively autonomous and share the agreement that currently supports the Brazilian Federation.

The restructuring of the constitutional framework legitimises the deep transformation that occurred within the internal limits of the national political framework in the last decade. In 1940, there were 1,574 municipalities. In the year 2000, the number of municipalities reached 5,507. The changes that took place along municipal borders make it clear that it is urgent to outline a new political map for Brazil is clear (**Map 4 - Municipal Bords 1940 - 2000**).

The last constitutional charter certainly made municipalities take on multiple responsibilities when it legitimised the increase in municipal power in its jurisdiction. This made the municipality an independent infrastate agency goes beyond the urban centre. The new territorial dimension of municipalities and also their resources and economic and environmental potential create new realities to be considered.

The municipality finally became a defined entity in terms of national public law and consequently a consolidated infrastate agency for the Union and States. It then took on numerous responsibilities regarding the regulation of the use of territory, especially in the environmental field. These attributes are shared by the Union and States.

Environmental legislation has added new items to the Brazilian public agenda. These issues concern the limits on federal, state and municipal responsibility over the use of the territory and its natural resources.

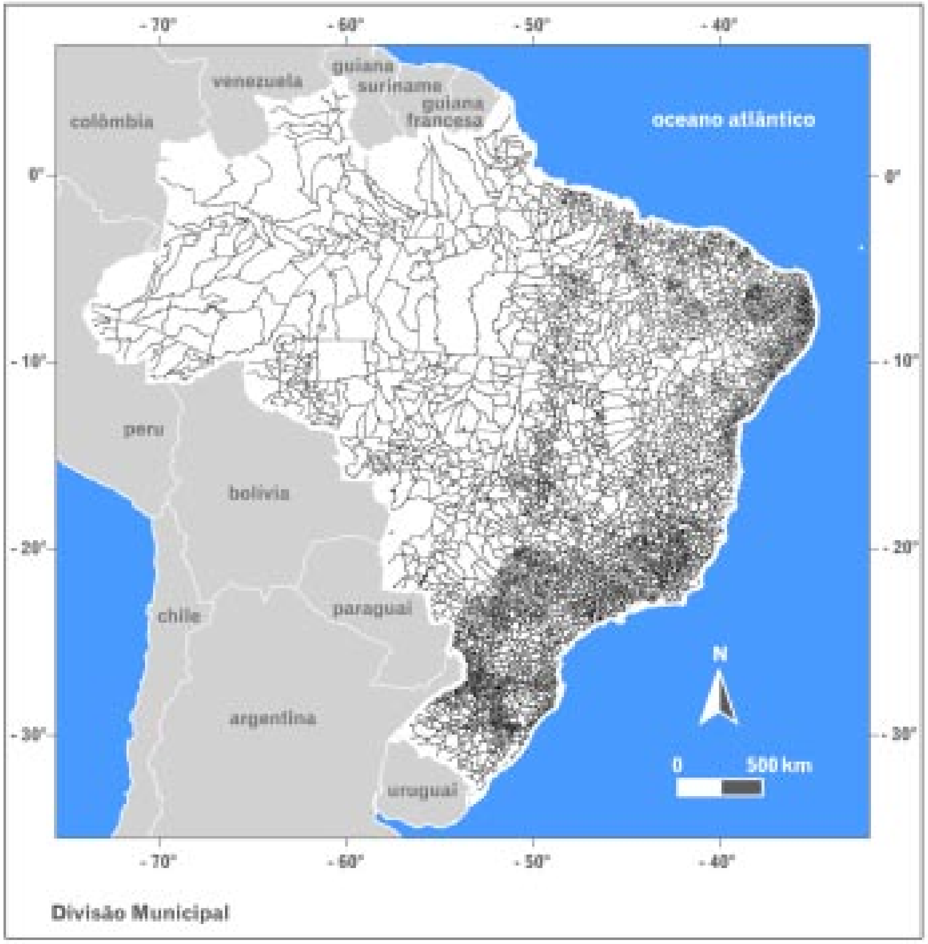
It should be noted that the same legislation that embraced the project for the decentralisation of power simultaneously increased the means for the creation of another division in the national political sphere. This division comprises Indigenous Lands and Conservation Units, whose implementation in the territory also strengthens the role of civil society in local management.

This new environmental division of the territory does not require political-administrative representation. However, it has acquired legitimacy through the political strength reached by the environmental movement worldwide. Currently, the areas for the conservation of nature and indigenous culture represent, on the national level, around 20 percent of the Brazilian territory. In the Legal Amazon region, however, they reach 30 percent of the territory. Taking up more than half of the national territory, the states that make up the Legal Amazon (AM, PA, MT, TO, RO, RR, AP, AC and part of MA) transfer the weight of their physical and strategic dimension to political legitimacy in the Brazilian federation.

It should also be noted that the Legal Amazon concentrates about 94 percent of the territory comprised by Indigenous Lands and Conservation Units in the country. In January, 2002 they reached, respectively, 101,822,449 ha and 76,544,735 ha in all of Brazil. 99 percent of Indigenous Lands and 87 percent of Conservation Units were located in that region, where they gained concrete political expression. This happened because a great part of the States of Roraima and Amazonas, for example, are subject to legal segmentation due to the need to preserve either nature or indigenous culture. This makes the management of the political sphere at local/regional level more complex.

Environmentalism thus strengthens the contemporary trend to deepen differences in the use of territory. This happens through local action according to logic and interests that are mostly connected on a global level.

**Map 4 - Municipal Division 1940 - 2000**




Source: IBGE

The effort for the analysis of the state of the environment in Brazil, the focus of this chapter, follows the same trend. It tries to highlight the pressures whose impact on the territory is greater. These are caused by use and abuse of natural resources. The following sections will report on the state, the pressures and the impacts related to themes chosen by the Brazilian Institute for the Environment (IBAMA – *Instituto Brasileiro do Meio Ambiente*) and the United Nations Environment Programme.

# the state of biodiversity



The Brazilian Federal Constitution of 1988 placed the environment within the focus of political decision-making, affirming the relationship between social and economic development and environmental quality. Gradually, an integrative approach began to take place, in opposition to the classical development vision that had been adopted until then. This gradual change in paradigm is occurring not only at the federal level, but also in the various States, Federal District and Municipalities that now share with the Federal Government a considerable parcel of responsibility for the execution of environmental policies.

By hosting the United Nations Conference on Environment and Development, in 1992, and by ratifying the signature of the Convention on Biological Diversity, Brazil reaffirms and reassumes its constitutional commitment to protect the biodiversity and the country's genetic patrimony, giving new impetus to the history of conservation activity in the country.

The change in behaviour observed is especially important in countries such as Brazil, which harbour approximately 10 to 20 percent of the total number of species known to science and about 30 percent of the tropical forests in the world (MMA 1998). These forests, which occupy less than 7 percent of the Earth's land, have more than half of the known species of fauna and flora (Pádua 1997). Widely distributed tabulations place Brazil among the richest countries in biodiversity in the planet, especially in the group of vertebrates and superior plants (Mittermeier *et al.* 1997).

Brazil has the greatest number of known species of mammals, freshwater fish and superior plants, the second in richness regarding amphibians, the third in birds and the fifth in reptiles. Regarding its diversity of endemic species (that exist exclusively on Brazilian territory), in all groups mentioned, the country is among the first five and, within the group, Brazil occupies the second position worldwide Mittermeier *et al.* 1997). These estimates do not include, however, the invertebrates, that represent, in fact, a great mass of living biological species, and for which it is still very hard to present an evaluation. For many of the groups of invertebrates and, moreover, for microorganisms, information is very incomplete.

Around 200,000 species have already been described for Brazil (**Table 1**). It is estimated that the country's biodiversity comprises a number 6 to 10 times greater, that is, approximately 2 million forms of life (Lewinsohn & Prado 2000). From these, the great majority belongs to taxonomic groups for which classification in the country is still very incomplete, such as insects, which must represent from 50 to 55 percent of the total existing species in Brazil (**Table 2**).

A thorough survey of available information for all taxonomic groups was recently undertaken, as an input for the National Biodiversity Policy (Lewinsohn & Prado, 2000). Despite satisfactory scientific knowledge for some groups in some of the Brazilian biomes, overall, small collections, with little representative samples of ecosystems, as well as taxonomy problems and lack of specialists are some of the reasons that made classification of the Brazilian biodiversity a difficult task. Thus the identification of the number of species that comprise our fauna and flora has been made through estimates that were often undertaken from extrapolations throughout the country, based on data of a well-known region. Other estimates are produced through the premise of proportionality of less known groups in relation to those that are better studied.

Superior plants, despite better-classified, are still far from a reliable total count. The estimate presented here, from 40,000 to 45,000 (Shepherd, 2000), is smaller than others that have been distributed (e.g. in Groombridge 1992), which vary between 50,000 and 55,000 species. Many important groups such as, for example, fungi, nematodes, and protozoa must count millions of species already described, but their classification in Brazil is still incomplete or simply non-existent.

An increase of approximately 10 percent in the number species is estimated for the group of plants and approximately 30 percent for the vertebrates, especially freshwater fish. For the groups of anthropoids, molluscs and other larger groups of invertebrates and algae, an increment is estimated of at least 10 times the number of species already known. Fungi, arachnids specially acarids, nematodes, bacteria and virus, are the practically unknown groups, and it is estimated that the number of species to be described varies from 15 to 100 times the ones already known. The objective of these estimates, many of which include a great deal of uncertainty, is to

**Table 1 - Number of species known (described) in Brazil andin the world**

| **KINGDOM / Phylum or subdivision** | **Brazil** | **World** |
|---|---|---|
| VIRUS | *250–400 | 3,600 |
| MONERA – bacteria and green-blue algae | * 1,100–1,350 | 4,760 |
| FUNGI | *12,500–13,500 | 70,500–72,000 |
| | | |
| PROTIST | * 7,000–9,900 | 75,300 |
| Protozoa | *2,600–3,900 | 36,000 |
| "Algae" | *4,100–5,700 | 37,700 |
| | | |
| PLANTS | 45,300–49,500 | 264,000–279,400 |
| Moss (Bryophytes) | 3,100 | 14,000–16,600 |
| Ferns (Pteridophytes) | 1,200–1,400 | 9,600–12,000 |
| Coniferae – pines (Gymnosperms) | 15 | 806 |
| Flower plants with ovaries (Angiosperms) | 40,000–45,000 | 240,000–250,000 |
| | | |
| ANIMALS | *113,000–151,000 | 1,287,000–1,330,000 |
| Invertebrates | *107,000–145,000 | 1,236,000–1,287,000 |
| Sponges (Porifera) | 300–400 | 6,000–7,000 |
| Corals and jelly-fish (Cnidarians) | 470 | 11,000 |
| Flattened worms (Platyhelminths) | *900–1,300 | 12,200 |
| Round worms (Nematodes) | *1,000–2,200 | 15,000–25,000 |
| Earthworms and polychaetes (Annelids) | 1,000–1,100 | 12,000–15,000 |
| Molluscs | 2,600 | 70,000–100,000 |
| Starfish, sea-urchins (Echinoderms) | 329 | 7,000 |
| "Arthropods" | | |
| Insects | *91,000–126,000 | 950,000 |
| Centipedes and "gongolos" (Myriapods) | 400–500 | 11,000–15,100 |
| Spiders and acarids (Arachnids) | 5,600–6,500 | 92,500 |
| Crustaceans | 2,040 | 36,200–39,300 |
| | | |
| **Chordata (Vertebrates and others)** | 6,200 | 41,400–42,200 |
| Sharks and electric rays (Chondrichthyes) | 150 | 960 |
| Fish (with bones – Ostheichthyes) | 2,660 | 13,070 |
| Anphibians | 600 | 4,220 |
| Reptiles | 468 | 6,460 |
| Birds | 1,677 | 9,700 |
| Mammals | 524 | 4,650 |
| | | |
| TOTAL | 179,000–226,000 | 1,706,000–1,766,000 |

Contagens publicadas ou estimativas para os principais grupos Taxonômicos (modificado de Lewinsohn & Prado 2000) * Os números são apresentados conforme publicados, seja números exatos, arredondados ou faixas. Quando não há contagens, são usadas estimativas (Lewinsohn e Prado, 2000) assinaladas com asteriscos, aqui apresentadas como valores arredondados do intervalo estimado. Os totais para os reinos (em maiúsculas) e subdivisões principais são mostrados em negrito. O arranjo taxonômico e os nomes seguem Margulis e Schwarz (1998), mas incluem alguns grupos tradicionais hoje subdivididos.

Fonte: Heywood - 1995 e outros (ver Lewinsohn e Prado - 2000).

contribute an order of size to the knowledge of biodiversity and focus on the need for studies. An example of the great potential of diversity is still unknown in Brazilian ecosystems is the recent discovery of two species of primates in the Amazon. The monkeys are from the Sauá groups that live at the dense treetops in family groups, and are the size of cats.

Table 2 - Number of animal species in Brazil that are officially recognised as endangered species for each animal Class or Phylum, number of publications on such species, and publication rate by species.

| Group | No. Species | No. Publications | Pub/species |
|---|---|---|---|
| Mammals | 65 | 2567 | 39.5 |
| Birds | 109 | 748 | 6.9 |
| Turtles * | 6 | 2759 | 459.8 |
| Other reptiles | 3 | 4 | 1.3 |
| Amphibians | 1 | 1 | 1.0 |
| Insects | 30 | 6 | 0.2 |
| Onychophora | 1 | 0 | 0.0 |
| Cnidarians | 1 | 0 | 0.0 |
| All ** | 216 | 6105 | 28.3 |

* Sea turtles have been dettached from other reptiles due to the significant discrepancy in the number of publications.
** Not equal to the total amount of publications by group due to the redundancy of some publications.
Source: Zoological Records 1978-2000 (Volumes 121 to 137), enquiry of all records of publications on species that appear in the official list of endangered fauna (IBAMA Decisions No. 1522, of 19/12/1989, and No. 62, of 17/06/1997).

This richness has always lead to the idea that Brazilian biodiversity is abundant and not exhaustive, and for this reason explored in a predatory and disorderly manner since the colonial period. Occupation of forest land – be it for use of forestry resources or for its transformation into areas for food production – has been an important characteristic in the process of economic growth for most part of the country. To revert this process and meet the objectives of Agenda 21, it is fundamental that society internalise the ideal that natural resources will only be available for this and future generations if we use them in a rational manner, respecting the necessary time for their regeneration and reposition. To adapt human development needs to situations that enable conservation of natural resources and survival of species and ecosystems is one of the greatest challenges of sustainable development as defined in the agreements of the Convention on Biological Diversity and Agenda 21 MMA 2000a).

The Convention on Biological Diversity (CBD) is no doubt the main existing treaty on this theme and brings, among its articles, specific items that recommend the identification, monitoring and protection of ecosystems and habitats that are most important for biodiversity conservation (MMA 2000a).

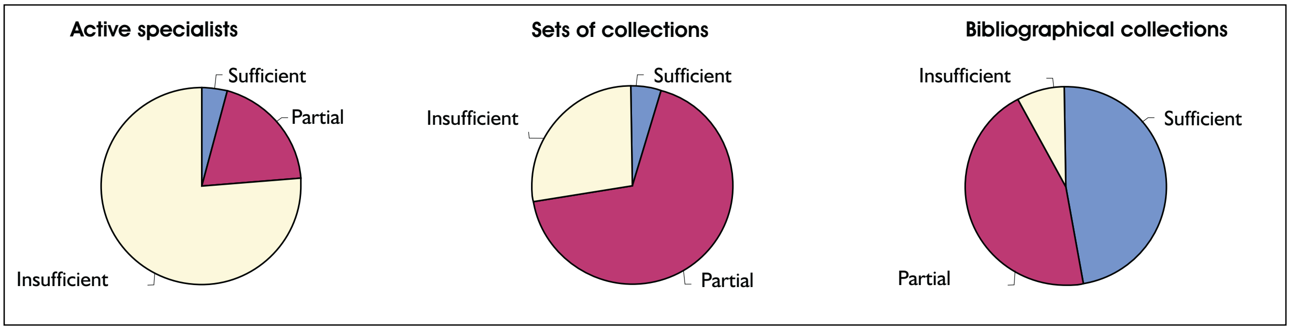
Environments such as the Atlantic Forest and Amazon Forests harbour a great number of endemic species. Even biomes that exist in harsher bio-climate conditions, such as Cerrado and Caatinga, have some of the richest flora and fauna in the world compared to regions that present the same conditions in other countries or continents (Lewinhson & Prado 2000).

Despite uncertainties regarding the composition of Brazilian species, direct exploitation of natural resources and deforestation of vegetation caps have led to the accelerated loss of our natural endowment. Impact on ecosystems derives from processes of land occupation and, furthermore, with the use of archaic economic and social practices, that are developed based on the premise of non-exhaustion of natural resources.

It is important to highlight that these numbers hide significant differences of biodiversity knowledge between regions and ecosystems. Existing knowledge is concentrated in the South, Southeast and North regions of Brazil with an enormous lack of studies in the Central-west and Northeast regions, respectively. The number of recent diversity inventories in the Pantanal and Caatinga biomes and in the Northeast coast is extremely small compared to other large Brazilian biomes.

Another aspect to be considered is that today various components of Brazilian biodiversity are threatened (**table 2**) to an extent that they will only be able to survive through human intervention, management of native population or communities and natural ecosystems. This management is only possible with knowledge of the species and ecological processes that sustained the intervention. In Brazil, as previously mentioned, human and material resources to produce knowledge are still well below current needs **(Figure 1)**, although Brazilian science possesses an extensive and consolidated system of professionals and institutions, if compared to other developing countries (Lewinsohn & Prado 2000). The result is that today there is lack of basic information for most species, even of groups considered to be the most studied **(Figure 2)**. In addition to being insufficient, information on species is badly distributed, with a predominance of studies on some groups, such as large vertebrates, in detriment of others, such as insects.

**Figure 1 - Proportion of taxons of organisms in Brazil with a sufficient number of specialists and collections in the country for research purposes.**




Source: Lewinsohn & Prado - 2000

**Table 3 - Assumed number of known species in Brazil as compared to estimates of the total number of species in Brazil and in the world. ***

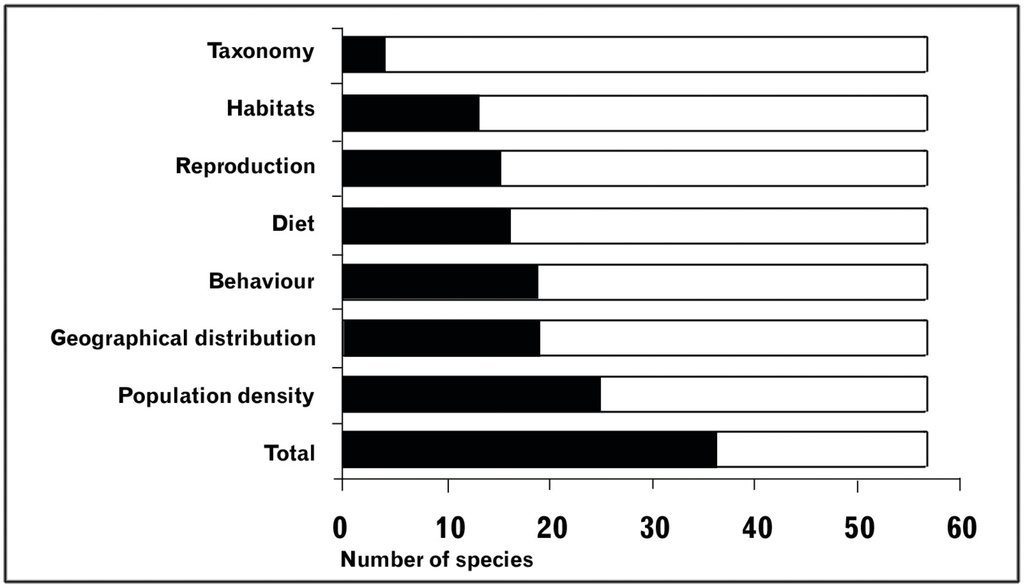
| | Brasil | | | | Mundo |
|---|---|---|---|---|---|
| Taxon | Number of Known Species | Estimated total of Species | Reliability Interval of Total Species | Known/unknown ratio1 | Estimated total of Species |
| Virus | 400 | 55,000 | (39,000 - 71,000) | 136 | 400,000 |
| Bacteria [2] | 1,400 | 136,000 | (97,000 - 176,000) | 96 | 1,000,000 |
| Protozoa | 3,200 | 27,000 | (19,000 - 35,000) | 8 | 200,000 |
| Fungi | 13,000 | 205,000 | (145,000 - 264,000) | 15 | 1,500,000 |
| Algae | 4,900 | 55,000 | (39,000 - 71,000) | 10 | 400,000 |
| Plants | 47,000 | 52,000 | (49,000 - 56,000) | 0.1 | 320,000 |
| Arthropods | 116,500 | 1,214,000 | (860,000 - 1,568,000) | 9 | 8,900,000 |
| Other Invert. [3] | 9,700 | 116,000 | (82,000 - 150,000) | 11 | 850,000 |
| Vertebrates [4] | 6,200 | 8,000 | (7,000 - 9,000) | 0.3 | 50,000 |
| Total | 202,500 | 1,870,000 | (1,340,000 - 2,400,000) | 8 | 13,620,000 |

All amounts are rounded off to thousands, except those in the first column.
[1]The unknown/known species ratio is equal to (total estimated of unknown/known species); [2]Bacteria include cianobacteria (blue algae); [3]Other invertebrates include all invertebrates, except arthropods; [4]Vertebrates include all other chordata.

Situation analysis shown above represents a considerable challenge to science. The total number of institutions and researchers with existing methods and financial support cannot solve the problem of lack of knowledge of Brazilian biodiversity. This is also true for knowledge regarding world biota, whether it is around 13 million species as it is considered today (**Table 3**), or more than 100 million, as considered by some biologists (Heywood 1995).

Finally, data in general are scarce and in difficult to access sources. Thus, it is a priority that a compilation be made of basic biological information, as well as its publication in accessible means also to technicians and managers, as for example the Red Book of Brazilian Endangered Mammals (Fonseca *et al.*, 1994), and the manuals for the germination and cultivation of native (São Paulo State Secretariat 2000, National Council of the Biosphere Reserve 1997).

**Figure 2 - Number of endangered mammal species in Brazil on which basic biological data for management purposes is either non-existant or extremely incomplete.**




Black bars means the number of species with insufficiency for each information class, and as a total.
Source: Livro Vermelho de Mamiferos Ameaçados de Extinção (Fonseca et al. 1994) and Especial Group of Commision for Species Survaival of IUON.

Studies undertaken, in 1995, by the World Wildlife Fund (WWF) and the World Bank present a threat analysis of Brazilian biomes (WWF 2001). In first place, there is the Atlantic forest with only 8 percent of original forest cover and following, the Cerrado and Caatinga, Mangrove, Grassland, Pantanal, and finally, the Amazon Forest. This study also mentions that the rate of change in the Cerrado is the highest among other biomes. It is no surprise that the Atlantic Forest and the Cerrado are considered among the world's 25 most diverse and threatened regions, according to world hotspots identification undertaken by Mittermeier and collaborators (1999). For different reasons, various forms of life in these regions are at risk of extinction and for this reason are critical areas for biodiversity preservation in global terms.

The Atlantic forest, the 5$^{th}$ most threatened biome in the world, originally covered more than one million square kilometres, distributed along the Brazilian coast, with some penetrations into the interior. The great geographic extension and diversity of the climate, soil and relief led to the existence of incomparable biological diversity. According to Myers *et al.* (2000), there are 20,000 species of plants in the Atlantic forest (27 percent of the total species in the world) 8,000 of which are endemic. This biome holds the world record of ligneous plant diversity, with 458 species found in a single hectare in the region of Southern Bahia.

The diversity and number of endemic species among vertebrates is also impressive; 251 species of mammals, 160 endemic; 620 species of birds, with 73 endemic; 200 reptiles, with 60 endemic; and 280 amphibians, of which 253 are endemic (Mittermeier *et al.* 1999). According to these numbers, 2.1 percent of the total species of these four groups of existing vertebrates only exist in the Brazilian Atlantic Forest.

In this biome area reside 70 percent of the Brazilian population, as well as the biggest cities and most important Brazilian industrial sectors. Land occupation and use, undertaken in a disorderly manner, resulted in its almost complete destruction. Recent data (SOS Atlantic Forest Foundation *et al*. 1998) estimated that only 8 percent of the original biome area still exists in isolated spots (Conservation International *et al.* 2000). In some regions of the Brazilian Northeast, there is less than 1 percent of the original Atlantic Forest cover.

The Cerrado, the second largest Brazilian biome, occupies around 2 million square kilometres, almost 25 percent of the Brazilian territory. It comprises a mosaic of vegetation types, including the open formations of Central Brazil (clean field, dirty field, cerrado field and rocky fields) and the characteristic forest formation (vereda, riverbank, cerrado and mesophyte forest). Considered the world's richest savannah, it is estimated that over 40 percent of wood species and 50 percent of the biome's existing bee species are endemic (Conservation International *et al. 1999*). The diversity of vertebrates is also considerable, with approximately 161 species of mammals, 837 species of birds, of which 3 percent are endemic; approximately 120 reptiles, 20 percent endemic; and 150 amphibians, with 30 percent of endemism. This totals 1,268 species of vertebrates, of which 117 are endemic.

This biome was also the target of intense and uncontrolled occupation. Considered, for many years, as non-important from the biological point of view, great extensions of the Cerrado were the object of expansion projects for agricultural frontiers and production of grains for exports, with no concern for consequent environmental impacts. Many of these projects were implanted through government incentives, as Polocentro and Prodecer, with the objective of incorporating the Cerrado region into the production of grains in the country, increasing competitiveness of agricultural products in the international market (MMA 2000b).

Preliminary analysis about the integrity of the Cerrado forest demonstrated that only one third of the biome has little human presence. At the same time that a radical change in its landscape is observed, it is concluded that around 70 percent of the Cerrado area was not adequately studied (Conservation International et *al.* 1999).

The Caatinga region comprises an area of approximately 735,000 km$^2$, approximately 11 percent of the national territory, including part of the states of Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia and Minas Gerais. This biome is dominated by few vegetation types with distribution restricted to Brazil. The region has a considerable number of endemic species. Of the 596 registered arboreal and shrub species, 180 are endemic. Many new species of animals and plants have been recently described, indicating precarious zoological and botanical knowledge.

There are no concrete data as to the rate of loss of vegetation cover for the Caatinga. Maps from the Radambrasil Project (IGBE 1993) demonstrate that the area covered by agricultural activities in the biome consisted of 201,786 km$^2$, which corresponded to 27.47 percent. A simulation of the effects of roads as axes for environmental change, considering the width of seven kilometres of area impacted from roads, resulted in an altered area of 131,044 km$^2$. Combining these estimates, the total altered area covered by man in the region would be 332,830 km$^2$, in other words, 45.32 percent of the biome. This figure places Caatinga as one of the environments most altered by man in Brazil, being surpassed only by the Atlantic Forest and Cerrado (Casteleti *et al.* 2000).

Pantanal is the greatest wetland in the world, covering an extension of approximately 365,000 square kilometres among Bolivia, Paraguay and Brazil. In the Brazilian territory it occupies 140,000 km$^2$, 35 percent in the State of Mato Grosso and 65 percent in the State of Mato Grosso do Sul (MMA 2001). During the flood period, water bodies meet and run into waters from the Paraguay River. The summer weather determines floods between November and March in the north and between May and August in the South, in this case under the regulating influence of the Pantanal.

The Pantanal contains transition zones, with both the Cerrado and the Amazon, where it physiognomies of both these ecosystems can be found on non-flooded lands, providing a great diversity of fauna and flora (IBAMA 2001). There are at least 3,500 species of plants, 264 of fish, 652 of birds, 102 of mammals, 177 of reptiles and 40 of amphibians (Lourival *et al.* 2000). One of the most interesting aspects is the high density of many species of large Brazilian vertebrates, not found anywhere else on the

continent.

The fragile equilibrium of the Pantanal ecosystems, defined by periodic flood dynamics, is being threatened by new trends of economic development. After the 1970s, there was a process of expansion that caused demographic growth in the Brazilian MidWest. The region of Pantanal plains, with its land distribution structure – large properties used for cattle breeding in flooded areas - was not incorporated into the population growth process. However, in the plateau, the standard of urban growth was accelerated. The cities expanded at this time, both in Mato Grosso and Mato Grosso do Sul, did not have and still do not have adequate infrastructure to minimize environmental impacts of accelerated growth, caused, mainly, by contamination of the water courses by domestic or industrial waste. This type of pollution directly affects the plains that receive sediments and residues from the plateau areas (IBAMA 2001).

Traditional methods of fishing and cattle-breeding are being rapidly substituted by intensive exploitation, coupled with deforestation and alteration of natural areas (Conservation International *et al.* 1999), resulting, among other factors, in soil erosion and in the significant increase in the load of sediment particles in various rivers. Moreover, the problem of contamination of many rivers with biocides and fertilizers increases (IBAMA 2001). In addition, the presence of gold and diamonds in the low *cuiabana* and in the Paraguay and São Lourenço river springs has attracted thousands of gold miners, compromising the biological productivity of water courses, as well as contaminating them with mercury.

Very little of the Pantanal ecosystem is officially protected, especially along the main central humid plains. Recently, Pantanal has been facing problems, mainly related to great occupation projects such as the construction of highways, roads (MMA 2000c), or large-scale projects of soybean cultivation.

As a whole, the Amazon, the planet's greatest biodiversity reserve containing almost 10 percent of freshwater available in the world (Rebouças 1999 em MMA 2000b), is also the repository of a valuable source of natural services and of genetic stock that can be the origin of new medicines and foods.

Despite being the most well conserved biome in the country, deforestation and burnings are the main environmental problems in the Amazon. Deforestation is the result of the advance of the agro-pastoral frontier, mainly in the States of Tocantins, Mato Grosso, Pará and Rondônia, and of activities from timber companies. The low cuts for agro-pastoral means in the Amazon has increased considerably in the1980s due to the adoption of erroneous public policies, such as fiscal incentives for programs that convert forest into agro-pastoral projects. As a result, there was a loss of 11 to 13 percent of the vegetation cap in that decade alone (MMA, 2000b).

Practically 80 percent of the national wood production in the form of logs is extracted from the Amazon region, which corresponds to 40 percent of Brazilian wood exports. In 1996 alone, 71,166 sawed cubic meters were exported, generating resources of around 447 million Dollars (MMA, 2000d). Wood related activities not only affect species selected for cutting but the composition and distribution of the remaining species in the forest. The complete devastation verified in the states of Rondônia and Pará, especially in the south region, is a demonstration of the need for a reorientation of the land occupation structure in the region.

A more detailed description of Brazilian biomes, highlighting their biological importance and main threats upon them, is presented in **Annex 1**.

In Brazil, the coastal zone presents a mosaic of ecosystems, and the contiguous marine zone includes all diversity derived from zoned variation and from different masses of water present in the regions of platform and continental slope. Thus, from the bio-geographical point of view, the group considered does not characterize a unit, nor does it encompass a single specific biome (Fundação Bio-Rio *et al.* 2002). However, the Brazilian Coastal Zone is a territorial unity defined by legislation for environmental management purposes. It extends over 17 states and encompasses over 400 municipalities, distributed from the north of the equator to the temperate south, keeping strong contact with two other important high biodiversity biomes, the Amazon, with expressive territorial overlap and the Atlantic Forest, with less than 5 percent of its original forest cover, practically concentrated in the coastal zone (Fundação Bio-Rio *et al.* 2002).

It is estimated that a biological diversity superior to that existing in the terrestrial part of the country can be found in this region. Harbouring 12 percent of all known fish species, it serves as a refuge and reproduction site for five out of seven of the Earth's marine turtles (Fundação Bio-Rio *et al.* 2002).

However, this biological diversity is not evenly distributed along the many coastal ecosystems. Sandy beaches and swamps are systems of low diversity due the absence of available surface for fixation and limited food offer. Shoal and craggy, cliff-like coasts are found in an intermediary position regarding biological diversity, whereas coastal lagoons and estuaries form fertile systems that serve as refuge and breeding sites for numerous aquatic species. Coral reefs comprise a variety of animals, proximate to that observed in humid tropical forests (Fundação Bio-Rio *et al.* 2002).

Studies conducted by the "Evaluation and Priority Actions for the Conservation of Biodiversity in the Marine and Coastal Zones" Project of the Ministry of Environment, indicate that increase in urbanization, with irregular occupation and land use, is the main anthropic activity impacting on coastal environments, followed by disorderly tourist activities and domestic, industrial, port, agricultural and mining pollution (Fundação Bio-Rio *et al.* 2002). Fishing activity was also mentioned, being that over-fishing, disrespect for off fishing periods, inadequate use of nets and pollution by oil were considered the main problems (Fundação Bio-Rio *et al.* 2002).

To protect mega-biodiversity, Brazil has 8.49 percent of its territory in the form of federal and state conservation

units (IBAMA, 2002), among categories of integral protection and sustainable use[1] (**Table 4**). These values include areas of Environment Protection (*Área de Preservação Ambiental* - APAs) that, despite having as their objective biodiversity protection and sustainable use of natural resources, are frequently instruments of territorial planning in urban areas and do not always meet their biological diversity conservation function.

Despite the unavailability of reliable data about the group of state and municipal APAs, a preliminary analysis of federal APAs in the Atlantic forest indicate that around 70 percent of federal APAs of Atlantic Forest do not have management nor zoning plans, and only 38 percent have a Management Council (Herrmann 1999). Additionally, many APAs overlap one or more conservation units of integral protection.

The protection percentage of biomes and their transition zones (ecotones) is, in reverse order: Coastal (9 percent), Amazon (4.6 percent), Cerrado-Caatinga Ecotone (3.4 percent), Atlantic Forest (1.8 percent), Caatinga (0.7 percent), Cerrado-Amazon Ecotone (0.6 percent), Pantanal (0.6), Southern Fields (0.3 percent), and finally Caatinga-Amazon Ecotone (0.1 percent) (Figure 3).

Added to these categories of conservation units are the Private Natural Heritage Reserves – RPPN, which total 345 federal areas in a total of 412,739 hectares, distributed throughout the seven Brazilian biomes (data on state RPPN are not available). This category of conservation unit is of paramount importance. Despite representing only 0.05 percent of the Brazilian continental territory, RPPNs play an important role in the protection of forest remnants and of areas adjacent to conservation units of integral protection. They are also important instruments for the maintenance of connectivity between forest fragments, mainly in the Atlantic Forest.

Despite not being part of the National System of Conservation Units,

Indigenous Lands (TI) are also important for *in situ* biodiversity conservation. With a total of 586 areas, TI occupy a total extension of 105,091,977 hectares (12.3 percent of the continental area of the country), 98 percent of which are situated in the Legal Amazon (ISA, 2002). When added to federal and state conservation units, the percentage of protected areas, with different degrees of protection increases to 20.78 percent of the national territory.
As demonstrated by the various factors addressed, Brazilian biodiversity has suffered significant losses and will only be preserved through the protection of large areas that enable the maintenance of viable ecosystems and of evolutionary processes. Despite this alert, the existing protected areas in Brazil are, in general, small, isolated and their implementation presents various problems. Moreover, the conservation unit system, often directed towards the protection of some species and ecosystems, is not sufficient to conserve the biodiversity totality. The current system does not account for the protection of gradients between ecosystems that permit the dispersal of individuals, adaptation to disturbances and maintenance of genetic flux between populations.

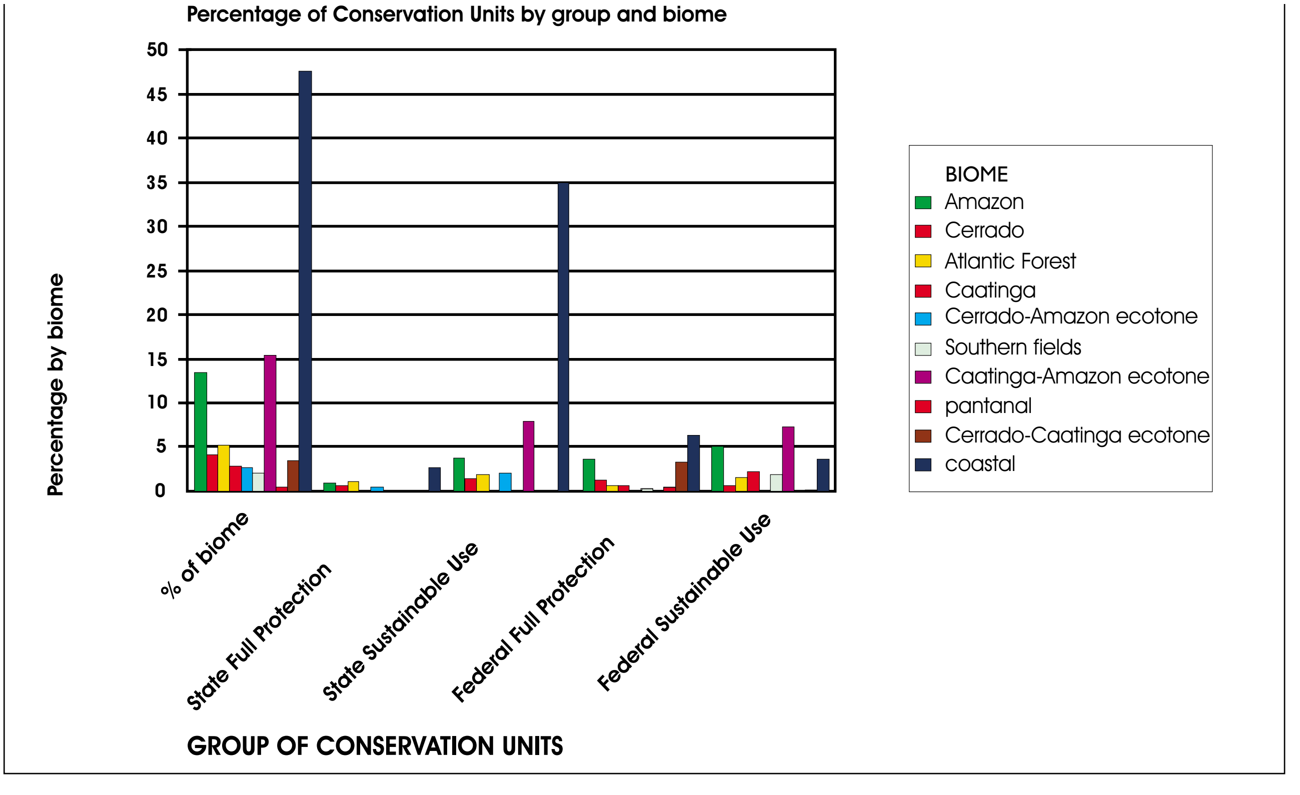
**Table 4 - Percentage of Federal and State Conservation Units by category of use.**
**The data on Conservation Units in the States of GO, MS, BA, CE, PB, PE, PI, RN, SE, ES, and RS are incomplete. They do not include overlapping areas.**

| Conservation Units | Federal | State | Total |
|---|---|---|---|
| Full Protection | 2.15 | 0.76 | 2.91 |
| Sustainable Use | 2.65 | 2.93 | 5.58 |

Source: IBAMA - 2002

The units of integral protection that effectively protect

**Figure 3 - Percentage of biome areas in conservation units per group of unities**




Source: IBAMA - 2002

**Tabe 5 - Percentage of areas of Brazilian biomes that are protected by Federal and State Full Protection and Sustainable Use Conservation Units.**

| Area/km2 | Area in Cons. Unit/km2 | % | State Full Protection | % | State Sustainable Use | % | Federal Full Protection | % | Federal Sustainable Use | % |
|---|---|---|---|---|---|---|---|---|---|---|
| 368,896,022.37 | 49,693,825.92 | 13.47 | 3,485,406.08 | 0.94 | 13,981,733.10 | 3.79 | 13,568,630.10 | 3.68 | 18,658,056.64 | 5.06 |
| 196,776,092.28 | 8,189,279.24 | 4.16 | 1,401,123.38 | 0.71 | 2,787,202.68 | 1.42 | 2,638,266.89 | 1.34 | 1,362,686.29 | 0.69 |
| 110,626,617.41 | 5,890,119.16 | 5.32 | 1,237,021.15 | 1.12 | 2,090,504.03 | 1.89 | 790,857.21 | 0.71 | 1,771,736.77 | 1.60 |
| 73,683,115.53 | 2,122,355.04 | 2.88 | 2,886.15 | 0.00 | 17,379.71 | 0.02 | 504,938.65 | 0.69 | 1,597,150.53 | 2.17 |
| 41,400,717.92 | 1,121,247.16 | 2.71 | 233,833.73 | 0.56 | 845,607.63 | 2.04 | 5,678.78 | 0.01 | 36,127.02 | 0.09 |
| 17,137,704.54 | 368,008.56 | 2.15 | | 0.00 | | 0.00 | 50,992.75 | 0.30 | 317,015.82 | 1.85 |
| 14,458,259.63 | 2,223,804.20 | 15.38 | 4,124.74 | 0.03 | 1,155,505.10 | 7.99 | 6,659.04 | 0.05 | 1,060,515.32 | 7.34 |
| 13,684,530.26 | 75,719.01 | 0.55 | 224.41 | 0.00 | | 0.00 | 75,494.59 | 0.55 | | 0.00 |
| 11,510,813.00 | 403,206.81 | 3.50 | 3946.12 | 0.03 | | 0.00 | 383.732.97 | 3.33 | 15,527.72 | 0.13 |
| 5,056,768.47 | 2,412,198.78 | 47.70 | 136,893.05 | 2.71 | 1,764,204.14 | 34.89 | 322,674.95 | 6.38 | 188,426.64 | 3.73 |

Source: IBAMA - 2002

natural environments represent less than 3 percent of the national territory. None of the Brazilian biomes protect the minimum of 10 percent of its extension, as suggested at the World Congress for Parks in 1982 (**Table 5**). Compared to the world average of 6 percent and to the percentage of other South American countries - Colombia 7.9 percent, Venezuela 22 percent, and Bolivia 3.9 percent - the current Brazilian system, with 2.91 percent protected, is clearly deficient (Sales 1996, IUCN 1997b).

In addition to the unsatisfactory extension of the conservation unit system, the same can be observed regarding is effectiveness. An evaluation of federal conservation units of integral protection undertaken in 1999 (Lemos & Ferreira 2000) stated that, of the 86 units analysed, 47 (55 percent) were in a precarious state, 32 (37 percent) were considered as minimally implemented, and only 7 (8.4 percent) were considered satisfactorily implemented.

Existing units are also not distributed according to representative criteria throughout the different bio-geographic regions, a fact that can further reduce the effectiveness of the system for conserving biological diversity (Pressey *et al.* 1993, Ferreira 2001, Fonseca *et al.* 1997). The Amazon, for example, concentrates around 68.5 percent of the total protected areas in the country, whereas the Atlantic Forest protects only 8 percent of Brazilian territory. The average size of conservation units also indicates the differences between biomes. In the Amazon, the average size is of 485,603 hectares and in the Atlantic forest it is 29,681 hectares (**Figure 4**). This implies the adoption of differentiated management and protection measures.

Among the main problems of conservation units is the lack of adequate planning instruments, such as management plans and the insufficient number of staff per unit. The use of the unit that is incompatible with its objective also occurs in almost all regions, as well as lack of physical demarcation – a situation also evidenced in the North and Northeast. In the South and Southeast regions, the difficulties registered regard the lack of financial resources. These results demonstrate the great variety of problems encountered by conservation units regarding implementation issues, thus the need for the adoption of general and specific policies to solve problems within each region. Additionally, both the

reduced extensions of the conservation unit system and the distribution pattern throughout bio-geographic regions impede the effective conservation of Brazilian biological diversity in the long term.

After the establishment of IBAMA and already in the context of the current Brazilian Constitution (1988), which contains provisions for environmental preservation, a revision of the Brazilian list of animals in danger of extinction was published in 1989, with small inclusions in 1992 and 1997 totalling 218 species (Bernardes *et al.* 1989; Ibama 1992 and 1997), almost three times more than the numbers registered on the previous list (**Table 5**). The list of plants, published in January 1992, includes 107 endangered species (IBAMA 1992), almost ten times more than the list of 1968. These data are underestimated both due to the time in which these revisions were carried out and to the incipient knowledge of our fauna and flora.

In addition to resource losses due to exploitation of natural resources and bio-piracy, Brazil has not been investing in rescuing its culture regarding the use of native species. The strong correlation between a popular plant use and the pharmacological activity for some therapeutic categories (Brito & Brito 1993) confirms the rich knowledge of traditional communities. The cultural legacy of specific ethnic groups is a strong source of knowledge for the discovery of bioactive vegetation species, depository of substances that can become prototypes for the development of new pharmaceutics. Unfortunately, few studies in this sense have been carried out in Brazil. Of the 122 estimated indigenous cultures in the Brazilian Amazon, less than 22 have been studied and even these were incompletely conducted (Elizabetsk & Wannmacher 1993).

Pressures on the Brazilian environment began during the time that Brazil was still a Portuguese colony. The destruction of the Atlantic Forest cover is related to the beginning of the economic cycle of sugar cane in 1550.

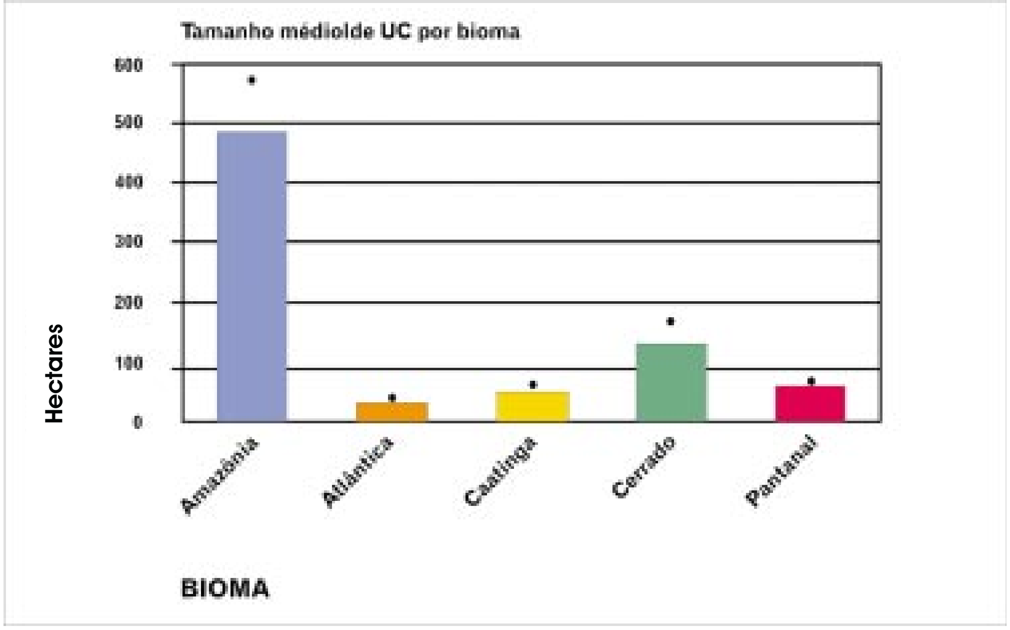
According to Dias (2001), the main pressures of human intervention on the environment are: habitat destruction and habitat fragmentation, such as deforestation, desertification, burning, mining, water dams, erosion, silting, urbanization and transport ways; introduction of exotic species and illnesses (in agriculture, cattle breeding, fishing and urbanization); excessive exploitation of plant and animal species (vegetal, firewood and coal extraction; selective exploitation of wood, hunting and fishing); contamination of soil, water and air (toxic gases, air particles, pesticides and agricultural fertilizers, salinisation, toxil solid waste, water toxic residues, water eutrofization.

Among indirect economic and social factors, there are: accelerated growth of human population; increase in deforestation and commerce of threatened species; uneven distribution of land, of generation and flux of benefits from biodiversity use and conservation; political and economic systems that do not adequately value the environment and natural resources accordingly; legal and institutional systems that promote unsustainable extraction of natural resources; and insufficient and knowledge gaps in its application (Dias 2001).

However, among all factors mentioned above, there is no doubt that the main causes of biodiversity loss are the destruction and fragmentation of habitats, that are associated sometimes to specific factors for certain species: predatory collection, restrict distribution, small population, isolated or declining population. The most significant variant of habitat change is, since the colonial period, the conversion of lands for agricultural expansion. The deforested area in the Amazon has increased 170 percent from 1978 to 1990. From 1985 to 1990 the cultivated area in the Cerrado increased 6.5 percent and soybean processing in the central-west increased 150 percente from 1988 to 1990. In the 1990s this expansion trend continued, overcoming all historic rates of deforestation in the country (Rodrigues 2001).

Additionally, food resources generation methods have been questioned due to the high use of pesticides, the adoption of techniques that increase the loss of agricultural soils in the medium-term and the industrial production system, guided by generation of Gross Domestic Product despite social and environmental impacts being caused. This practice has led to the fact that, increasingly, native vegetation is converted for use, instead of efforts to improve land productivity in already cultivated areas.

**Figure 4**: **Average size and standard deviation of federal full protection units, by biome**




Even today, a significant part of development policies stimulates the conversion of native vegetation in areas for agriculture and cattle breeding and, until very recently, agricultural credit systems stimulated landowners to deforest their lands. If there were considerable changes regarding this aspect, there would still the difficulty in articulation of development policies with those of environmental conservation. Great infrastructure projects (highways, waterways and hydroelectric dams) are planned and implemented frequently with significant damage to biodiversity.

The Brazilian legislation is robust regarding the obligation in maintaining areas of permanent protection in agricultural land, but the law has not been enforced. In the same way, there is no criteria for preservation that prioritise areas of high diversity nor designs of reserves that favour the optimal use of conservation of a greater number of species. As for the use of pesticides, or other modern techniques with contamination risks, regulation and security norms enforcement has also been weak, always resulting in biodiversity loss.

Despite biological diversity being an important potential source of financial resources, through access to chemical compounds of commercial importance or the generation of silvo-cultural products, there are no political efforts to value such resources against pressures for Brazilian agricultural expansion. The great richness of natural products is still unknown to science, sub-used by Brazilians and exploited without

conservation criteria, which should be based in a strong regulation and control.

Despite habitat loss being the greatest threat to the survival of animal species in Brazil, the traffic of wild fauna also plays a relevant role (LeDuc 1996). Traffic of wildlife, which includes fauna and its products and by-products, is the third greatest illegal activity in the world, after arms and drugs. It is estimated that annually it generates from 10 to 20 billion dollars (Webb 2001).

Main consumers of this traffic are, in order of importance: private collectors and zoos; persons interested in biotechnology (bio-piracy), persons responsible for traffic of spiders, scorpions, snakes and countless plant species; persons interested in pets; and persons that trade wildlife products, such as handicrafts and clothing. In this illegal market, Brazil is among the main exporters and the United States the main consumer, followed by countries from the European Community, Saudi Arabia and Japan (LeDuc 1996, RENCTAS 2001). The traffic of animals is especially harmful for those rare and most threatened species, such as the blue macaw (*Anodorhynchus leari*).

Wood extraction, the use of native plants in landscape planning, medicinal use and bio-piracy are some of the pressures that impinge upon selected species. The state of Minas Gerais, considered the centre of genetic diversity of many families of evergreens on a world scale (Mendonça & Lins 2000), does not have a policy or any other preventive action for the protection of the group.

Wood exploitation, as occurred with mahogany, in addition to representing a direct threat to the species, brings disastrous consequences to neighbouring areas. The routes specifically open to extract logs of wood, increase forest susceptibility of being converted to lands for cultivation by migrant rural workers, resulting in habitat alteration and loss of biological diversity. Annually, more than 120,000m$^3$ of Latin American mahogany are traded internationally, of which the United States imports 76,000m$^3$, or 60 percent of the global trade. According to data from TRAFFIC (2000), the United States imported mahogany from eight Latin-American countries in 1998 with 95 percent of these imports coming from Brazil.

Direct and uncontrolled exportation of medicinal plants are also a factor that threaten the Brazilian flora. Similarly to world trends, the Brazilian market of phyto-therapeutics is also in expansion. It is estimated that, in 1994, the phyto-therapeutics market generated an amount of US$ 355 million in Brazil (Ferreira 1998). The World Health Organization (WHO) estimates that around 20,000 species of superior plants are used as medicine all over the world (Phillipson 1994), with a global generation of around 20 billion Dollars a year. More than two thirds of species used are native, mainly from tropical forests (Franz 1993).

The growth in the use of natural plants/products with medicinal purposes results, most of the time, in predatory exploitation of natural resources. According to IBAMA/SP, in the Ribeira valley alone, around 400 tons of green leaves are extracted, probably collected from native species (Garcia *et al.* 2000). Among the most explored native plants in the region one can find the espinheira-santa herb(*Maytenus ilicifolia*), pata de vaca (*Bauhinia forficata*), carqueja (*Baccharis trimera*), guaco (*Mikania glomerata*) and verbanacea herb (*Cordia verbenacea*) (Reis 1996).

The introduction of exotic species is another relevant environmental problem in Brazil, with mechanisms and consequences that are totally unknown. Biological invasions are badly documented and knowledge about its consequences is still incipient. Even so, a simple list of most known cases demonstrates that the country offers conditions for the establishment of a numerous and varied group of exotic species (**Annex 3**). One of the few evident aspects is that intentional human action, including governmental, was responsible for many of these introductions.

The introduction of exotic species in Brazil dates from the first century of European colonization, but has intensified significantly with globalisation at the end of the 20th century. The explosive growth of international trade and tourism, coupled with rapid development of transportation, increased considerably the artificial transit of species, as an example of what already occurs throughout the world (Convention of Biological Diversity - Subsidiary Body on Scientific, Technical and Technological Advice 2001). According to GEO document – Environmental Statistics for Latin America and the Carribean, between 1980 and 1995, international commerce grew 150 percent in Brazil, in which the extensive network of roads, ports and airports was the main South American door to the rest of the world.

Data regarding agricultural pests, which are among the most complete, indicated an increase in risk of invasion by exotic species in Brazil. The number of plagues introduced in Brazil increased by 170 percent in relation to 1995. In a recent revision of the Official List by the Committee for Vegetation Health from Conesul (Cosave), the technical-scientific team for the sanitation area of Mercosur, researchers from Cenargen discovered that since the Brazilian list was elaborated in 1995, insects alone increased more than 100 percent. Of a total of 280 plagues, the list had 102 species of insects listed and now has 340, with a possibility of increasing to 500 species, including fungi, virus, bacteria, nematodes and acarids (Radiobrás 2001).

The Department of Sanitation listed another 63 species and varieties at a high risk of invasion in the Brazilian territory. Normative instruction nº 38, from October 14, 1999, of the Secretariat of agriculture and cattle - ranching Defense, list plagues quarantined for Brazil and gives maximum alert against the ones considered high potential risk. The

number of species or total varieties and the high risk (parenthesis) is of 9 (5) acarids, 112 (26) insects, 27(10) nematodes, 17(3) bacteria, 20 (3) virus and related, 52 (11) fungi, 3 (2) weeds. EMBRAPA, which is one of the main centres in the country for germoplasm analysis intercepted 65 species and varieties of agricultural plagues in vegetable material imported by Brazil, between 1976 and 1997 (Sujii *et al.* 1996).

In addition to plagues, many other species were introduced accidentally through other living species or through biological material. Abiotic vectors such as baggage, boxes, cargo, and even transports, also brought various species accidentally into the country. Most recent cases are the introduction of crabs (*Charybdis hellerii*) and of golden-mussels (*Limnoperna fortune*) by discharge of ballast water in the coast of South America (IEAPM 2000, Galván 2000 e Karen Larsen com.pess.).

In Brazil, the intentional introduction of exotic species is as frequent as accidental introductions causing some of the worst cases of invasions. African bees (*Apis mellifera scutelatta*) were brought into the country in 1950, for research and genetic improvement and experimental hybridisation with the European bee, which does not adapt well to tropical climates. Experimental beehives had barriers to impede the exit of queens that, nonetheless, escaped. Propagating at an alarming rate of 300-500 km a year, the bees occupied the whole of America, until the South of the United States and in some natural environments its deadly populations reached the density from 4 to 10 colonies per square kilometre (Kerr 1967, Taylor 1985, Southwich 1990). More recently, the African snail (*Achatina fulica*), considered one of the worst invaders in the world (ISSG, 2000), was brought to Brazil for commercial reproduction, and were released through space and discharge. (Paiva 2000).

Many intentional introductions were carried out directly into natural environments. The import of freshwater species for aqui-culture was the most extensive action of this type of introduction, undertaken mainly by government sectors, or with their incentive (Vieira & Pompeu 2001; Agostinho & Gomes, at press). At least twenty-seven exotic species and two of its hybrids were introduced in Brazil, of which thirteen established wild populations in natural water bodies (Welcomme 1988, Ibama 1998). Additionally, 28 native species and four of its hybrids were transferred to basins where they didn't exist originally (IBAMA 1998). Despite escapes having contributed for part of these introductions, the majority of these were caused by intentional and massive liberation of individuals in natural water bodies and its barriers, by programs for repopulating reservoirs and increasing fish stock, also known as fisheries. At least twenty exotic fish species or species from another basin were liberated in reservoirs of south and southeast basins (Agostinho & Gomes, at press). Only in the Basin of the São Francisco River, the federal government liberated 38.7 million fish, from 1995 and 1997 (Vieira & Pompeu 2001).

The impact from commercialisation of flora, as well as the consumers, is very diversified.

There is little data on the impact of exotic species on Brazilian biodiversity. The scarce available reports indicate the elimination or reduction of native species by competition, predatory measures, introduction of parasites and changes in the ecosystem process. However, some cases have already been documented as, for example, introduced fish that eliminated native species in natural lagoons of Minas Gerais (Vieira & Pompeu 2001) and introduced parasites that attacked native species (Agostinho & Gomes, at press); packs of deadly dogs that are hunting wild animas in the Brasilia National Park (unpublished data of the Project for Control of Wild Dogs – UnB); European rabbits that may be competing with the Brazilian rabbit (*tapiti*), but that has been the prey for native carnivores (Auricchio & Olmos 1999); African grass, introduced as forage, that is invading non-forest formations, such as Cerrado, excluding various native vegetable species, exhausting soil nutrients, and changing the fire regime, due to its flammability (Williams & Baruch 2000).

Even economic impacts are now well known. The best estimates available are of direct losses caused by agricultural plagues, calculated by the reduction of production volumes. These values, from millions to billions of dollars per introduced specie, are certainly underestimated, as they do not take into account environmental and indirect losses. As an example, the nematodes of soybean cysts caused the loss of 360,000 tons of production, in the first five years of its presence in Brazil alone (1991-1995), equivalent to US$ 54 millions; the losses caused by the white moth in Brazil reached US$ 1 billion. The losses estimate for South America regarding the introduction of the carombola fruit fly is US$ 1.2 billion in 12 years.

## 1. Patrimony and current soil conditions

The Brazilian territory is made up of a great diversity of types soil. They are directly associated to different types of relief, climate, originating material, vegetation and organisms. The latter may trigger different soil formation processes.

A summarised picture of Brazilian landscapes per region shows that the North Region is characterised by plains and low plateaus, equatorial climate, permanent heat and high humidity. Besides, deep, highly intemperate and acidic soils with a low natural fertility and saturated with aluminium significantly reduce the production capacity in the region.

In the Northeast, climate types vary from hot and humid to hot and dry (semi-arid) , passing by a semi-humid transition. In a great part of this region, medium to high natural fertility soils can be observed. These are generally not very deep due to the low intemperance degree.

The MidWest region is a vast surface affected by natural erosion processes. It corresponds to the Brazilian Central Plateau, where hot tropical climate with conspicuous Indian summers prevails. Also, it is marked by great extensions of deep, well-drained soil, with a low natural fertility, but with favourable physical characteristics. Finally, the topographic conditions enable the full development of mechanised agriculture.

In the Southeast, plateaus and ridges are typical, with several altitude peaks superior to 2,000 meters. The climate is tropical with hot summers in the lowlands, and milder temperatures in high-mountain areas. There are mostly well-developed soils, generally with a low natural fertility.

In the South of Brazil, soil originated from basic rocks and varied sediments, spreading over a landscape with diversified relief, where the subtropical is the typical climate, with well-defined seasons. Lands are considered fertile and have a high potential for agriculture, silviculture and shepherding.

This regional differentiation concerning type of soil, climate and relief, is directly reflected by the agricultural potential of the lands, landscape diversity and the use of the soil. Based

**Table 1 - Extension and distribution of soils in Brazil and regions**

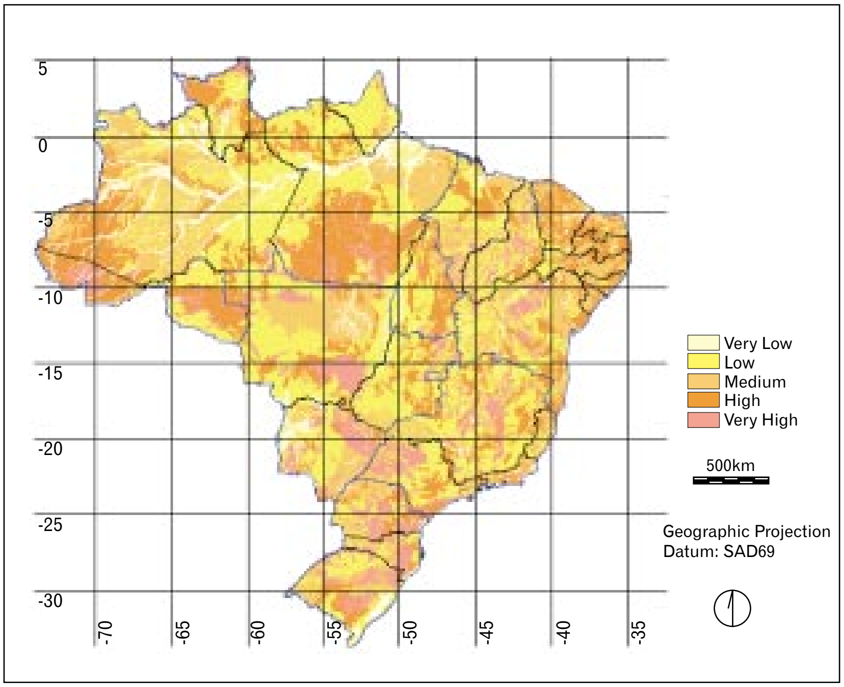
| Soils | Brazil | | According to the Region | | | | |
|---|---|---|---|---|---|---|---|
| | Absolute | Relative to total | North | Northeast | Central West | Southeast | South |
| | km2 | % | | | | | % |
| Alisols | 371,874,48 | 4.36 | 8.67 | 0.00 | 0.00 | 0.00 | 6.34 |
| Alfisols | 1,713,853,49 | 19.98 | 24.40 | 17.20 | 13.77 | 20.68 | 14.77 |
| Cambisols | 232,139,19 | 2.73 | 1.06 | 2.09 | 1.59 | 8.64 | 9.28 |
| Chernosols | 42,363,93 | 0.53 | 0.00 | 1.05 | 0.27 | 0.21 | 3.94 |
| Espodosols | 133,204,88 | 1.58 | 3.12 | 0.39 | 0.26 | 0.37 | 0.00 |
| Gleisols | 311,445,26 | 3.66 | 6.41 | 0.78 | 2.85 | 0.5 | 0.4 |
| Latisols | 3,317,590,34 | 38.73 | 33.86 | 31.01 | 52.81 | 56.30 | 24.96 |
| Luvisols | 225,594,90 | 2.65 | 2.75 | 7.60 | 0.00 | 0.00 | 0.00 |
| Neosols | 1,246,898,89 | 14.57 | 8.49 | 27.55 | 16.36 | 9.38 | 23.23 |
| Nitosols | 119,731,33 | 1.41 | 0.28 | 0.05 | 1.22 | 2.56 | 11.48 |
| Planosols | 155,152,13 | 1.84 | 0.16 | 6.61 | 1.73 | 0.16 | 3.00 |
| Plintosols | 508,539,37 | 5.95 | 7.60 | 4.68 | 8.78 | 0.00 | 0.00 |
| Vertisols | 169,015,27 | 2.01 | 3.20 | 0.99 | 0.36 | 1.20 | 2.60 |
| Water | 160,532,30 | 1.88 | 3.20 | 0.36 | 0.31 | 1.20 | 2.60 |
| Total | 8,547,403,50 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

on the Map of Soils in Brazil (Embrapa, 1981) and on the current Brazilian Soil Classification System (Embrapa, 1999), 13 main types of soil classification may be distinguished to represent Brazilian landscapes. Their extension is presented in **Table 1**.

### 1.1. Soil vulnerability to erosion

Natural vulnerability to erosion is a function resulting from the interaction among climate conditions, land topography and type of soil. Through the analysis of the interaction among these factors and experimental estimates of soil losses, it was possible to establish five degrees of vulnerability to land erosion in the country. Thus, lowland soils, hydromorphic or not, plain, very porous, deep and well-drained such as those found in plateaus have a very low or low vulnerability degree, in plain relief. More susceptible to erosion are commonly sandy soils or those with remarkable change of texture in depth, as well as shallow ones. Shallow soils are generally found in dissected reliefs, with medium, high or very high degrees of erosion vulnerability to (**Figure 1**).

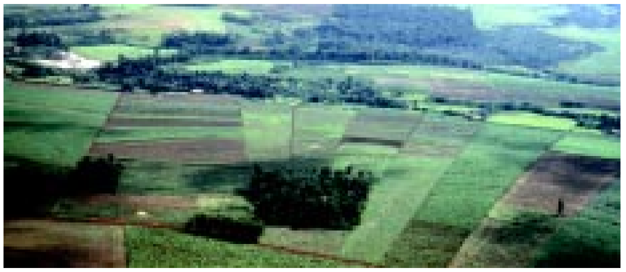
**Figure 1 - Map of the vulnerability of the soils to water erosion.**




According to these interpretations, 65 percent of Brazilian lands may be classified under a medium to low degree of vulnerability expressed differently in each region. Therefore, in the North, low levels of vulnerability may be observed in the meadows of the Amazon River and its tributaries, as well as in low plateaus, where clay or highly clay, very deep, porous soils are usually in plain relief. These environments, mostly composed of *Gleissolos*, *Neossolos Flúvicos*, Yellow and Red-Yellow *Latossolos*, represent approximately 46 percent of the land in the Amazon (**Table 1**). Lands with the highest erosion potential, accounting for approximately 36 percent of the region, are found in more dissected reliefs and are made up of *Argissolos*, *Luvissolos* and *Cambissolos*.

In the Northeast of Brazil, 33 percent of the land has a very low or low vulnerability, 34 percent, medium, and 33 percent, are highly or very highly susceptible. *Soils like Neossolos Quartzarênicos, Litolic and Regolíticos* have the highest erosion potential due to the remarkable contents of sand, associated, in some cases, to dissected reliefs. Although rains in semi-arid areas are short and rare, their high intensity in some areas enables superficial drainage, disintegration and transport of soil, even in more flat reliefs. Soils like *Luvissolos*, usually containing a lot of clay and found in very dissected reliefs, are highly susceptible to erosion. Expressive *Latossolos* areas, accounting for about 30 percent of the region, have a low vulnerability. Finally, the occurrence of superficial sandy horizons, as well as increased levels of clay in depth, make *Argissolos* and *Planossolos* moderately susceptible under typical climate conditions in the region.

In the MidWest, around 70 percent of soils have low to very low vulnerability, generally due to the dominating flat relief found in the Brazilian Central Plateau associated to deep and well-drained soils, Latossolos. The remaining land (30 percent) corresponds, in general, to highly



sandy soils, such as *Neossolos Quartzarênicos* and some *Latossolos*, which are weakly structured and are easily washed out by rain waters, even in a relatively flat relief. It is important to note the occurrence of severe erosion in this area, especially the major erosion tendencies found near drainage lines. This type of landslide is triggered by the conjugation of very friable soils and irregular relief. Examples may be found in the tablelands in near the boundaries of the States of Goiás, Mato Grosso do Sul, Minas Gerais and Mato Grosso, where several river springs make up the Prata and the Amazon water basins.

In the Southeast Region soils with low vulnerability erosion prevail (46 percent). Like in the MidWest, remarkable occurrence of Latossolos in flat reliefs, well structured and with high levels of clay results in low vulnerability to erosion. However, 40 percent of the region is made up of very susceptible soils, due to more accented relief and/or highly sandy soils or remarkable textural difference in depth, such as those found in the west of the State of Sao Paulo and in the accented relief along the Serra do Mar.

In the South, soils have high to very high vulnerability to erosion, owing to the remarkable occurrence of shallow soils, such as *Cambissolos* and *Neossolos Litólicos*, or even deeper, like *Argissolos*, all of which found in the accented reliefs of the ridges and plateaus in the South. Very low and low vulnerability soil adds up to 29 percent. These are generally associated to plateaus and sediment plains in flat reliefs, where *Latossolos* and *Planossolos* are found, respectively. Under a moderate vulnerability degree are *Alissolos*, *Nitossolos* and *Chernossolos*, usually in irregular relief.

## 1.2. Land potential use

The adequate use of the land is the first step towards sustainable, appropriate agriculture and the preservation of the soil as a natural resource. To do so, each portion of land should be used in accordance with its properties, sustainability and economic productivity, so that natural resources are made available to man for its best use and benefit. Equally important, land should be preserved for future generations (Lepsch et al., 1991). In the forthcoming evaluation, trends and environmental restrictions such as vegetation, biodiversity and others have not been taken into consideration, as these will be approached in other chapters.

**Table 2** presents the agricultural land potential in Brazil in different regions, including different technological levels of management (primitive, intermediate and advanced) and types of use recommended. Its analysis shows that farming land prevails, as compared to other activities. Considering different technology levels, approximately 65 percent of the Brazilian available territory (5,552.673km$^2$) is made up of potential farming land.

By analysing agricultural activity in Brazil as a whole, it is evident that handling levels, or the intensity of technology use in soil handling prevails to determine agricultural potential. It is clear that, to manage level A (primitive), there is a predominance of land that has serious limitations (restricted potential) in the whole country. In other words, the use of rudimentary technology restrains agricultural activities (**Table 2**). To manage level B (little development), there is certain balance between moderately and strongly limited lands (regular and restricted potential) in most regions. For management level C (developed; high technology) there is a remarkable prevalence of moderately restricted lands, taking into account the current level of technology. In light of that, it is noticeable that more fertile agricultural lands (Good potential) are mostly found in handling levels B and C, predominantly in the Southeast and South of Brazil.

**Table 2 - Potential of Brazilian lands by region and by levels of management according to the different types of use assigned.**

| Types of use | Region | Land potential by handling level (km2) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Handling level A | | | Handling level B | | | Handling level C | | |
| | | Good | Regular | Restricted | Good | Regular | Restricted | Good | Regular | Restricted |
| Agricultural lands | North | 25,850 | 204,982 | 2,046,873 | 106,878 | 1,751,585 | 427,377 | 30,032 | 1,731,001 | 326,120 |
| | Northeast | 13,394 | 145,079 | 435,307 | 15,555 | 421,060 | 321,150 | 7,482 | 436,452 | 267,025 |
| | Southeast | 22,715 | 118,648 | 147,506 | 102,929 | 130,785 | 330,767 | 78,230 | 266,287 | 45,966 |
| | Central West | 2,508 | 68,048 | 358,065 | 10,708 | 385,902 | 579,222 | 107,426 | 636,919 | 231,460 |
| | South | 46,191 | 96,824 | 142,717 | 64,975 | 171,474 | 162,399 | 38,388 | 233,857 | 48,078 |
| | Total | 110,658 | 633,581 | 3,130,468 | 301,045 | 2,860,806 | 1,820,915 | 261,558 | 3,304,516 | 918,649 |
| Cultivated pastures1 | North | – | – | – | – | 234,113 | 4,935 | – | – | – |
| | Northeast | – | – | – | 4,908 | 91,636 | 27,967 | – | – | – |
| | Southeast | – | – | – | 2,957 | 40,215 | 96,807 | – | – | – |
| | Central West | – | – | – | – | 339,309 | 22,119 | – | – | – |
| | South | – | – | – | 34,125 | 16,836 | 10,210 | – | – | – |
| | Total | – | – | – | 41,990 | 722,109 | 162,038 | – | – | – |
| Silviculture 2 | North | – | – | – | – | – | 3,816 | – | – | – |
| | Northeast | – | – | – | 1,939 | 33,908 | 71,854 | – | – | – |
| | Southeast | – | – | – | – | 58,619 | 9,415 | – | – | – |
| | Central West | – | – | – | – | 139,418 | 71,006 | – | – | – |
| | South | – | – | – | 3,127 | 7,322 | 11,238 | – | – | – |
| | Total | – | – | – | 5,066 | 239,267 | 167,329 | – | – | – |
| Natural pastures 3 | North | – | – | 9,469 | – | – | – | – | – | – |
| | Northeast | 287 | 141,564 | 290,781 | – | – | – | – | – | – |
| | Southeast | – | 945 | 77,084 | – | – | – | – | – | – |
| | Central West | – | – | 209,181 | – | – | – | – | – | – |
| | South | 19,789 | 10,359 | 3,102 | – | – | – | – | – | – |
| | Total | 20,076 | 152,868 | 589,617 | – | – | – | – | – | – |

1 Exclusively for cultivated pastures; no potential for agriculture.
2 Exclusively for silviculture; no potential for agriculture and cultivated pastures.
3 Exclusively for natural pastures, other types of use are not recommended.
Source: Ramalho Filho e Pereira - 1999

About 10 percent of the national territory – or around 926,137km$^2$, is made up of land that is appropriate for cultivated pasture. The south is positively noticeable for its high potential for this activity. Around 56 percent of its lands have a good potential for cultivated pastures, 28 percent are classified as regular, e only 17 percent are severely restricted to that use. The other regions are made up of lands with a regular or restricted potential for cultivated pasture purposes.

**Table 3 - Current land use in Brazil (*)**

| I. Lands used with economic purposes | Millions of Hectares |
|---|---|
| . Temporary croplands (1) | 38.5 |
| . Temporary iddle crop lands | 4.0 |
| . Permanent crop lands | 7.5 |
| . Cultivated pastures | 99.7 |
| . Natural pastures | 78.0 |
| . Artificial forests | 5.4 |
| . Irrigated lands | 3.0 |
| SUB TOTAL | 236.1 |
| II. Lands with other uses | |
| . Amazon Forest (encompasses all types of reserves) | 365.0 |
| . Indigenous Reserves (2) (approved, reserved or in identification process out the Amazon Forest) | 101.9 |
| . Urban centres, lakes, roads, and rivers (3) | 30.0 |
| . State-owned lands | 6.1 |
| . Iddle productive lands | 16.3 |
| . Other uses, or indefinite | 99.3 |
| SUB TOTAL | 618.6 |
| TOTAL | 854.7 |

(*) Table adapted from the book "*Os Caminhos da Agricultura Brasileira*" (The Paths for Brazilian Agriculture), Espírito Santo, Benedito Rosa - 2001
Sources: IBGE - Agricultural Census - 1996. / 1- CONAB - Safra Estimates - 2000/01 /

Regarding silviculture, the South is also highlighted as around 48 percent of land have a good to regular potential (14 percent and 34 percent, respectively). The remaining lands (52 percent) are rated as restricted. Despite the high percentage of land with a restricted potential (67 percent), the Northeast has 31 percent of land classified as regular, and only 2 percent considered good for silviculture (**Table 2**).

Once again, the South stands out positively concerning the use of land for natural pastures, presenting 60 percent of good potential for this activity. The Northeast comes second with regular (33 percent) and restricted (67 percent) potentials. The other regions are mostly restricted for natural pastures.

Thus, in light of a summarised evaluation of the agricultural potential of land in Brazil, it is clear that the country has a great potential. There are 5.55 million square kilometres of potentially agricultural lands, 2.79 million km$^2$ located in the North. Brazil is also endowed with a great extension (964,334km$^2$) of cultivated pasture and silviculture.

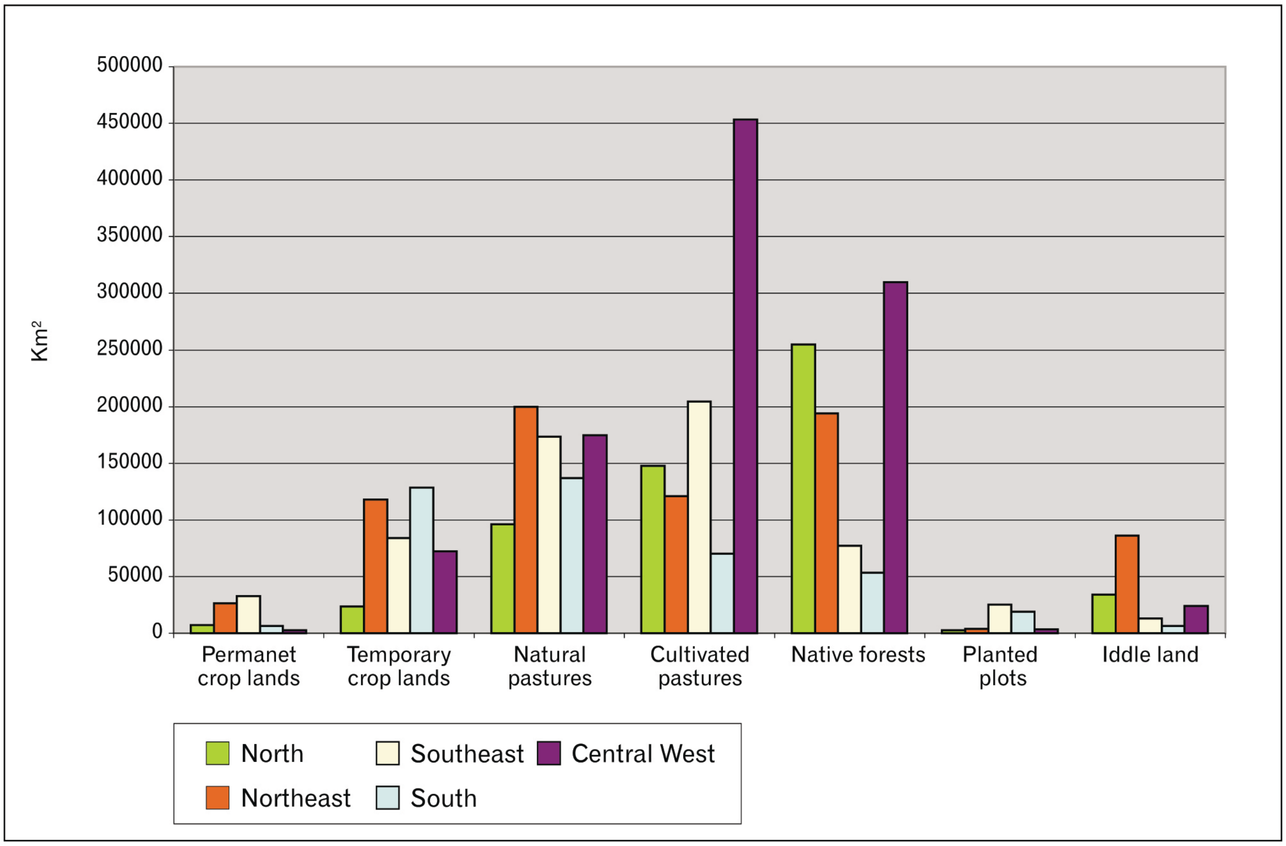
### 1.3. Land use nowadays

Among the varied uses of the solos identified by the Agricultural Census of 1996, agriculture and cattle raising activities occupy nowadays approximately 27.6 percent of the territory (**Table 3**). Permanent preservation areas and already delimited ones represent about 55 million hectares. It is estimated that this percentage will come up to 10 percent of the national territory with new delimitation in progress. Although that is an expressive estimate, it is still insufficient for the preservation of the various biomes in Brazil.

An analysis of the productive structure in the country reveals that the main use of the soil is for cattle ranching. Thus, 21 percent of the Brazilian territory is occupied with pastures, which represents three times as much as the lands for permanent cultivation and crops. Regionally speaking, the use of natural pastures is still relevant, despite regional climate differences, land value, cultural patterns, productive opportunities and agricultural technology implementation (**Figure 2**). As for cultivated pastures, the Central West stands out in relation to the others, with 46 million hectares, or almost half of all cultivated pastures in Brazil, followed by the Southeast, with about 20 million hectares.

In spite of the country's excellent potential for soil irrigation, estimated in 29.5 million hectares, its use is still limited. In 1998, an area of 2.87 million

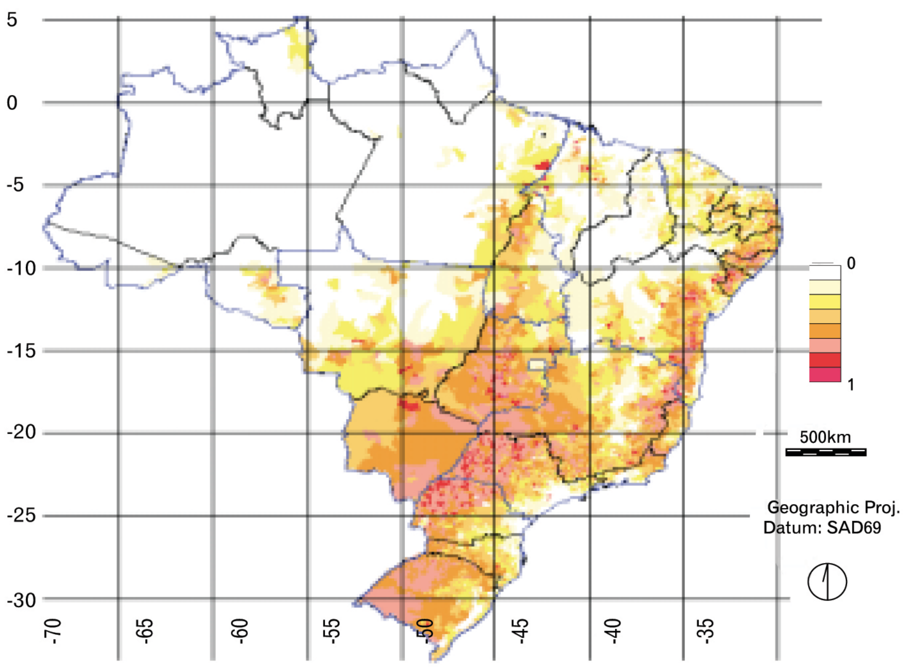
**Figure 2 - Current use of land in Brazil (per region).**




hectares, or only 6.19 percent of the agricultural lands, far below world standards and the opportunities offered by the country.

The measurement of the intensity of land use for agricultural, silvicultural and cattle raising activities was based on the Agricultural and cattle - ranching Census of 1985/86. Also, variables that represent the three main categories of land use – **Agriculture**, **Cattle-ranching** and **Silviculture** – were selected from the municipal data basis. The data was standardised and grouped, resulting in a final index of the territorial intensity of occupation by the above mentioned activities in municipalities (**Figure 3**). Agriculture and cattle raising are more intensive in the South, Southeast and MidWest

**Figure 3 - Relative index of soil use intensity, per municipality, By agricultural, silvicultural and ranching activities**



of Brazil, respectively. The Northeast, although modified by the man, has a moderate intensity of land use, due to climate limitations; and the northern municipalities have a low or even non-existent rate of intensity.

## 2. Soil use dynamics

### 2.1. Land Tenure Regime

Land tenure in Brazil causes pressure on soil use. It may be analysed in two different perspectives. The first concerns how land is distributed among landowners and leaseholders. The second considers how land occupation and exploitation is done by farmers. Therefore, there are smallholdings (*property units*) and large agricultural holdings *(production units)*. In order to evaluate land distribution, data collected by INCRA has been used. In the second case, data in the IBGE Agricultural and cattle - ranching Census was used for analysis. Although these sources are based on different methods and concepts, both indicate the occurrence of unequal land distribution in Brazil.

**Table 4 - Evolution of the incidence rate of malaria registered in Brazil, per region, in the 1980s and 1990s (per 100,000 inhabitants).**

| Regions | 1980/84 | 1985/89 | 1990/94 | 1995/99 |
|---|---|---|---|---|
| North | 14406.2 | 23085.1 | 17943.8 | 19110.4 |
| Northeast | 327.1 | 640.7 | 297.8 | 353.5 |
| Southeast | 21.0 | 36.7 | 14.1 | 6.0 |
| South | 3.9 | 80.3 | 41.9 | 10.0 |
| Central West | 1242.7 | 1942.5 | 20650.0 | 22140.0 |

Source: MS/FUNASA - 2001

According to statistics from INCRA in 1998, rural estates with more than 1,000 ha, or 1.4 percent of the catalogued sample, represented 49 percent of the total area. Regarding large agricultural holdings, 0.9 percent of the total number, measuring more than 1,000 ha occupied 43.7 percent of the total area in the 1996 census. On the other hand, 31.1 percent of land estates with less than 10 ha amounted to 1.4 percent of the total area. In a more dramatic fashion, 52.9 percent of agricultural holdings with less than 10 ha solely represented 2.7 percent of the total area.

The fact that Brazil is a large country with 415 million hectares catalogued by INCRA in 1998 and 353.6 million hectares according to the last IGBE Agricultural and Cattle - Ranching Census makes it clear that land in Brazil is strongly concentrated. An impressive example is the fact that the total area of rural estates with more than 1,000 hectares is 33 times as large as the national average and for agricultural holdings, it is 43 times as large.

As a consequence of historical colonial system of land ownership and recent disorderly land occupation, land tenure in Brazil is inequitable. This situation has been dealt with by successive governments, but little success has been achieved. Nowadays, agrarian reform has been intensified due to pressure from organised civil society. Also, land regulations and policies have contributed to more concrete changes, especially during the last three governmental terms.

Another aspect to be considered is the fact the analysis of national indicators shows a high concentration of land ownership in the whole country. These indicators tend to disguise or even distort regional differences in land ownership in systems of occupation and dimension throughout history. This has been pointed out by the Gini index (**Table 4**), used as a measure to evaluate ownership concentration. The index varied between 1992 and 1998. It is important to note that the North was the only region presenting higher values than the national ones during the two periods previously mentioned.

Data catalogued by INCRA indicates that approximately 2.9 million and 3.6 million of rural estates were distributed on an absolute basis among the five Brazilian regions in 1992 and 1998, as shown in **Table 5**. The analysis of these two periods shows that most of the land estates in Brazil are concentrated in the South – 35.53 percent in 1992 and 31.57 percent in 1998. These estates are always the smallest portion of the total registered area. Farms have an average area of 38 ha, and half of them are not larger than 14 hectares.

The number of farms was similar in the previously mentioned periods both in the Northeast and Southeast. However, this is not true for catalogued areas, which are more concentrated in the Northeast. In 1998, average farm sizes in the Northeast was 79.1 ha, whereas the average in the Southeast was 70.2 ha. Unequal land distribution among the regions is even more noticeable in medium-sized holdings. Half of the farms in the Southeast have up to 19 ha, whereas medium farms in the Northeast are smaller than 16 ha.

More than half of the catalogued area in the country is located in the North and Central West. Nevertheless, the quantity of real estate, even when considered jointly is inexpressive in comparison to any other region in Brazil. As a consequence, the average farm size in both regions is over 400 ha and medium-sized holdings have approximately 70 ha.

Taking the previous periods into consideration, the dynamics of change concerning the catalogued data may be evaluated. In Brazil, landholdings increased by 22.7 percent in number and 34 percent in size. However, considerable stability may be observed in the Brazilian land tenure system between 1972 and 1998. This was confirmed through the analysis of average farm sizes. According to Hoffmann[1] " there was a 3 percent decrease from 109.3 ha in 1972 to 106 ha in 1992. The national median area fell slightly from 18.7 to 18.5 ha. The Gini index remains slightly above 0.83. The percentage of total area occupied by 10 percent of large agricultural holdings varies between 77 percent and 78 percent".

**Table 4** demonstrates the previously mentioned stability during the period 1972/1998. Besides the Gini index, the Theil index was used to measure concentration. Still according to Hoffmann, one of the reasons for this stability in land tenure is the impressive extension of the Brazilian territory. This reduces the effectiveness of government distribution schemes.

## 2.2. Land holdings, area and Gross Production Value

In Brazil, there are 4,859,864 holdings occupying an area of 353.6 milllion hectares. In the agricultural period of 95/96, Gross Production Value (GPV) was R$ 47.8 billion. Total financing was

**Table 5 - Demonstration of number and area rural properties, Brazil and regions**

| Geographical units/years | Numbers of properties | | Total area (1,000.0) | | Evolutions numbers properties | Evolution area |
|---|---|---|---|---|---|---|
| | 1992 | 1998 | 1992 | 1998 | 1992/98 (%) | 1992/98 (%) |
| Brazil | 2,924,204 | 3,587,967 | 310,031,0 | 415,571.0 | 22.7 | 34.0 |
| North | 131,174 | 225,520 | 59,684.0 | 93,014.0 | 22.7 | 55.8 |
| Northeast | 780,804 | 1,007,819 | 60,488.0 | 79,725.0 | 29.1 | 31.8 |
| Southeast | 766,268 | 954,961 | 55,292.0 | 43,739.0 | 23.5 | 20.0 |
| South | 1,0039,234 | 1,132,762 | 39,805.0 | 43,739.0 | 9.0 | 9.9 |
| Central West | 206,724 | 275,905 | 94,762.0 | 132,732.0 | 33.5 | 40.1 |

Source: INCRA Record Estatistics - Partnership INCRA/UNICAMP

[1] Hoffmann, Rodolfo. Land Tenure in Brazil according to data from INCRA. INCRA/UNICAMP Agreement.

R$ 3.7 billion. Out of the total number of holdings, 4,139,369 are owned by smallholders, totalling 107.8 million ha. Smallholdings are responsible for R$ 18,1 billion out of total GPV total and rural incentives for these holdings amounted to R$ 937 million. Large landholders own 554,501 farms occupying 240 million ha. The remaining numbers refer to holdings that could not be classified under a certain category.

A regional analysis points to the importance of smallholdings in the North and South. In both regions, more than 50 percent of GPV is produced by smallholders. In the North, smallholdings amount to 85.4 percent, occupy 37.5 percent of the area and produce 58,3 percent of GPV in the region. They are granted 38.6 percent of total agricultural incentives.

In those regions, land is mostly cultivated with the use of old-fashioned technology (management level A). Thus, poorly mechanised smallholdings prevail in an itinerant fashion. Burning causes acute pressure on soils, and soil productivity is reduced by high temperatures, elevated rain precipitation levels and small average farm sizes.

In the Southeast, the highest concentration of ownership in a minority of landowners can be found. Agricultural incentives for smallholdings are disproportionate to the area that they occupy. Smallholders own 29.2 percent of the total area but receive only 12.6 percent of the agricultural incentives. Mountainous parts in the Southeast are under pressure of use, as smallholders usually found in this region are penalised by the lack of financial resources that would enable the adoption of new technology, mechanisation and alternative products. All this is added up to the limited size of land holdings.

The Northeast has the largest number of smallholders (88.3 percent), which occupy 43.5 percent of the region, produce 43 percent of the regional GPV and are allocated only 26.8 percent of total incentives. The historical occurrence of severe climate as well as the insufficient amount of agricultural land has been leading to a progressive depletion of natural vegetation cover and overexploitation of the soil. As a consequence, production capacity decreases causing erosion and desertification in more serious cases.

This has triggered a search for land with a lower use potential, which increases the risk of overusing and degrading soil resources. This may be observed in already degraded pastures and erosion processes found in these regions. In the North, high temperatures and frequent rain bring about more intensive depletion in soil productivity and pastures. These lands have been recently occupied by croplands. In the Northeast, due to the vulnerability of the Caatinga, this is a concerning indicator, as there is a risk of desertification.

In general terms, when cultivating pasture farmers usually manage to do soil correction through the use of short-cycled cultivation (maize and rice among others). However, they cannot afford to manage this cultivation through fertilisation maintenance and proper handling techniques. Thus, overpasturing may occur. In the same fashion, the use of burning to handle and recover pastures during dry periods dramatically affects soil conservation and other natural resources.

Regarding cattle production, there was an expansion caused by an increase in the number of pastures. Also, as expansion has been occurring steadily, it may be associated to a progressive mechanisation in the sector. There are several examples of this modernisation, such as public and private

**Figure 4 - Average area of households por hectare**

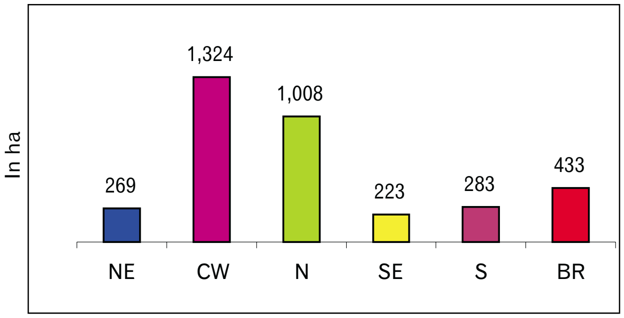
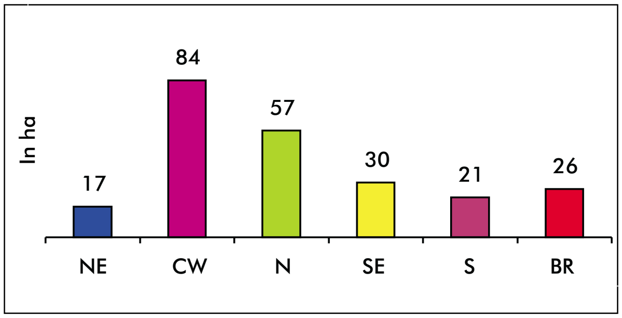



**Figure 5 - Áverage area of patronal lands in hectares**




programmes for the production of genetically enhanced crops, artificial insemination and embryo transfer, crop-cattle ranching integration, animal confinement and semi-confinement, and the recently launched programme for electronic tracking of animals. As a result, cattle slaughter rates climbed from 16 percent in 1990 to 23 percent at the end of the decade, higher than the world average of 20 percent. These indicators associated to new biotechnological methods for genetic enhancement point to an increasing trend towards an intensified use of up-to-date technology in national cattle ranching. Therefore, consumption demands may be met along with higher productivity dependent on the sectorial policies. This would diminish the expansion into the Amazon, one of the principal forms of land occupation today.

The average size of smallholdings in Brazil is 26 ha. (**Figures 4 and 5**), whereas large holdings 433 ha. These numbers may greatly vary among different regions and has its historical origin in the colonial system of land ownership. Therefore, in regions where landholdings are larger, smallholdings are also larger. While the average size of smallholdings in the Northeast is 16.6 ha, it is 84.5 ha in the MidWest. Regarding large farms, with a national average of 433 ha, the average size in the MidWest is up to 1,324 ha. In the Southeast are the smallest farms among large holdings, with 223 ha.

A regional analysis points to the importance of smallholdings in the North and South, where more than 50 percent of GPV is produced by smallholders. In the North, smallholdings add up to 85.4 percent of farms, occupy 37.5 percent of the area and produce 58.3 percent of GPV, receiving 38.6 percent of agricultural incentives (**Table 6**).

The South is predominantly made up of smallholdings representing 90.5 percent of all farms in the region. They occupy 43.8 percent of the total area and produce 57.1 percent of the regional GPV. Smallholders receive 43.3 percent of incentives applied in the region. It is also noted

**Table 6 - Brazil: establishments, areas, Gross Value of Production (VBP) and Total Financing (FT)**

| Categories | Total Establish. | % establish. Without total | Total Area (Thous ha) | % Area Without total | VBP (Thous. R$) | % VBP Without total | FT (Thous. R$) | % FT Without total |
|---|---|---|---|---|---|---|---|---|
| Households | 4,139,369 | 85.2 | 107,768 | 30.5 | 18,117,725 | 37.,9 | 937,828 | 25.3 |
| Patronal | 554,501 | 11.4 | 240,042 | 67.9 | 29,139,850 | 61.0 | 2,735,276 | 73.8 |
| Inst. Pia/relig. | 7,143 | 0.2 | 263 | 0.1 | 72,327 | 0.1 | 2,716 | 0.1 |
| Public Entities | 158,719 | 3.2 | 5,530 | 1.5 | 465,608 | 1.0 | 31,280 | 0.8 |
| Non-identified | 132 | 0.0 | 8 | 0.0 | 959 | 0.0 | 12 | 0.0 |
| Total | 4,859,864 | 100.0 | 353,611 | 100.0 | 47,796,469 | 100.0 | 3,707,112 | 100.0 |

Source: INCRA - 2000. Elaboration of Technical Cooperation Project INCRA/FAO.

that in this region family agriculture is more technical, including the adoption of conservation systems in production, such as the Direct Planting System. In the MidWest, the lowest percentage of small landholders can be found. This type of property represents 66.8 percent of landholdings and occupy only 12.6 percent of the region. In addition, land use has been intensified with a remarkable specialisation in the production of grains and fibres for industrial purposes, as well as fruit cultivation and extensive cattle ranching.

**Table 7 - Land use structures (in %) for the country in 1970 and in 1996 (per region).**

| Geographic Entity | Year | Lavper | Lavtmp | Pasnat | Paspla | Matnat | Matpla |
|---|---|---|---|---|---|---|---|
| Brazil | 1970 | 3.17 | 12.62 | 49.41 | 11.81 | 22.33 | 0.66 |
| | 1995 | 2.34 | 13.21 | 24.23 | 30.94 | 27.60 | 1.68 |
| North | 1970 | 0.52 | 4.63 | 33.33 | 4.43 | 56.91 | 0.18 |
| | 1995 | 1.37 | 4.39 | 18.09 | 27.75 | 47.93 | 0.48 |
| Northeast | 1970 | 7.03 | 14.44 | 39.13 | 10.17 | 29.05 | 0.18 |
| | 1995 | 4.00 | 17.78 | 30.13 | 18.25 | 29.25 | 0.59 |
| Southeast | 1970 | 3.45 | 13.46 | 54.20 | 16.90 | 10.57 | 1.42 |
| | 1995 | 5.48 | 14.07 | 29.04 | 34.28 | 12.94 | 4.20 |
| South | 1970 | 3.83 | 27.55 | 44.20 | 8.94 | 14.05 | 1.42 |
| | 1995 | 1.56 | 31.02 | 33.04 | 16.95 | 12.83 | 4.60 |
| Central West | 1970 | 0.20 | 4.13 | 64.12 | 13.42 | 17.57 | 0.05 |
| | 1995 | 0.23 | 7.10 | 17.18 | 44.64 | 30.51 | 0.34 |

Source; IBGE data based on Agrotec. SEA/EMBRAPA.

## 2.3. General Aspects in Land Use Dynamics

Based on 1970 and 1996 Census, the percentage variation of the total area in use shows an average expansion of 28 percent in the country. The growth was not the same in all regions and the greatest variations took place in the North (85 percent) and MidWest (62 percent), indicating a strong agricultural expansion in these regions. In the Northeast, there has been an increase of 17 percent. In the South, figures remained stable and, in the Southeast, they were 5 percent lower.

Data about different types of land use - permanent crop lands -LAVPER, temporary agricultural land -LAVTMP, natural pasture land-PASTNAT, cultivated pasture land -PASTPLA, natural wooded areas and forests-MATNAT and cultivated wooded areas and forests-MATPLA (**Table 7**), in comparison to their total areas (table 7), guides the analysis of essential aspects in land use.

A brief analysis of data on an essentially qualitative basis leads to the following conclusions about production trends in Brazil:

**a)** the main change was a decline in the percentage of natural pastures and a raise in cultivated pasture areas in all regions and logically, in the country.

**b)** in general, crop lands (temporary and permanent) present slight variations, but some aspects may be observed. On the whole, there has been a decrease in permanent agricultural lands and an increase in temporary agricultural lands, specially in the Northeast and the South. In the North, permanent croplands have expanded and temporary croplands have slightly declined. In the South and Central West, temporary and permanent croplands have increased in number. However, in the Southeast, there was a significant increase in permanent croplands and a slight decrease in temporary croplands. The opposite took place in the Central West, which has gradually become an important grain producer;

**c)** regarding wooded areas and forests, there was an increase both in natural and cultivated areas. The same occurred in different degrees in the Northeast, Southeast and MidWest. In the North and South, there was a decrease in natural wooded areas and an increase in cultivated wooded areas.

A distance concept (in metres $L_1$) between two structures enables the assessment of land usage changes. Thus, it is possible to conclude that:

**a)** for the entire country and each region taken separately, variations in pasture areas are much more remarkable than those in agricultural land, wooded areas and forests ranging from 65 to 85 percent of the total variation;

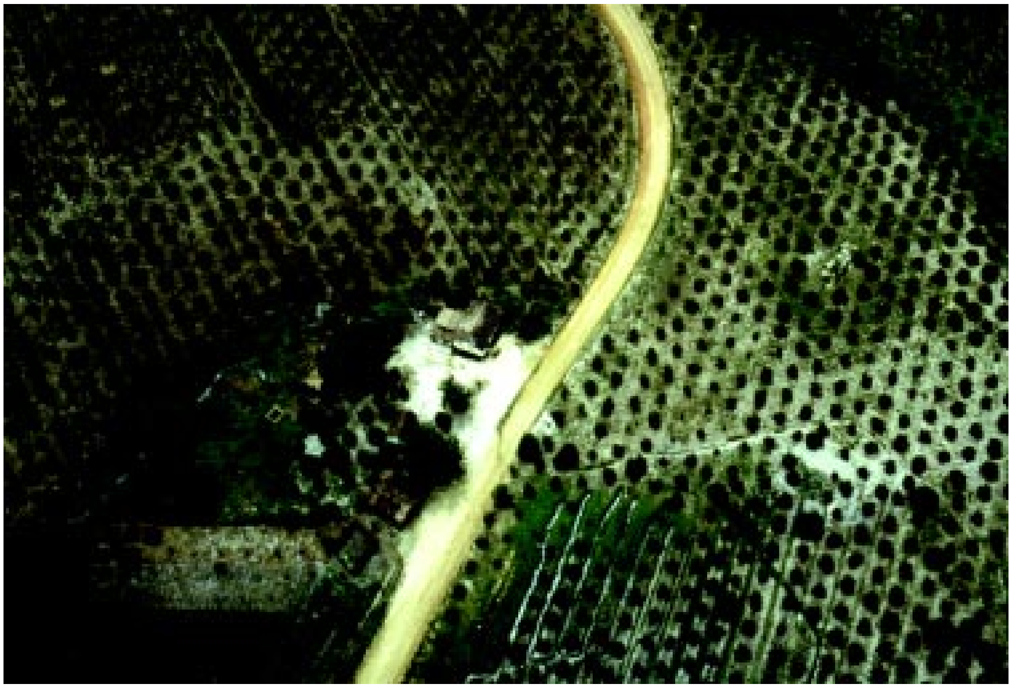
**b)** in general, wooded areas and forests represent 12 percent of the land use variation and agricultural land is approximately 3 percent;

**c)** considering Brazilian regions separately, variations in agricultural land, wooded areas and forests display two different pictures: in the North, Southeast and MidWest, wooded areas and forests represent a greater portion of land variation (they are about twice as large in the Southeast, four times in the MidWest and nine times in the North). However, the total agricultural area is about ten times as large as the area covered by woods and forests in the Northeast and only 30 percent larger in the South.

In aggregated terms, distance can be used as an indicator of land use dynamics. Consequently, taking the calculated distances into account, the most dynamic region is the MidWest, followed by the Southeast, North, South and Northeast.

### 2.4. Dynamics and Changes Agriculture and Cattle Ranching Activities

Over the previously analysed decades, it is clear that agriculture has efficiently played its role in the Brazilian economy by providing food, energy, and fibres to the population among others. It has also raised capital for the industrialisation of



the country and foreign reserves through the export of production surplus.

Large investments in infrastructure resulted in multi-modality, increasingly efficient and inexpensive transportation system, which enhanced farm and cattle production. Exports from difficult-to-access areas have been benefited and now have competitive prices. This has occurred in the North Corridor, which connects Madeira and Amazon Rivers via Itacoatira Port, and in the Middle Northern Corridor, connecting the State of Mato Grosso to the Ponta Madeira Port in the Northeast of the country. Improvements have also included new production areas in the States of Tocantins, Piauí and Maranhão. One example of the infrastructure changes regarding land potential and comparative advantages has been the cultivation by these states of approximately 210 thousand hectares or 3 million hectares of soybeans in 1998. This would be roughly equivalent to the cultivated area of the State of Rio Grande do Sul.

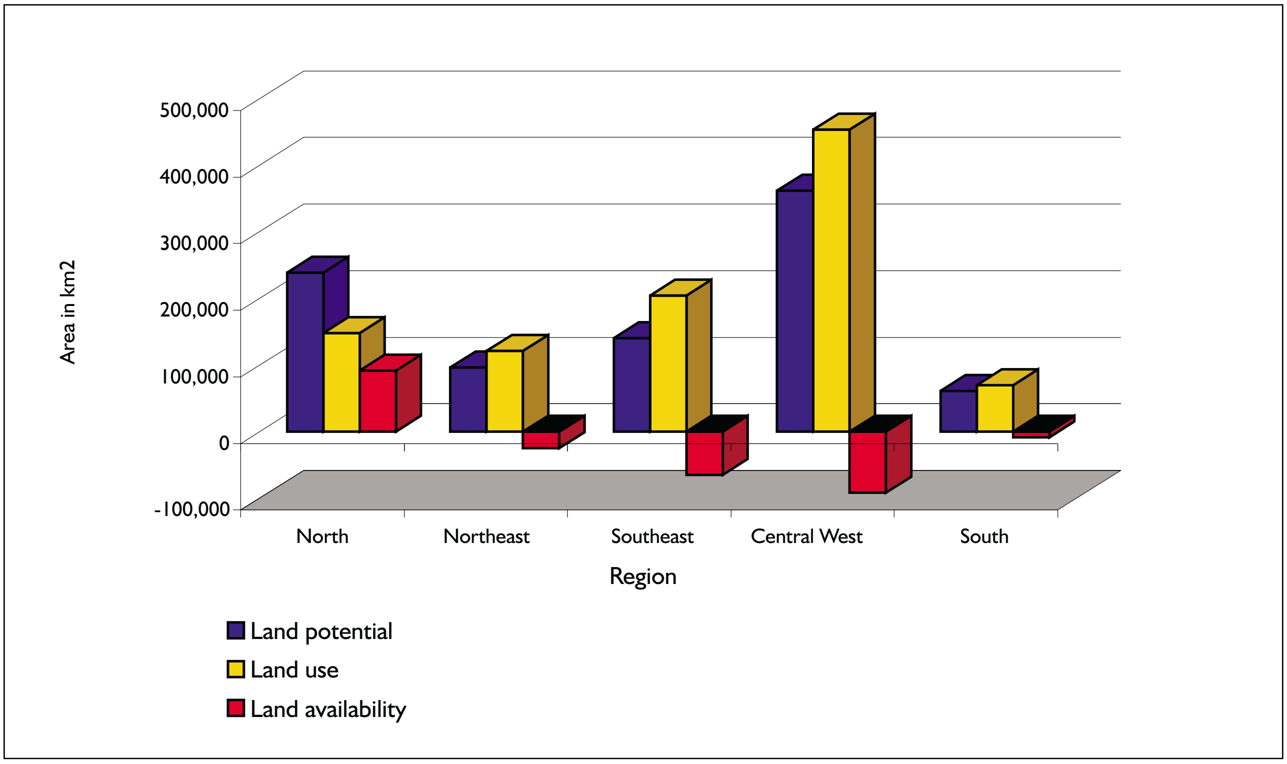
Similarly to agriculture, the development and use of new production technologies has also been the solution adopted by the raising sector over the years to face profitability difficulties and meet market demands, as indicated by the steady rise in meat production (**see Figure 9**). Pork and poultry production has sharply increased since the 1990s. Brazilian Agriculture is currently one of the most competitive in the world, with perspectives to influence prices.

Nevertheless, harvest losses and failures in seasonal non-irrigated cultivation were significant. Losses caused by droughts ranged from 60 percent to 32 percent due to heavy rains in the summer. In the winter, losses caused by droughts reached 30 percent, 32 percent of which due to heavy rains during harvest time and 30 percent as a result of frost.

Technology is not available in all regions and for farmers working on non-irrigated land. The Northeast is the most vulnerable region and the least competitive in comparison to irrigated regions that make use of up-to-date technology. This region is favoured by light and temperature and could become very competitive if specific technology were developed for the local environmental conditions. This would lead to raising productivity in maize, rice, beans and cotton plantations.

Irrigation in Brazil had considerably increased until 1990. However, it has been developing at a slower pace even though it brings about advantages in land use and tenure. For instance, only 6.19 percent out of 38.3 million hectares of cultivated area are irrigated in the country, in comparison to 17 percent out of 1.5 billion hectares irrigated around the world. The quality of irrigation is a determining factor, as 35 percent of all agricultural production in Brazil derives from 2.87 million hectares irrigated, whereas 17.7 percent of irrigated areas around the world are responsible for only 40 percent of the food produced. Therefore, irrigation does not bring about land pressure, taking into consideration its present reach and low impact on land in Brazil. Far from

**Figure 6 - Current use, Agricultura capacity and evalvation of the availability of lands apt for planted pasture activities per regido in Brazil**




Source: Embrapa Solos – 2002

that, it may be a possible solution to reduce the need for occupation and agricultural use of land by increasing agricultural income, production and productivity. To accomplish that, it is necessary to implement new credit policies in order to enable technological investment and access to credit to overcome high financial costs. These policies should also include the participation of small farmers. For this to occur, alternative solutions should be found in order to guarantees, liabilities and other issues that cannot be controlled by these farmers.

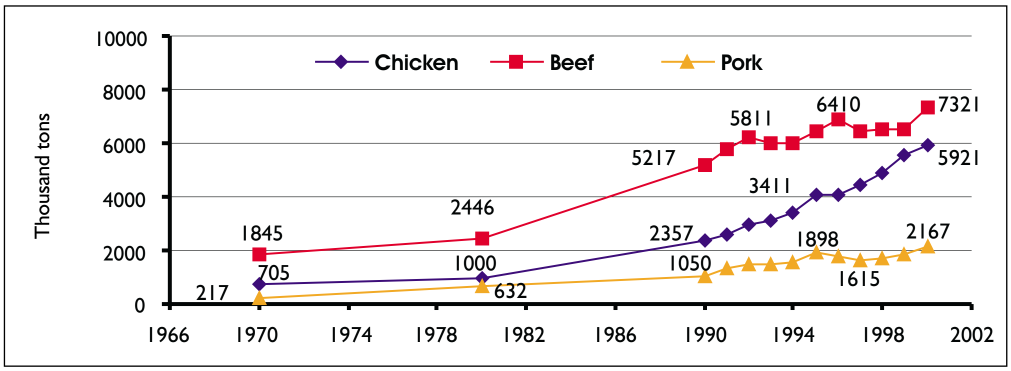
The national livestock is the second largest in the world, estimated in 157 million heads of cattle (32 million dairy cattle and 125 million beef cattle) distributed among 1.6 million raising farms. In order to reach these numbers, it was necessary to recycle pasturelands. Thus, the use of cultivated pastures prevailed over other types of land management. This demonstrates spatial movement and has been relatively important to the expansion of the agricultural frontier in Brazil. A comparative analysis using aggregated data shows that the cultivation of pasture areas has been done beyond land capacity, except for the North. (**see figure 8**).

Although this comparison does not necessarily indicate that agricultural activity is taking place on less appropriate or inappropriate land, it works as an indirect indicator of land pressure. Consequently, because of the lower comparative profitability of agricultural land, there is a tendency to replace it with natural or cultivated pastures in the South, Southeast and MidWest Regions.

A report on the average profitability in the raising sector reveals that medium size cattle raisers own an average of 75 heads of cattle, which represents a R$ 100 monthly income, considering a 15 percent net margin (EMBRAPA 2001- unofficial estimate from aggregated data). These figures illustrate the difficulties faced by small producers and the pressure exerted on less appropriate land like that situated in mountainous regions of the Southeast. Thus, there is a need for programmes and policies regarding agriculture diversification/ organisation, pasture and soil recovery and even the reforestation of threatened biomes.

Pasture degradation is a cause for concern in Brazil, chiefly because of the current extension of land in use. Even though technological alternatives are available, the low profitability, specially of small and medium cattle raisers, leads to reduced use of soil and pasture management technology.

**Figure 7 - Evolution of meat production in Brazil.**




Source: Embrapa - 2001 e ANUALPEC - 1999 / 2000

## 3. Land Degradation

Land degradation is associated to edaphic, climatic and human factors. The intensity and development of these processes are increased by the inadequate use and handling of land - indiscriminate deforestation, overexploitation of the soil, intensive use of disk harrows in soil preparation. The latter exposes the soil to severe weather conditions and lead to gradual destruction of physical, chemical and biological properties of the soil. Overgrazing is the main sign of land degradation in Brazil and erosion is its main cause.

### 3.1 Erosion

The main agricultural model adopted in the country is based on the use of fossil energy and chemicals, intensive mechanisation and a strong concern about economic efficiency towards productivity gains. Still nowadays, the soil is intensively prepared through the use of ploughs and disk harrows. Consequently, erosion is triggered by factors such as the exposure of the soil to the sun and the rain, destruction of its aggregates, formation of compact layers, decrease in permeability and infiltration. All this results in great losses of soil heritage.

Water erosion is the main type of soil degradation in Brazil, and it occurs in

**Box 1 - Economic Valuing of Losses**

A erosão gera perdas anuais correspondentes a 15,2 milhões de t de Calcário Dolomítico (23 percent de CaO) valorados em R$563 milhões; 879 mil t de Superfosfato Triplo que valem R$483 milhões e 3 milhões de t de Cloreto de Potássio valorados em R$1,7 bilhões. A reposição das perdas de N e S, totalizam 5,3 milhões de t de Uréia ou R$2,77 bilhões e 995 mil t de Sulfato de Amônio custando R$394 milhões. Somando-se a esses valores R$2,06 bilhões que é o custo do adubo orgânico necessário à reposição da matéria orgânica ao solo, estima-se que a erosão hídrica gere um prejuízo total relativo às perdas de fertilizante, calcário e adubo orgânico, da ordem de R$ 7,9 bilhões por ano.

Pode-se ainda estimar com base em diferentes autores, o efeito da erosão na depreciação da terra (Landers et al., 2001a), no custo do tratamento de água para consumo humano (Bassi, 1999), no custo de manutenção de estradas (Bragagnolo et al., 1997) e na reposição de reservatórios, decorrente da perda anual da capacidade de armazenamento hídrico (Carvalho et al., 2000). Somando-se os impactos anteriores estima-se, de forma parcial (há uma extensa relação de efeitos aqui não valorados), que a erosão promoveria R$13,3 bilhões de prejuízos por ano **(Tabela 8)**.

**Table 8 - Valuing of Soil Erosion Impacts in Brazil**

**Table 8 - Valuation of the impact of erosion and brazilian soil**

| Category of negative impact | Total (Bi US$) | Total (Bi R$) |
|---|---|---|
| Lossn of nutrients and organic matter | 3,178.800 | 7,947.000 |
| Land depreciation | 1,824.000 | 4,560.000 |
| Water treatment for human consumption | 0.374 | 0.934 |
| Road maintenece | 268.800 | 672.000 |
| Reposition of reservoirs | 65.440 | 163.600 |
| Total | 5,337.400 | 13,343.534 |

1 US$ = 2.5 R$
Source: Based and Landers et al. 2001a; Bassi - 1999; Bragagnolo et al. 1997 and Carvalho et al. 2000

1 US$ = 2,5 R$.
Fonte: Baseado em Landers et al. - 2001a; Bassi - 1999; Bragagnolo et al. - 1997 e Carvalho et al. - 2000

three stages: disaggregation, transport and deposal. Its main manifestations are laminar, sulcos and major erosion tendencies (Bertoni & Lombardi Neto, 1990). In 1982, it was calculated that 12.5 million tonnes of sediments were released every year into the reservoir of the Itaipu hydroelectric power plant, 4,8 million tonnes coming from the State of Paraná (Derpsch et al., 1991). In Sao Paulo, for every 194 million tonnes of fertile land eroded yearly, 48.5 million have caused sand accumulation and pollution in water springs. This means that, for every kilo of soy, 10 kilos of soil eroded and for every kilo of cotton, 12 kilos of eroded soil (Bertolini et al., 1993). In the state of Rio Grande do Sul, soil losses reported added up to 40 tonne ha-$^{1}$.year$^{-1}$ (Schmidt 1989). In 1949, it was estimated that losses of 500 million tonnes of land would occur in Brazil every year, caused by erosion (Bertoni & Lombardi Neto, 1990). Losses of 600 million tonnes were broadcast in 1992 (Bahia et al., 1992).

Nowadays, due to the expansion of the agricultural area and the intensive use of the land, soil losses have increased in some regions. Considering the total area taken by agricultural lands (annual and perennial) and pastures (natural and cultivated) reported in the Agricultural and Cattle - Ranching Census of 1995/1996, and admitting average annual losses of 15.0 tonnes ha$^{-1}$ for agricultural land (Bragagnolo & Pan, 2000) and 0,4 t ha$^{-1}$ for pastures (Bertoni & Lombardi Neto, 1990), total soil losses added up to 822.7 million tonnes per year – 751.6 million in agricultural lands and 71,1 million tonnes due to pastures (Table 3.1). In the end, 247 million tonnes of sediments (or 30 percent) out of that amount may have been stored in rivers, dams and roads, causing great socio-economic and environmental drawbacks. Even higher numbers were obtained by Vergara Filho (1994), who calculated that annual soil losses in Brazil were around 1,054 billion tonnes.

Besides the suspended soil particles, superficial drainage washes out nutrients, organic matter seeds and pesticides that pollute water resources and hinders agriculture and cattle raising activities. According to Hernani et al. (1999) and the data previously shown, calcium depletion may be around 2.5 million tonnes. Other mineral depletions are: Mg, 186,000, P, 142,000, K, 1,45 million tonnes and 26 million tonnes of organic matter. Considering N and S depletions of 863,000 e 86,000 caused by erosion in agricultural lands (Malavolta, 1992), and 50 percent lower depletion in pastures, it was estimated that total depletion would be about 2.4 million and 239,000 tonnes every year.

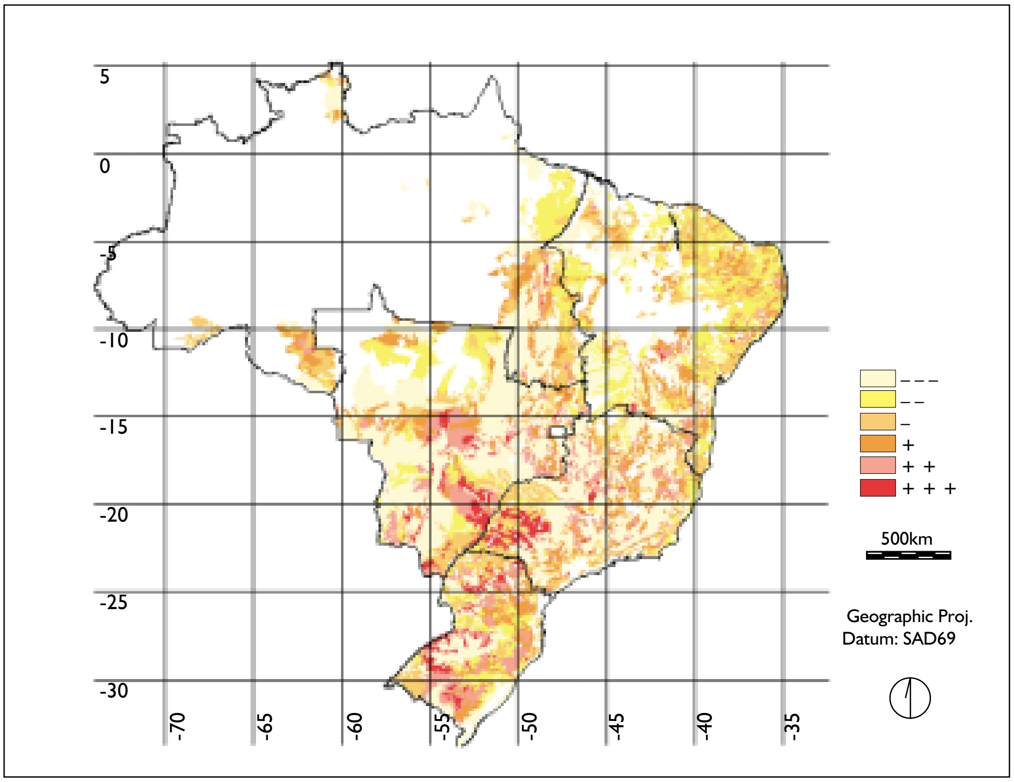
According to De Maria (1999), water depletion amounts to 2,519 m$^{3}$ ha$^{-1}$/year$^{-1}$ in cultivated agricultural lands and one tenth of this number in pastures. Thus the estimated annual water depletion adds up to 126,2 billion m³ in agricultural lands and 44.8 billion m³ in pastures, totalling 171 billion m³ of water. This volume does not infiltrate into the soil or return to lençóis freáticos. Thus, river flood and water availability declines, which is one of the hidden reasons behind the energy crisis recently faced in Brazil.

A cross comparison between the map of use intensity and that of erosion vulnerability illustrates these depletions, as presented in **Figure 10**. Therefore, in the North, where soils have a high vulnerability to erosion, the elevated volume of rain makes 98 percent of land less vulnerable to water erosion, especially because of the little use of land in agriculture. On the other hand, in the Northeast, climate limitations make 82 percent of the areas more vulnerable. Although the Central West is considered less vulnerable in 78 percent of its occupied area, there are extremely critical zones such as the surroundings of Pantanal and important river springs in the formation of the Amazon River and Paraguay/ Prata river watersheds.

In the South, 40 percent of the land is highly vulnerable, which indicates that soils with a higher vulnerability to erosion are being overexploited. However, since the 1980s, there has been an increasing adoption of soil handling systems aiming at preservation based on Direct Planting in 85 percent of area cultivated yearly and integrated handling programmes in watersheds. This measure has been changing the critical situation previously described towards a path of sustainable agriculture.

Erosion generates a total annual depletion of 15,2 million tonnes of Dolomitic Rock Lime (23 percent of CaO), which has an estimated cost of R$563 million; 879,000 tonnes of Triple In addition, it is essential to highlight the inadequacy of dirt roads in rural and periurban areas– especially related

**Figure 8 - Areas critically subject to erosion due to agricultural practices, as a result of combining land use and the soil's vulnerability to erosion.**




to land distribution schemes and land occupation by low-income population. The impact caused by erosion is due to inadequate execution or preservation (Bertolini & Lombardi Neto, 1993). Several forecasts point to the aggravation of erosion as a consequence of climate changes likely to occur in the next century. (Williams et al., 1996 e Williams, 2000).

### 3.2. Soil fertility depletion

Modern fertilisation practices were implemented more than one century ago. They are based on the concept of plant nutrition and have contributed a great deal to increase agricultural production and improve the quality of food, forests, forage and agricultural production. Improvement of soil fertility through the use of fertilisers, as well as plant improvement, increased crop productivity between 1970 and 1998, resulting in an economy of land use in Brazil - 60 million hectares. This area could have been even larger if fertilisation were a more widespread practice in the country.

Brazilian soils are generally acid, poor in phosphorus, calcium, and magnesium and rich in toxic elements (aluminium, manganese and iron); however, the quantity of fertiliser and corrective applied is much below the recommended level. Because of excessive acidity, about 75 million tonnes of lime should be used. Although the installed capacity for mining and processing is currently 50 million tonnes per year, only 15 million de tonnes are applied every year-1. This number remained practically unchanged between 1984 and 1999. Therefore, around 60 million tonnes of lime are not applied every year. As a consequence, the efficiency of fertilisers is reduced, agricultural land is less productive, farmers have a lower income, productive capacity is decreased and, finally, there is pressure on natural resources.

It is estimated that the contribution of fertilisers in the positive results obtained in crop production is about 35 to 50 percent. The use of mineral fertilisers (chemical) and organic ones (winter and summer green mulch and manure) in the country is still very little. That is why they do not cause environmental damage (underwater contamination, for instance) like that found in countries such as Holland and Germany. In spite of the fact that Brazil is responsible for ¾ of total fertiliser consumption (N, $P_2O_5$ e $K_2O$) in Latin America, it has not reached 5 million tonnes/year (1970-1989). Between 1989 and 1999 consumption increased by only 800,000 tonnes, totalling 5.8 million tonnes. Consumption of Nitrogen fertiliser, between 1970 and 1989, increased from 0.5 to 0.9 million tonnes/year-1 and between 1989 and 1999 it was raised to about 1.5 million tonnes per year-1.

Fertiliser consumption seems to be related to economic situation of farmers, as it increased by 48 percent between 1991 and 1994, dropped 9 percent in 1995, increased again between 1995 and 1998 and fell by 7 percent in 1999. Reduced consumption is related to credit restrictions, disastrous harvest and low crop prices, whereas increased consumption usually involves a favourable cost-benefit relation between fertilisers and crops associated to productive harvest.

Out of 120 million hectares of pasture, around 80 million are cultivated (~ 50 million ha Cerrado areas; 20 million in the Amazon and 20 million in the Atlantic forest), or about 10 percent of the total country area. In the Amazon, pastures were mostly cultivated with almost no fertilisation and productivity depends on burned land ash residues. In other parts of Brazil, pastures were introduced after the pioneering plantations of rice and other cereals. Thus, productivity was dependent on the residual effect of chemical fertilisers applied during cereal cultivation. Livestock extraction established in soils exhausted by other cultures or erosion, the absence of adequate fertilisation (specially Phosphorus and Nitrogen) and overpasturing are some of the main causes of pasture and soil degradation in Brazil.

Under these circumstances, the prerequisites for the cultivation of forage plants are not met unless it is done shortly after the period when ashes or decomposed organic matter is favoured by recent soil preparation and some nutrients are made available. In Brazil, the use of fertilisers in native or cultivated pasture is too little, generating insignificant zoo technical indices. Nonetheless, beneficial effects of fertilisation can be observed during the first year after its use, and loss compensation may increase fertilisation efficiency, once recycling rates in productive quality pastures are very high.

### 3.3. Desertification

Land vulnerability to desertification in the Northeast is presented in Table 9, where types of soil, relief, erosion vulnerability and geoenvironmental units of Agro-ecological Zoning in the Northeast (Silva et al., 1993) has been taken into account. However, areas where rain precipitation is over 500 mm, still susceptible to desertification, have not been considered. Thus it is very likely that vulnerable areas are underestimated.

In fact, by analysing data collected by EMBRAPA in Agro-ecological Zoning in the Northeast (Embrapa Soils, 2001), it was concluded that approximately 1/3 of the semi-arid zone, or about 353,870 $Km^2$, is made up of very low environmental availability (shallow, rocky or saline soils in arid climates), which have currently been used for extensive cattle raising, subsistence farming and cotton plantations, in narrow land belts.

### 3.4. Decharacterisation of humid areas

Humid areas in Brazil add up to 44.7 million ha or 5 percent of the territory. Also known as *meadow soils solos de várzeas*, the are mostly constituted by Organossolos, Gleissolos e Neossolos. Despite the small extension they represent in the total Earth surface, they are extremely relevant to certain economies due to their agricultural potential. Generally, these soils are especially used in an intensive manner for the production of rice, sugar cane, olerícolas and livestock. When drained and/or cultivated, they are subject to considerable changes in their attributes.

The UN Convention to Combat Desertification (United Nations, 2001) has defined desertification as "land degradation in arid, semi-arid and dry sub-humid areas brought about by factors such as climatic variation and human activity". This refers to degradation of soil, fauna, flora and water resources. Arid and semi-arid areas in the Northeast are the most vulnerable to desertification.

Exploitation consisting of small and medium land shares together with the average population density of 15-20 inhabitants/km$^2$ exert a lot of population pressure on soil and vegetation. Thus, the amount of vulnerable areas to desertification must be larger than previously estimated.

As a result, some of these areas have been degraded by desertification. Four degradation zones, where extremely severe degradation is concentrated on small portions of land (about 15,000 Km$^2$), have been recently divided: Gilbués in the State of Piaui, Irauçuba in the State of Ceará, Seridó between Rio Grande do Norte and Paraiba, and Cabrobó in Pernambuco.

Intensive and inadequate use of land (excessive draining, for instance) causes expressive quantity and quality alterations in its organic matter owing to oxidation, affecting physical, chemical and morphological properties, besides hampering productivity. Spontaneous burning in Organossolos, as seen during drought periods at the Golden Lion Tamarin Reserve in Silva Jardim, state of Rio Superphosphate costing around R$483 million e 3 million tonnes of Potassium Chloride at R$1,7 billion. In order to make up for N and S depletions, around 5,3 million tonnes of Urea or R$2,77 billion and 995,000 tonnes of Amonium Sulphate at R$394 million are necessary. As organic fertilisers are necessary to replace organic matters, almost R$2,06 billion must be added to the costs above. In conclusion, it is estimated that water erosion should generate a total loss of around R$ 7.9 billion every year, spent on Lime, chemical and organic fertilisers.

The effect of erosion on land depreciation may also be evaluated in light of other studies (Landers et al., 2001a) about cost of water treatment for human consumption (Bassi, 1999), road conservation costs (Bragagnolo et al., 1997) and reservoir restocking, as a consequence of the annual loss of water storage capacity (Carvalho et al., 2000). If all the impact costs are added, a partial estimate –as there is an extensive list of unmentioned effects – would be R$ 13.3 billion.(Table 08).
de Janeiro is an example of inadequate soil management and/or excessive draining.

Although official data is not available, it is estimated that soil decharacterisation occurs in all parts of Brazil, due to draining for agricultural purposes and sedimentation resulting from erosion in highlands. A typical example of the latter is may be observed on the Pantanal Plain in the State of Mato Grosso. In addition, macro-draining and river straightening actions for sanitation purposes, as seen during the 1960s and 1970s, totally decharacterised soils originally classified as *Organossolos* and *Gleissolos* in the States of Rio de Janeiro, Espírito Santo and others. These works also caused an increase in salinisation an/or extreme acidification of acidic sulfate soils, in several States, with negative impacts on water resources and the ichthyofauna even nowadays.

### 3.5. Sandification

Sandification is here defined as the process of re-projection of sand deposits, consolidated or not. This process brings about difficulties in vegetation for the adherence of vegetation coverage, due to the intense mobility of sediments through the action of water and wind. This type of degradation is related to humid weather, in which reduced biological potential does not lead to desertification. In Rio Grande do Sul, where average rain precipitation is 1,400 mm, areas undergoing sandification are located in the southwest of the State. The municipalities involved are Alegrete, Cacequi, Itaqui, Maçambará, Manoel Viana, Quaraí, Rosário do Sul, São Francisco de Assis and Unistalda, where sandy areas occupy 3.67 $Km^2$. Besides this number, 1,600 ha of land are at risk of sandification.

### 3.6. Salinisation

Salinisation, brought about by natural processes or agricultural use, only occurs in about 2 percent of the national territory or estimated 85,931 $Km^2$ (Pereira, 1990). In general terms, salinisation is related to the occurrence of little rain precipitation, high water deficit and low natural draining.

Irrigated agriculture is one of the main causes of soil salinisation in deficient or non-existent draining areas, especially under semi-arid climate conditions.

Under such conditions, if not drained artificially, soils are likely to become saline, which has been occurring in some lands in the Northeast. The São Francisco watershed is the most important to irrigation and, in its semi-arid part, Medium, Sub-medium and Lower Regions, soils are at very high to medium risk of salinisation. On the highest course, deeper, well-drained soils, and more elevated rain precipitation result in low to non-existent risk of salinisation

Estimates carried out by the Ministry of the environment in 1998 indicated 495,000 ha irrigated in the Northeast. Out of that, 139,000 ha belonged to public irrigation projects, and 2093 ha were salinisated. In addition, 750 ha were at risk of salinisation. Therefore, despite the unavailability of data about salinisation in private areas, and even considering that it represents a constant risk under soil and climate conditions in the Northeast, salinisation is not relevant as a soil degradation process in the country, especially in the other parts of the country, as general conditions do not allow for salinisation to occur.

### 3.7. Land burning

Burning occurs all over Brazil, in itinerant cultivation performed by Indians and backwoodsmen, or in highly intensified production systems, such as sugar cane and cotton, causing local and regional environmental impacts. It is used for clearing, preparing harvests, renewing pastures, burning residues, eliminating plagues and diseases, hunting and many others. There are several types of burning moved by different interests in different locations and production systems.

Fire directly affects physical, chemical (N and S deletion) and biological characteristics of the soil. It also deteriorates air quality, reduces biodiversity and harms human health. If uncontrolled, fire may damage public and private property (forests, fences, telephone and transmission cables, buildings and others). Burning may also alter the atmosphere composition and exert a negative influence over global changes.

### 3.8. Contamination by urban, industrial and agrochemical residues

The main impacts on soils is potential contamination by the use of pesticides and overexploitation of land with a low agricultural potential, especially with pastures.

All and any human activity leads to residue production (urban and industrial garbage, sewage, etc) that has been improperly disposed of, causing environmental contamination. Nevertheless, there is no available data about the amounts or systematic studies about soil contamination caused by the use of pesticides or other activities in agriculture.

Another source of contamination, also restricted to urban surroundings is urban waste. About 13 percent of the waste produced is catered for in controlled landfill sites, 10 percent in sanitary landfill sites, 0.9 percent is composted and 0.1 percent is incinerated. The remaining waste (76 percent) is disposed in open air, in landflus.

Urban wastewater, which is one of the main pollutants of water bodies, may also cause soil contamination when released directly into river or sewage canals. Solos de várzea under such conditions may be decharacterised and/or contaminated by biological agents. This situation is relatively common in large urbanised areas. In addition, the use of irrigation with superficial water contaminated with waste from various sources, especially in the production of olerícolas also contributes to soil contamination.

On the other hand, adequate waste management, which contributes to reduce river pollution and improve population health, results in the production of residue that is rich in organic matter and nutrients. The sewage or bio-solids must be properly disposed of. Among the most usual manners to do so is by using it in agriculture and forests (direct application into the soil, compost, fertiliser and artificial soil). Although this is one of the most convenient uses for bio-solids, it is not a widespread practice in the country. Thus, even though bio-solids might contain pollutants such as heavy metals and pathological organisms to man, it does not lead to decharacterization or contamination of the soil, due to its almost insignificant use nowadays.

Regarding pollution, only sanitary landfills are considered safe for they adopt very strict engineering criteria and operational procedures. In other types of landfills for disposal (trash heaps and controlled landfills), besides overgrazing, soil is not impermeabilised, resulting in risk of

subsoil and underground water contamination by organic products from decomposed organic waste. The use of compost from garbage and organic compost in agriculture does not contribute to soil decharacterisation, as this practice is not widely adopted in Brazil.

As for soil contamination by industrial residues, occurrence is usually restricted to urban surroundings, like that caused by pó-de-broca in the State of Rio de Janeiro, radioactive residues in Goias,etc. There are frequent reports about the impact of acid rain, industrial release and burning of fossil fuel on population health and agricultural production, but their effect on soil decharacterisation has not been studied in depth.

The same applies to contamination of the soil by chemical fertilisers. The available data comes from reports aiming at quality control of water and food. However, there is little information about specific situations such as copper and zinc contamination in crop and fruit plantations or compounds of atrazina in irrigated rice plantations, among others.

The Brazilian subsoil holds important natural resources. These include minerals, oil, coal and gas, in addition to water. These resources contribute to the socio-economic development of the country. They are also essential for the maintenance of life, culture and the welfare of mankind. The speleological, archaeological and paleontological wealth are also worth noting, as are the natural monuments. The Brazilian subsoil consists of rocks whose ages range from over 1.8 billion years, like Archean rocks, to Phanerozoican rocks. They are divided into three distinct groups (Delgado & Pedreira (1994) (**Figure 1**).

**Archean–Paleoproterozoic** rocks, which are over 1.8 billion years old, are represented by greenstone belts, meta-volcanic-sedimentary belts and highly metamorphic mobile belts. These are heterogeneous, fractured rocks containing a large number of structural weakness planes that originate argillaceous to arenaceous soil types. If underdeveloped, these soil types can suffer severe natural erosion, as is the case with the crystalline rocks found in the semi-arid region of the Northeast of Brazil. When thick, these layers of soil can have extremely varied geomechanic behaviours, with lateral and vertical variations. In relation to hydrogeology, they constitute fissural aquifers whose storage capacity depends on geometry and the local hydrological regime. These aquifers are very vulnerable to surface contaminants. Their exploitation capacity depends basically on the efficiency of their recharge areas, as well as on the interconnection between the fractures. Their potential is smaller than that of sedimentary aquifers and they offer more difficulty for the drilling of productive artesian wells.

**Mesoproterozoic to Neoproterozoic** rocks – 1.8 billion to 570 million years old – make up the mesoproterozoic cover, neoproterozoic cover, rift systems and mobile belts. The geotechnical features of these rocks are variable. Carbonatic rocks, for example, are highly soluble, and thus highly prone to collapses – sharp subsidence in the surface due to underground collapse. Carbonatic rocks are also important local aquifers, despite being extremely vulnerable to contamination. Meta-sedimentary rocks have tight compositional layering and well-developed schistosity. These features encourage the development of weakness planes, making it easier for fluid to percolate and landslides to happen. Volcanic-sedimentary rocks hold aquifers, mostly of the fissural type because of their low porosity and permeability. Sedimentary rocks are porous aquifers, in general of the confined type, which show fissural behaviour when cemented or metamorphosed.

**Phanerozoic** rocks are those aged 570 million years and under. They make up the eopaleozoic basins, paleomesozoic/tertiary basins and cenozoic covers. They contain large pockets of sandstone, siltstone, claystone and shale, which have variable geotechnical behaviour. In the Paraná Basin, for instance, basaltic rock spills become soil that contains expanding clay. Sandstone rocks, which are porous and permeable, are naturally very vulnerable to contamination. They have, on the other hand, a large bearing capacity and can be easily excavated. Argillaceous rocks have low bearing capacity. The best confined and open Brazilian aquifers are found in the subsoil of sedimentary basins. The Guarani, Parnaiba and Amazon aquifers are good examples. Most of these aquifers are of the confined type, and are thus protected from contamination because of a thick layer of intercalated impermeable sediments and associated basaltic rocks. At the border of the basins (recharge areas), where porous sediments outcrop, aquifers are exposed to contamination. Cenozoic sediments comprise the main coastal aquifers, being responsible for most of the domestic and industrial water supply in coastal cities of the Northeast region of Brazil. In the Brazilian semi-arid region, water supply is made via alluvial aquifers.

**Figure 1 - Geologic units that are important because of deposit occurrence and/or potential of minerals present**

| |
|---|
| **Greenstone belts:** |
| Gold; |
| **Meta-Volcanic-Sedimentary Belts:** |
| Chromium, Iron, Manganese, Copper, Barium, Gold and Emerald; |
| **High Degree Mobile Belts:** |
| Chromium, Titanium-Vanadium, Nickel-Cobalt, Gold-Uranium, Iron, Manganese, Copper, Lead and Phosphorus; |
| **Mesoproterozoic Cover and Associated Plutonism:** |
| Tin - Tungsten-Molybdenum - Tantalum - Niobium - Zirconium - Uranium Rare-Earth, Gold, Iron Titanium - Vanadium and Diamond; |
| **Neoproterozoic Cover:** |
| Phosphorus, Lead - Zinc - Silver, Fluorine and Barium. |
| **Rift System:** |
| Copper-Silver, Magnesite and Calcareous rock; |
| **Mobile Belts:** |
| Lead - Zinc - Silver - Gold, Barium, Fluorine and Phosphorus; |
| **Eopaleozoic Basins:** |
| Copper, Gold, Barium, Lead, Zinc and Silver; |
| **Paleomesozoic Basins:** |
| Potassium salts, Magnesium, Sodium, Crude gypsum, Baryta, Phosphatus, Calcareous rock, Clay, Oil and Gas; |
| **Meso-Cenozoic Basins and Magmatism:** |
| Niobium, Phosphorus, Titanium, Zirconium, Barium, Uranium, Oil and Gas; |
| **Cenozoic Cover:** |
| Aluminium, Nickel, Manganese, Iron, Gold and Kaolin. |

Source: Delgado & Pedreira - 1994

## 1. Socio-economic context

All economic policy models adopted by Brazil since the 1970s have led to an increase in the number of urban centres as a result of its industrial park growth. This in turn was responsible for the exponential increase in the need for mineral exploitation, as much for resources for industrial use as for material for the building industry. Another pressure factor that results in the misuse of mineral resources is the Brazilian high unemployment rate. This high unemployment rate has encouraged a gold and precious stone rush. In this political and socio-economic scenario, civil society has been, in many cases, exploiting the natural resources (renewable and non-renewable) without further consideration, which leads to environmental degradation, sometimes irreversibly.

Some of these resources are mineral reserves of worldwide importance. Such resources have contributed to the maintenance and expansion of the Brazilian industrial park. In addition to the extraction industry, this also includes the steel, metallurgy, fertilisers, ceramic and concrete industries, among others, where the mineral input is the basic raw material in the production of goods. Brazil uses its mineral assets to produce approximately seventy substances, twenty one of which belong to the metallic mineral group, forty five to the non-metallic group and four to the energy group. In 2000, Brazil was responsible for 92 percent of the worldwide production of niobium, 20 percent of iron ores (second largest worldwide producer), 22 percent of tantalite, 19 percent of manganese, 11 percent of aluminium and asbestos, 19 percent of graphite, 9 percent of magnesite and 8 percent of kaolin. The country was also a major supplier of ornamental rocks, talcum and vermiculite, accounting for 5 percent of the worldwide production (Barreto 2001).

The Brazilian mineral sector is comprised of small mines (70 percent), medium size mines (25 percent) and large mines (5 percent). According to Minerios & Minerales, 1999 (*apud* Barreto, 2001), the data obtained from mining concessions show that 4 percent of Brazilian mines are located in the North, 8 percent in the Midwest, 13 percent in the Northeast, 21 percent in the South and 54 percent in the Southeast. It is estimated that, in 1992, there were approximately 16.528 small companies operating in metropolitan areas and extracting US$ 1.98 billion worth of material for the building industry. However, it is difficult to establish the accurate number of small size enterprises due to illegality, lack of control and inspection and other random factors, such as end of commercial activity, which can lead to incorrect figures. In 1995, mining was responsible for 75.3 thousand direct jobs and 3,2 million indirect jobs. In the last 20 years, a reduction in the employment capacity of the sector and a migration to the services sector has been observed (Barreto 2001).

According to BRASIL, 1993 (*apud* Barreto, 2001), there were 400 thousand illegal miners in the country at the beginning of the 1990s. 61 percent of these miners were working in the Amazon region (Pará and Mato Grosso), 20 percent in the Midwest, 8 percent in the Southeast, 7 percent in Northeast and 4 percent in the South. The majority (72 percent) were employed in gold mines, 11 percent in precious stones mines, 10 percent in diamond mines, 1 percent in cassiterite mines and 6 percent other minerals.

The mineral extractive industry has grown considerably recently, with a mean annual growth rate of 8.2 percent, observed in the period of 1996-2000. In 2000, it accounted for 8.5 percent of the GDP (Barreto 2001). The oil sector had an annual growth rate of 28.3 percent in the period between 1997 and 2000, accounting for 5.4 percent of the GDP in 2000 (Machado 2002). Thus, the mineral/energy sector is responsible for a significant part (13.9 percent) of the Brazilian GDP.

## 2. Subsoil Degradation

The misuse of the subsoil can lead to several problems. These result from uncontrolled urban development, mining activities, environmental liabilities, agriculture, cattle, lack of technology, pollution of water resources, uncontrolled use of underground water and the need for improved legislation, among others.

A wide variety of human actions are also responsible for geotechnical problems (subsidence, landslides and erosion) that result in soil and subsoil degradation. In the coast, there are problems related to shoreline erosion. In hilly urban areas, such as São Paulo, Rio de Janeiro, Vitória, Belo Horizonte and Salvador, landslides are frequent, causing human, material and financial losses.

Subsidence (collapse) problems occur in carstic areas with natural underground caves and in areas of underground mining, as for example in the carboniferous region of the south of Brazil. Uncontrolled exploration in carbonatic areas leads to excessive decrease in groundwater level and change to the hydrologic regime.

Mining activities in urban and semi urban areas are also responsible for subsoil degradation. Today, we can easily observe vast degraded areas neighbouring large urban centres. This is a result of clay, sand, gravel and pebble extraction activities.

Erosion processes can be encouraged if a carefully designed plan, containing an environmental renewal element, is not followed during open-air mining activities. Normally, the openings used for scouring and/or removing the layer to be mined can cause severe damage to the surface of the ground.

The main environmental impacts of mineral production during research, mining, processing, storing or transportation stages are described in **Table 1** (Souza 2001).

### .2.1. Environmental Impact of Mining Activities

Charcoal – the water pollution caused by acid draining is probably the most significant impact of coal mining and processing activities. This is the result of the infiltration of rainwater that reacts with the waste generated from mining and processing activities, reaching superficial and/or underground water sources.

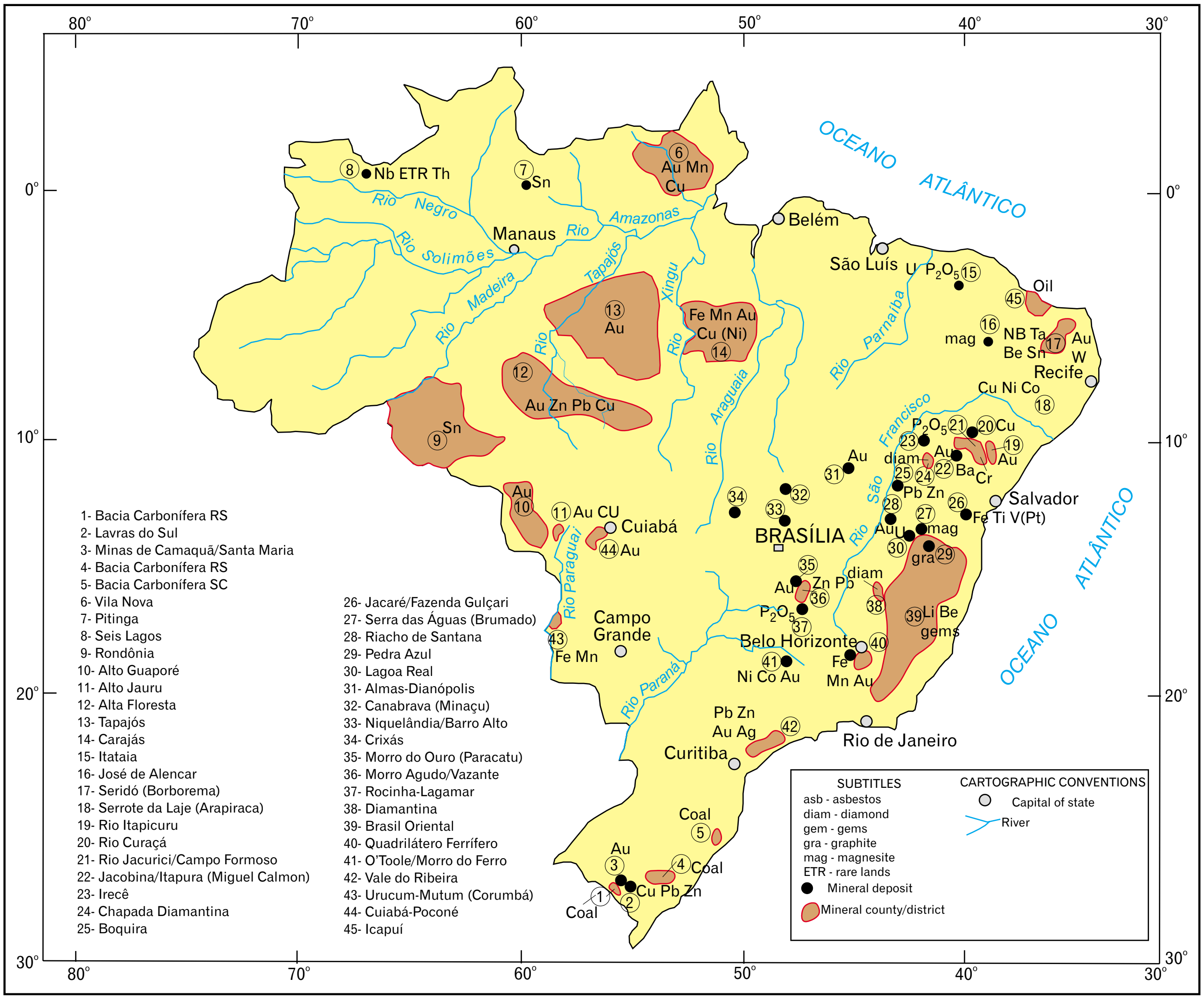
**Gold Mining** - the occurrence of arsenium, a toxic element, in the auriferous Quadrilátero Ferrífero region in the state of Minas Gerais (**Figure 2, area 40**), is worth noting as far as the environmental impacts of mining are concerned. In Nova Lima and Passagem de Mariana, arsenium oxide plants were

### Table 1 - Environmental Impacts on mineral production

| Activities | Problems | Effects |
|---|---|---|
| | Human beings | |
| Mineral Research | | |
| Farming | Underground, dust, humidity, noise, exhaustion gases of machines and equipment. | Contributes to labor turnaround. Possibility of respiratory diseases, caused especially by asbestos, fluorite and others. Stress and other physical problems. |
| Improvement and stocking | Dust, noise. Non-ferrous problems: hazardous gases, problems handling with some toxic reagents. Asbestos: dust, fiber. | Contributes to labor turnaround. Possibility of respiratory and cancerigenous diseases, caused especially by asbestos and other dry-improved minerals |
| Transportation | Noise, dust, exhaustion gases from heavy vehicles, conveyor belt dust. | For the consumer: heavy vehicles cause exasperation and are dangerous in populated areas (E.g.: Aggregates and building materials) |
| | Soil | |
| Mineral research | Trenchs, drillings, access ways, pits, abandoned equipment. | Erosion, undermining processes. Damage to the vegetation. Alteration of natural drainage. |
| Farming | Holes and stone-pits, subsidence. Unnecessary deforestation of the fields. Contamination of the water in the mine. Roads and access ways. Stone-dust piles.Impact of lack of planning. | Limited possibilities of sequential use of soil. Affects the beauty of the landscape. |
| Improvement and stocking | · Waste dams and basins, contamination due to leakings and spillover. Deformed piles (E.g.: sulphur). Waste deposits. Red mud (Alumina production). | Useless lands created by fine waste areas. Contamination by lixiviation and floods in fine and waste deposits. |
| Transportation | Long roads for heavy vehicles (associated areas of lending material). Dust. Unnecessary deforestation. Spillover in road accidents and derailments. | Exposes untouched areas to possible degradation. Heavy traffic may destroy the roads. |
| | Water | |
| Mineral research | Solids in suspension (erosion). Salt water from drillings is carried to acquifers (research on evaporites) | Contamination of ground water resources. |
| Farming | Solids in suspension in the water of the mine, heavy metals, pH of metallic mines. Alterations in ground water, water quality degradation. | Hazardous to acquatic life. |
| Improvement and stocking | Solids in suspention, precious metals, pH, toxidity from direct discharge and spillover of fine systems. Great water consumption. | Hazardous to acquatic life. Leads to environmental Unbalances |
| Transportation | Fluvial, lacustrine and marine transportation: color resulting from solids in suspention (iron ore) in embarking terminals. Spillover in derailments and road accidents. Possible pipeline problem. | Possibility of damage to acquatic life. |
| | Air | |
| Mineral research | | |
| Farming | Wind-carried dust. Combustion gases, detonation and boring dust. Asbestos dust and fiber. | Little importance. |
| Improvement and stocking | Asbestos dust, aerial particles and fiber, gases, odors, evaporation from fine basins. $So_2$ from the drying process (agglomeration of iron ore) Concentrated drying ($SO_2$, heavy metals) Generation of thermal energy (Hydrocarbon, $SO_2$, $No_3$). | Possibility of respiratory effects. The rain over particles affects the vegetation and the soil. High costs due to corrosion. Next to urban areas impacts on heatlth resulting from inhalation of asbestos fibers. |
| Transportation | Aerial particles from the transportation of material and from the road surface. | Little importance. |

Source: Souza - 2001 (adapted from Brooks - 1976 and Machado - 1989)

**Figura 2 - Principais províncias minerais susceptíveis à degradação**




Source: partially based on Dardenne & Schobbenhaus - 2001

operational for several decades, using the ore by-product. Ore waste, rich in arsenium, was stored at the river side or disposed directly into the drainage system, causing severe environmental damage to soil and water.

**Lead, Zinc and Silver Mines** – Lead, zinc and silver mines of the Vale da Ribeira region (**Figure 2 - area 42**) were operational over a long period of time during the 20th century, especially in the 1970s and 1980s. The material resulting from lead metallurgy and refining processes was stored at the Ribeira riverside. The last operational mines and refinery ceased their activities in November 1995. Cunha et al. (2000) carried out research on the level of lead present in blood samples and arsenium in urine samples taken among children from Adrianópolis and Cerro Azul, in the state of Paraná, and in Ribeira and Iporanga, in the state of São Paulo. Lead concentration in the blood samples was higher than the maximum accepted by the Disease Control Centre - DCC (1991). A lead metallurgy plant operating from 1960 to 1993, at the Sub riverside in Santo Amoral and Purificação in Bahia, has contaminated and is still contaminating everything – mangroves, fishermen, animals, vegetables, ground and children – with heavy metals, especially lead and cadmium in a 900 metre radius from the company's chimney. This occurs as a result of the random disposal of 490 thousand tons of waste. Part of the Santo Amaro population is also being contaminated by the use of waste matter in street paving, embankments, gardens, patios, squares and school areas (Anjo 1998).

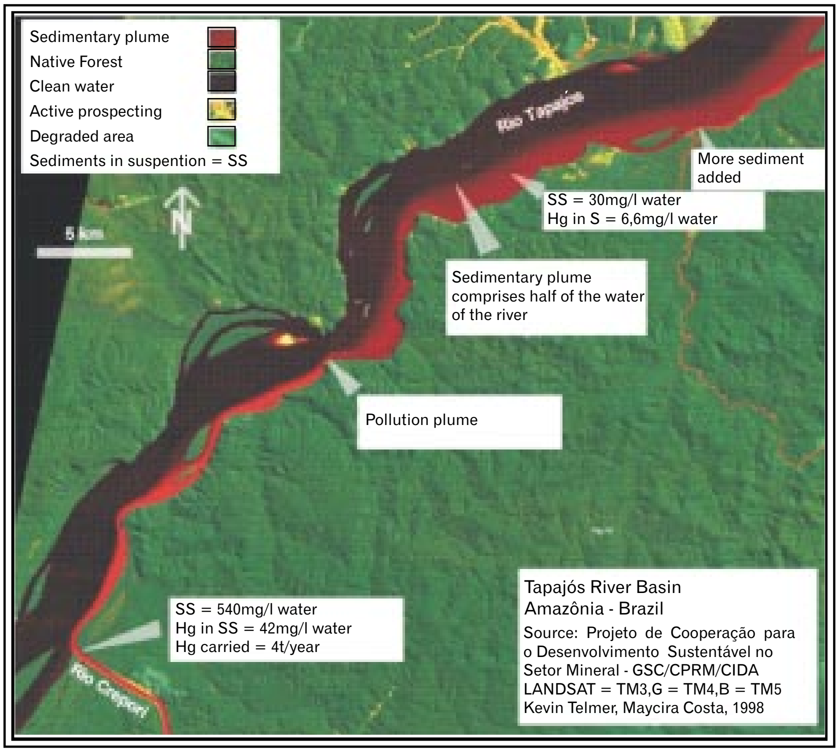
**Aggregates for the Building Industry** – the number of illegal businesses related to this activity is considerable and worrisome. Due to marketing factors, these minerals have to be produced in places close to consumer centres. Thus, this activity is typical of urban and metropolitan areas. The environmental impact of this activity is large and uncontrolled, causing the degradation of delicate ecological environments, such as dunes and mangroves, modifying natural river channels and landscape features. In general, the ditches that result from this activity are used for the disposal of building industry waste or even as landfill (BRAZIL 1998).

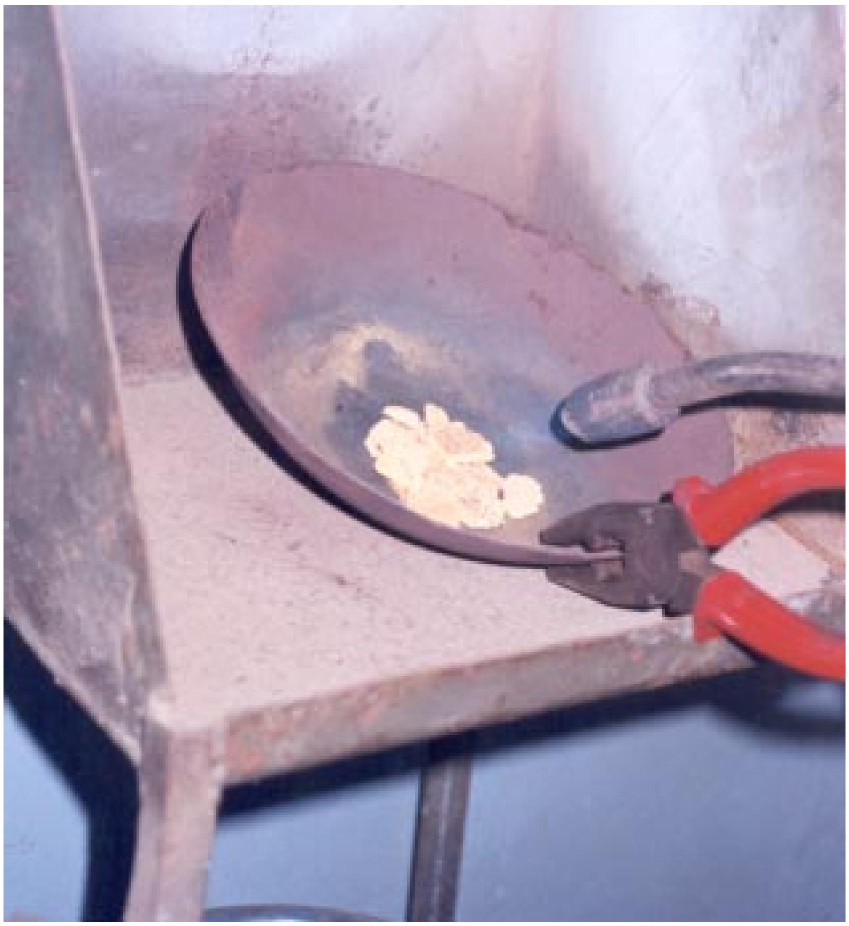
**Gold and other Precious Minerals Prospecting** – As production and marketing activities relating to prospecting tend to be of an informal nature, where legal, tax and labour obligations are avoided, the Brazilian government handles them in a distinct manner. Prospecting is rather regarded as a social issue, thus a separate matter from legally organised mining.

The environmental impacts of prospecting are common to all areas submitted to this type of rudimentary and predatory extraction activity. Contamination of water resources is the main one. As an example we can take the work of Telmer et al (1999) in the auriferous province of Tapajós, in Para (**figure 2, area 13**), where the volume of sediments in suspension in the Crepori River estuary (extensive ditches in tributaries, riverside and riverbed), carries approximately four tons of mercury. The polluting plume also travels a minimum distance of 30km down the Tapajós River (**Figure 3 - image**).

In Brazil there are several areas, located in the states of Minas Gerais and Bahia, where prospecting is a long-established activity (**Figure 2**). Recently, with the

**Figure 3 - Impact of gold prospection in the Tapajós River**

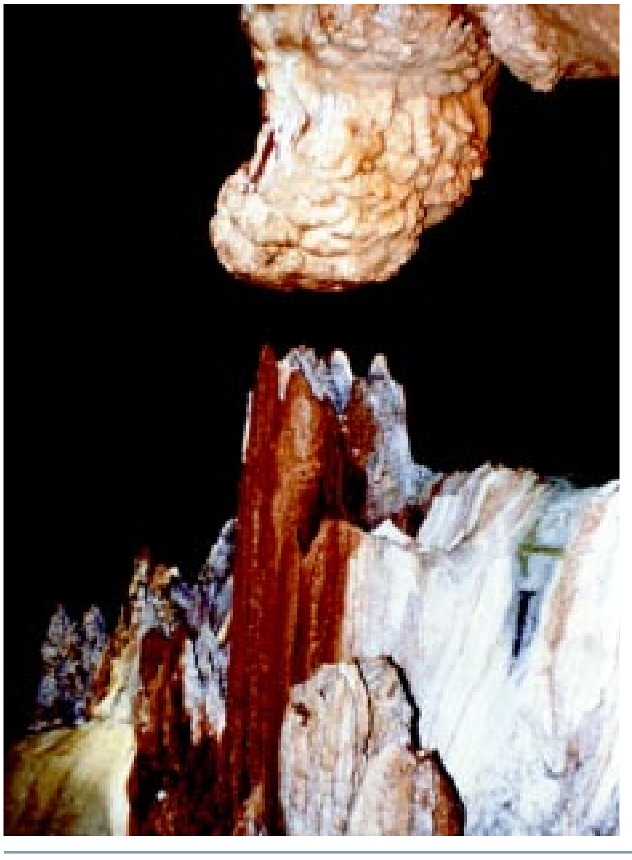


discovery of further gold and cassiterite ore deposits, an increase in prospecting activities has been observed in the following rivers: Madeira, Rondônia (**gold in river and cassiterite in area 9**), Tapajós – Parauari - Cumaru (**150,000 km2 - area 13**), Pitinga, Amazon (**area 7**); and in the following regions: Alta Floresta, Peixoto de Azevedo, Mato Grosso (**area 12**) and Cuiabá-Poconé, Mato Grosso (**area 44**), and Serra Pelada, Pará (**area 14**), Xingú-Araguaia (Tocantins), Gurupi (Maranhão), Tepequem (Roraima), Mara Rosa-Crixas-Pilar (Goias), Cacipore-Lourenço (Amapá) (Barboza & Gurmendi 1995).

The major environmental impacts of prospecting are:

- deforestation and forest fires;
- change in quality and in the hydrological regime of water courses;
- open air burning of metallic mercury;
- start of erosive processes outset;
- water turbidity;
- ichthyofauna mortality;
- fleeing of wild animals;
- chemical pollution caused by metallic mercury in the biosphere and atmosphere (IPT 1992).



## 2.2. Environmental Impacts on Underground Water Resources

**Saline wedge intrusion** – In large Brazilian coastal cities, such as Fortaleza (Cavalcante 1986), Recife (France et al. 1988), Sao Luis, Florianopólis and Maceió, underground water resources are used to supplement the domestic, industrial and agricultural water supply. When coastal aquifers are overexploited, the continuous pumping reduces freshwater pressure and, consequently, its discharge into the sea (Cabral 2000). This causes the intrusion of the saline wedge, which will in time bring about the salinization of the aquifer.

**Aquifer overexploitation** - There is no specific legislation regulating the use of underground water to avoid the opening of further wells. This legal loophole has contributed to the overexploitation problem. In the case of some aquifers, such as Acu (Feitosa 1996), Beberibe (Recife - France & Capucci 1978) and Guarani, there has been a gradual reduction in water output, and in some extreme cases, overexploitation is leading to aquifer exhaustion.

Another factor that is jeopardising the quality and water availability of aquifers refers to the uncontrolled occupation of recharge areas (Cavalcante & Sabadia 1992).

In densely populated areas or areas with a large concentration of industries, which do not have basic sanitation, tubular wells are installed. Initially, these provide good quality water, but later the water supplied becomes contaminated. Badly constructed or abandoned wells act as ducts for contaminants to reach the aquifers. Prolonged pumping takes the pollution plume to places in the aquifer that had not yet been contaminated. (Melo, et al. 1996).

## 2.3. Environmental Impacts resulting from the Disposal of Industrial and Domestic Waste

Buried waste produces liquid that is a potentially strong pollutant and that can contaminate the soil, subsoil and water resources (IPT 2000; Krebs et al. 1999).

The discharge of industrial and domestic effluents directly in watercourses without appropriate treatment results in the creation of diffuse pollution sources. These sources can contaminate water resources in large areas (Foster & Hirata 1993).

In the case of industrial waste, measures implemented by control agencies normally provide satisfactory results in reducing pollution by liquid effluents. These include preventive or remedial measures established in the environmental licensing, as well as acting on complaints by local residents.

However, the situation is completely different regarding domestic waste. Frequently, lack of investment from the public sector in treatment systems results in sewage reaching watercourses without treatment.

## 2.4. Spilling of Crude Oil Derivatives

Crude oil or derivatives spills are increasingly frequent (Manoel Filho 2000). In large urban centres, there are countless petrol stations that make use of buried steel tanks for storage of hydrocarbon derivatives. Petrol leakage is normal. In general, it takes a long time for it to be noticed, resulting in the contamination of underground water (Cavalcante & Sabadia 1992).

In Brazil, there are several oil and gas pipelines that are used to distribute oil derivatives. Careful and complex engineering plans are needed in order for these pipelines to pass over rivers or to be buried in geological and/or geotechnical hazardous areas. Furthermore, there are frequent accidents involving oil tankers during tank cleaning and spills at oil platforms, which are hazardous for the coastline.

## 2.5. Final Disposal and/or Spilling of Radioactive Products

Several stages are involved in the production of nuclear fuel, during which radioactive waste is produced. These stages include mining, milling, refining and uranium enrichment, fuel fabrication, fuel consumption in reactors, fuel reprocessing, residue solidification and residue storage in deep geological repositories (Manoel Filho 2000 *apud* Feitosa & Manoel 2000).

Health services are also an important source of radioactive waste. Several of these establishments dispose of biological waste containing radioactive elements. Sometimes radioactive equipment is also discarded. The best known case in Brazil of an accident involving radioactive material happened in Goiânia in September 1987. Radiotherapy equipment containing a cesium-137 capsule, found in a rubbish dump, was damaged. As a result, four people died; 55 were contaminated with high doses of radiation; 51 were contaminated with average doses; and 600 were contaminated with low doses and also needed to be monitored for a long period of time. This accident also produced 6,000 tonnes of radioactive waste (www fisica.net/denis/rad4.htm).

**Chart 1 - Main sources of underground water pollution and control parameters**

| Polluting activity | Main Pollution Parameters for Liquid Effluents | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Metals | | | | | | |
| | pH | Colour | Dissolved solid content | Faecal coliforms | $BOD_5$ | DQO | O.G. | $S^{-2}$ | CN | Hydrocarbon | ABS | Phosphorus and Nitrogen | Other Pollutants | Fe | Cu | B | Pb | Zn | Mn | Cr | Others |
| Ore Processing (1) | X | X | X | | | | X | X | X | | | | X | X | X | X | X | X | X | X | |
| Drainage of carved Areas (1) | X | X | X | | | | X | X | X | | | | X | X | X | X | X | X | X | X | |
| Metallurgy | X | X | X | | | | X | X | X | | | | | X | X | | X | X | X | X | |
| Iron metallurgy | X | X | X | | | | X | X | X | X | | | | X | X | | X | X | X | X | |
| Chemical industry | X | X | | | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | |
| Laundries and Dyer-cleaners | X | X | X | X | X | X | | | | | X | | X | | | | | | | | |
| Food industry | | X | X | | X | X | X | | | | X | X | | | | | | | | | |
| Hospitals and alike | | | | X | X | X | X | | | | X | X | | | | | | | | | |
| Petrol Stations | | | | | X | | X | | | X | X | | | | | | | | | | |
| Urban Residue Landfill | X | X | X | X | X | X | | X | | | | X | | X | X | X | X | X | X | X | |
| Industrial Residue Landfill | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| Agroindustries | X | X | X | X | X | X | | | | | | X | | | | | | | | | |
| Meat cold storage plants and slaughterhouses | | X | X | X | X | X | X | | | | X | X | | | | | | | | | |
| Oilducts and gas ducts (2) | | | | | X | X | X | | | X | | | X | | | | | | | | |
| Domestic sewage | | X | X | X | X | X | X | | | | X | X | X | | | | | | | | |

(1) For radioactive ores, radioactivity levels must be monitored in the influence areas (specially in uranium mine reject dams), in addition to the classic parameters used as mining pollution indicators.
(2) In case of infiltration or network breach.
Source: Alexandre & Krebs 1995 Modified

## 2.6. Impacts of Industrial Activities

According to Krebs & Nosse (1998) and Alexander & Krebs (1995), the production processes of inorganic chemical industries involve the release of chemical elements into the air and over the ground. These chemical products – compounds, gasses, etc. - contain variable quantities of particles in suspension, in the form of acids, alkalis, toxic salts, that can cause environmental problems because of the presence of fluorides, phosphates, sulphates, organic solvents, greases, oils, metals and hot water or vapour (for example, Metal Mecânica from Joinville-SC, Indústrias Têxteis from Blumenau-SC, Indústrias de Calçados from Vale dos Sinos - RS, Indústrias Químicas from Cubatão-SP).

Steel and metallurgy industries produce all sorts of steel and metal-alloy parts. These metals and steel-alloys have special properties due to the addition of one or more elements, such as manganese, nickel, chromium, molybdenum, vanadium, silicon, tungsten, cobalt, etc. (Alexander & Krebs 1995).

Foundries are great polluters. In addition to $SO_2$, $NO_2$, $CO_3$ and others, they release a significant volume of particles into the atmosphere (consisting of metallic oxides), such as CO, $SO_2$, $SO_3$, and $NO_X$ (Alexander & Krebs 1995).

The petrochemical industry has left environmental passives in places such as Vila da Carioca and Parque da Mooca, in the city of São Paulo, which are now the subject of a public hearing, currently conducted by the Legislative Assembly of the State of São Paulo. In the district of Recanto dos Passaros in Paulinia-SP, the soil and subsoil are also polluted, as is underground water, by organochlorine compounds: eldrin, aldrin and dieldrin. This matter is being investigated by the District Attorney's Office.

The main sources of underground water and subsoil pollution, as well as associated control parameters, are listed in **Chart 1**.

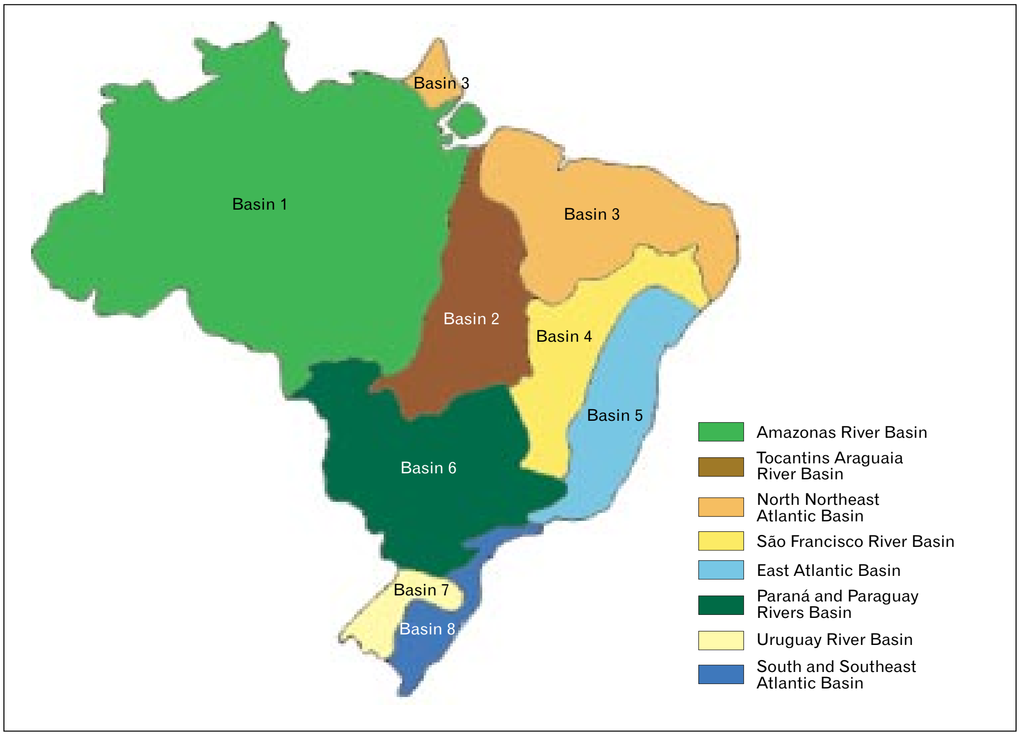
# 1. Superficial Waters

## 1.1. The Present Situation

Water is a finite natural resource which occurs in nature in the various stages of the hydrologic cycle. The cycle includes:

**a)** atmospheric precipitations;
**b)** interior water bodies; water bodies which flow, are born or shared among countries or neighbouring states;
**c)** coastal water bodies formed by ocean waters together with neighbouring estuaries;
**d)** aquifers, groundwater reservoirs, glaciers and perennial snow.

**Figure 1 - Hydrographic basins and regions in Brazil**




In Brazil, except for the Northeastern semi-arid regions, the remaining regions have water supplies that are sufficient for industrial, irrigation and domestic supply activities. However, the lack of sanitation and dumping of non-treated domestic and industrial effluents in the great majority of water bodies result in extensive degradation of the quality of these waters. This defines a paradoxical scarcity framework.

Due to Brazil's large territorial extension, simultaneous variations in the climatic and hydrological regime occur. In an attempt to define the characteristic behaviour of the processes involved in terms of region, eight of them, or large basins, may be identified in **Figure 01**. It is worth noticing that studies are under way at the Ministry of the Environment (Water Resources Secretariat – SRH (*Secretaria de Recursos Hídricos*) and at the National Waters Agency – ANA (*Agência Nacional de Águas*), for a re-definition of the division and codification of water basins in the country.

It is reckoned that 257,790 $m^3/s$ are drained in the Brazilian territory in terms of long term average discharge. Around 92 percent of this total is located in six large water basins with the following average outflow: Amazon: 209,000$m^3$ /s; Paraná (including Iguaçu): 11,000 $m^3/s$; Paraguay: 1,290$m^3/s$; Uruguay: 4,150$m^3/s$; São Francisco: 2,8500$m^3/s$.

Also worth mentioning in the Atlantic watershed are the Parnaiba river (800$m^3/s$), the Jaguaribe (133$m^3/s$), the Mundaú (30$m^3/s$), the Paraíba (27$m^3/s$) and the Paraguaçu (113$m^3/s$) in the North-eastern region; the rivers Doce (1,140$m^3/s$), Paraíba do Sul/Guandu (900$m^3/s$), Ribeira do Iguape (540$m^3/s$), Itajaí (270$m^3/s$) and Guaíba (1,740$m^3/s$) in the South-eastern and Southern areas.

In the Amazon Basin there are large tributaries that drain water basins of low level soil occupation and reduce the economic use of water: the Negro River (28,400$m^3/s$), the Madeira (31,200$m^3/s$), the Tapajós (13,500 $m^3/s$) and the Xingu (9,700$m^3/s$). **Chart 1** shows the country's water availability. A great diversity of situations can be observed, with abundant waters in the North and MidWest regions and shortage in the Northeastern region and in other developed states such as Rio de Janeiro and São Paulo. Around 89 percent of the potentiality of Brazil's surface waters is concentrated in the North and MidWest regions , where 14.5 percent of Brazilians live on only 9.2 percent of the water demand. The remaining 11 percent of the surface water potential is located in the remaining North, South and Southeast regions where 85.5 percent of the population and 90.8 percent of the water demand in Brazil are located.

The quality of the Brazilian water resources is regulated by technical standards with classification and frame-working criteria established in Resolution no. 20 of the National Environmental Council – CONAMA (*Conselho Nacional de Meio Ambiente)*, of June 18, 1986. Water is divided into fresh, briny and salty, and is characterised by new quality levels. Each level is defined by numerical patterns and attributes which signal quality objectives to be kept and recovered in view of the prevalent usage of water resources. The monitoring of water quality is carried out by sample collection networks within a national and state scope. However, the degree of efficiency by quantitative monitoring as well as the adequate periodicity to form a consistent historical pattern have not been achieved.

Although regulation was implemented over fifteen years ago, it cannot be stated that actions enabling a reversion in the water quality degradation scenario resulted from this regulation. The Programme for the De-pollution of Water

**Charter 1 - Water Availability in Brazil**

| Water Basins | Drainage area | Long-term average Discharge | | Average Runoff | |
|---|---|---|---|---|---|
| | $10^3$ km² | m³/s | l/s /km² | Km³/Year | Mm/year |
| 1 - AMAZONAS | | | | | |
| Total Basin | 6,112 | 209,000 | 34.2 | 6,592 | 1,079 |
| Basin in Brazilian territory | *3,900 | 133,300 | 34.2 | 4,206 | 1,079 |
| 2 - TOCANTINS | 757 | 11,800 | 15.6 | 372 | 492 |
| 3 - ATLANTIC | | | | | |
| NORTH/NORTHEAST | | | | | |
| North (Sub-Basins 30) | 76 | 3,660 | 48.2 | 115 | 1,520 |
| Northeast (Sub-Basins 31 to 39) | 953 | 5,390 | 5.7 | 170 | 180 |
| 4 - SÃO FRANCISCO | 634 | 2,850 | 4.5 | 90 | 143 |
| 5 - EAST-ATLANTIC | | | | | |
| Sub-Basins (50 to 53) | 242 | 680 | 2.8 | 21 | 88 |
| Sub-Basins (54 to 59) | 303 | 3,760 | 12.1 | 116 | 382 |
| 6 - PARANÁ | | | | | |
| Up to Iguaçu River mouth, including this Basin in | 901 | 11,300 | 12.5 | 356 | 394 |
| Brazilian Territory | *877 | 11,000 | 12.5 | 347 | 394 |
| 6b - PARAGUAI | | | | | |
| Up to APA's mouth, including this Basin | 485 | 1,700 | 3.5 | 54 | 110 |
| in Brazilian Territory | *368 | 1,290 | 3.5 | 54 | 110 |
| 7 - URUGUAI | | | | | |
| Up to Quaroi's mouth, including this Basin in | 189 | 4,400 | 23.3 | 139 | 735 |
| Brazilian Territory | *178 | 4,150 | 23.3 | 131 | 735 |
| 8 - SOUTHEAST-ATLANTIC | 224 | 4,300 | 19.2 | 136 | 605 |
| Water production with Total Basins | 10,724 | 258,750 | 24.1 | 8,160 | 761 |
| Brazilian Water Production | *8,512 | 182,170 | 21.4 | 5,745 | 675 |

Legend: * - Area in Brazilian territory
Source: Brazilian Ministry of Mining and Energy (National Electric Energy Agency -ANEEL ) /
Ministry of the Environment (Secretary of Water Resources - SRH and National Water Agency - ANA)

Basins was recently launched by the National Waters Agency – ANA (*Agência Nacional de Águas)* in order to stimulate the implementation of tributaries treatment systems and the increase of existing efficiency. Other initiatives have also been taken in order to improve water quality by means of a direct financial return to the service provider in view of both the quantity of water treated and the quality of the final product. This is an innovation action bound to be successful.

### 1.2. Urban - Industrial Supply - Contamination by Tributary

In 1940 the Brazilian population comprised 40M inhabitants of which 12,8 million lived in urban centres while the majority of the population lived in rural areas. By the beginning of this century, the Brazilian population had increased fourfold and the relationship had changed completely: today over 80 percent of the Brazilian population live in cities.

The evolution analysis of sanitation services supply levels in Brazil reveal that substantial improvement has occurred only in water supply services primarily provided to the urban population. In numerical terms, during the period between 1970 and 2000, the urban population increased 137 percent, going from 52 milion to around 123 milion. In a similar way, the number of households served with water distribution networks increased from 60 to 91 percent. Around 11 milion people who live in cities do not have access to water through the network. In the rural area, 9 percent of the population is somehow connected to the drinking water network. It is worth mentioning, though, that the larger part of this population is supplied directly by wells and springs.

On the other hand, the supply of sewage collection and disposal services is still rather inadequate even in large cities and reaches 15 percent of its intended coverage only. When sewage treatment systems are included in this analysis the coverage index drops to 8 percent only. Considering basic sanitation in a broader sense, it can be noticed that the deficiencies caused by a chronic absence of collecting systems and adequate destination of final solid residues help to form the picture that is largely responsible, in great part, for the public health problems that affect mainly the low income population.
The large cities suburbs, the small urban agglomerations and the poor regions concentrate the population most in need of sanitation services. According to the Ministry of Health, 65 percent of hospitalisations result from inadequate sanitation services and actions, dysentery is responsible, for 50 thousand infant deaths per year, the majority under one year of age.

The institutional model based on State Sanitation Companies, resulting from the National Sanitation Plan – PLANASA (*Plano Nacional de Saneamento),* created in 1971 and discontinued in 1986, was definitely capable of changing the supplying index before the 1960s. However, excessive centralisation in the companies, which conditioned fund raising to the municipality adhesion to the system, was responsible for the creation of bureaucratic structures dettached from the reality and incapable of operating either physical or financial solutions. Greater challenges have been faced by the few existing municipal services which, in the absence of funding sources, establish compulsory mechanisms, instruments and innovating solutions which guarantee, within small operational structures, certain financial health. **Chart 2** gives an overall view of services supply throughout the Brazilian regions by indicating the main suppliers and the population being served.

According to the Ministry of Planning and Budget and the Urban Policy Secretariat's data (*MPO / MPSS (Ministério do Planejamento e Orçamento / Secretaria de Política Urbana*) and according to diagnosis from the Sanitation Sector: Financial and Economic Studies, Brasília, 1995, in order to reach the water and sewage services universalisation target for the entire Brazilian population, investments of approximately US$42 billion within a period of around 20 years would be necessary.

In 1995, the National Information System on Sanitation was institutionalised. It represents a fundamental instrument for the efficiency of sanitation services supply and it is indispensable to the implementation of the sector's regulatory framework. The referred system is anchored in the implementation of an environmental sanitation data bank and in the use of performance indicators.

One aspect worth noticing regarding the sector's organisation is the insufficient link with programmes and activities in other areas, especially those related to the environment and water resource management. There is a

## Chart 2 - Population served with water and sewage

| Regions / State | Municipalities | Served municipalities | | Served Places | | Total population of served municipalities | | Urban population of served municipalities | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Municipalities | Water HQs | Sewage HQs | Water Places | Sewage Places | Water Inhabitants | Sewage Inhabitants | Water Inhabitants | Sewage Inhabitants |
| North Region | | | | | | | | | |
| CAER/RR | 15 | 15 | 1 | 7 | 0 | 266,922 | 167,185 | 203,316 | 163,390 |
| CAERD/RO | 36 | 36 | 2 | 14 | 0 | | | 735,612 | 280,286 |
| CAESA/AP | 14 | 14 | 6 | 23 | 0 | 432,395 | 374,732 | 390,302 | 351,352 |
| COSAMA/AM | 46 | 46 | 1 | 46 | 1 | 2,198,732 | 1,255,049 | 2,970,545 | 1,573,152 |
| COSANPA/PA | 62 | 62 | 1 | 13 | 1 | 4,146,861 | 1,246,088 | 2,395,593 | 861,372 |
| DEAS/AC | 15 | 15 | | 1 | | 236,899 | | 107,689 | |
| SANEATINS/TO | 125 | 125 | 3 | 225 | 1 | 1,024,233 | 256,579 | 713,489 | 242,472 |
| North Region Total | 313 | 313 | 14 | 329 | 3 | 8,306,042 | 3,299,633 | 7,516,546 | 3,472,024 |
| | | | | | | | | | |
| Northeast Region | | | | | | | | | |
| AGESPISA/PI | 134 | 134 | 2 | 11 | 0 | 2,337,808 | 756,311 | 1,655,583 | 707,274 |
| CAEMA/MA | 132 | 132 | 2 | 21 | 0 | 3,848,023 | 247,380 | 1,874,820 | 1,083,036 |
| CAERN/RN | 140 | 140 | 25 | 13 | 0 | 2,332,271 | 1,395,280 | 1,875,296 | 1,261,274 |
| CAGECE/CE | 132 | 132 | 11 | 45 | 0 | 5,506,762 | 2,954,179 | 4,175,170 | 2,843,256 |
| CAGEPA/PB | 167 | 167 | 12 | 16 | 0 | 3,085,199 | 1,517,502 | 2,572,010 | 1,506,321 |
| CASAL/AL | 80 | 80 | 1 | 84 | 1 | 2,276,666 | 786,288 | 1,533,897 | 742,026 |
| COMPESA/PE | 174 | 168 | 6 | 74 | 0 | 7,231,387 | 3,825,641 | 5,449,191 | 3,546,408 |
| DESO/SE | 71 | 70 | 3 | 253 | 0 | 1,612,263 | 557,634 | 1,156,723 | 503,965 |
| EMBASA/BA | 342 | 335 | 23 | 540 | 6 | 11,003,983 | 4,698,722 | 7,294,097 | 4,155,763 |
| Northeast Region Total | 1,372 | 1,358 | 85 | 1,057 | 7 | 39,234,362 | 16,738,937 | 27,586,787 | 16,349,323 |
| | | | | | | | | | |
| Southeast Region | | | | | | | | | |
| CEDAE/RJ | 61 | 59 | 6 | 160 | 0 | 11,273,517 | 8,146,916 | 10,769,065 | 7,782,369 |
| CESAN/ES | 52 | 52 | 11 | 160 | 17 | 2,076,511 | 1,445,201 | 1,722,897 | 1,336,627 |
| COPASA/MG | 513 | 513 | 53 | 72 | 8 | 11,524,145 | 5,555,878 | 10,035,920 | 5,548,262 |
| SABESP/SP | 366 | 366 | 365 | 339 | 339 | 21,274,244 | 20,614,640 | 19,181,000 | 19,107,000 |
| Southeast Region Total | 992 | 990 | 435 | 731 | 364 | 46,148,417 | 35,762,635 | 41,708,882 | 33,774,258 |
| South Region | | | | | | | | | |
| CASAN/SC | 220 | 220 | 9 | 94 | 4 | 3,980,440 | 1,279,390 | 3,008,349 | 1,200,892 |
| CORSAN/RS | 308 | 308 | 38 | 27 | 6 | 6,663,197 | 2,858,653 | 5,605,570 | 3,440,574 |
| SANEPAR/PR | 342 | 342 | 128 | 277 | 6 | 8,660,005 | 6,885,222 | 7,467,010 | 6,252,787 |
| South Region Total | 870 | 870 | 175 | 398 | 16 | 19,303,642 | 11,023,266 | 16,080,929 | 10,894,253 |
| | | | | | | | | | |
| Midwest Region | | | | | | | | | |
| CAESB/DF | 1 | 1 | 1 | 19 | 19 | 1,969,868 | 1,969,868 | 1,850,733 | 1,850,733 |
| SANEAGO/GO | 219 | 219 | 24 | 28 | 0 | 4,529,832 | 2,299,185 | 4,326,880 | 2,648,538 |
| SANEMAT/MT | 71 | 71 | 3 | 2 | 0 | 788,062 | 47,494 | 468,941 | 37,552 |
| SANESUL/MS | 68 | 68 | 11 | 48 | 0 | 1,285,780 | 521,911 | 1,033,328 | 439,215 |
| Midwest Region Total | 359 | 359 | 39 | 97 | 19 | 8,573,542 | 4,838,458 | 7,679,882 | 4,976,038 |
| | | | | | | | | | |
| Group Total | 3,906 | 3,890 | 748 | 2,612 | 409 | 121,566,005 | 71,662,929 | 100,573,026 | 69,465,896 |

Diagnosis of Water and Sewage Services - 1999
General Information - Regional scope service renderers
The quantities of municipal HQs are not contained in location quantities
Source: National Information System on Sanitation SNIS-SEDU/PR - 1999

great difficulty on the part of sanitation service agents to recognise the origin of water management as a natural resource.

## 1.3. IRRIGATION

Irrigation agriculture is a human activity which demands a larger total water quantity. It is estimated that this use represents around 80 percent of water derivations worldwide. According to data provided by the Getúlio Vargas Foundation and published in 1998, this total exceeds 63 percent. Irrigation is demanding in terms of water quality. In the case of large projects, it implies outflow controlling works, or else, dams which interfere in the fluvial regime of water bodies and in the environment. In the same way as in domestic use, irrigation is a consumption water use, that is, part of the water used in agriculture will not immediately return to its original flow and, consequently, a reduction of the sources available occurs.

The irrigated perimeters, considered areas of advanced technology, are promoters of several other industrial and commercial activities. They also invigorate economy through transfer of wealth and generation of jobs. It is estimated that Brazilian irrigated agriculture is responsible for 1,4 million direct and 2,8 million indirect jobs (Christofidies, 1999). This means the generation of 1,5 jobs per irrigated hectare approximately. As Brazil has the potential to irrigate 16,1 million hectares, irrigation will have the capacity to employ around 24 million people in the country if these indexes are maintained.

**Chart 3** displays the evolution of irrigation use in the country and the corresponding graph (**Figure 2**).

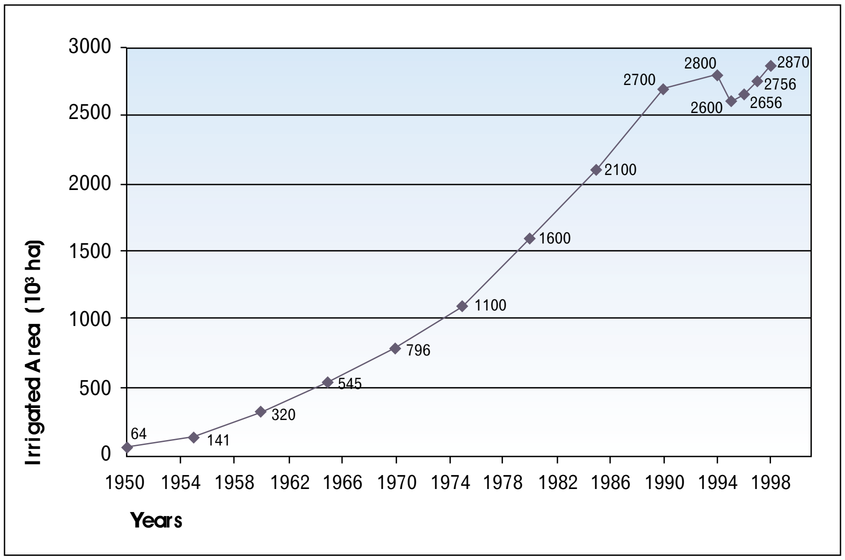
While the various uses of water are intensified, the increase in conflict is even more evident. In the São Francisco Basin, for instance, the projections of demand of irrigation water, transposition to other water basins and maintenance of the current hydro-electric power uses are a source of concern. According to data provided by the Ministry of the Environment Water Resources Secretariat – SRH (*Secretaria de Recursos Hídricos do Ministério do Meio Ambiente)* (1999) the total demand for granting water usage in this basin is 770m³/s. 99 percent of this total is used for irrigation projects. With an average discharge of approximately 2,850m³/s at the mouth of the river, the demanded outflow corresponds to 27 percent of this total. Therefore, it is imperative that more judicious studies be

**Chart 3 - Evolution of irrigated areas in Brazil**

| Year | 1950 | 1955 | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigated Area ($10^3$ ha) | 64 | 141 | 320 | 545 | 796 | 1100 | 1600 | 2100 | 2700 | 2800 | 2600 | 2656 | 2756 | 2870 |
| Growth rate (% per year) | | 17.11 | 17.81 | 11.23 | 7.87 | 6.68 | 7.78 | 5.59 | 5.15 | 0.91 | -7.14 | 2.15 | 3.77 | 4.14 |

Source: Christofidis, D. - 1999

**Figure 2 - Evolution of irrigated areas in Brazil**



carried out as far as requests for grants are concerned, since the impacts may cause great damage to society.

In the Southeast, conflicts around use of the waters of the Paraíba do Sul, Piracicaba and Capivari Rivers, among others, are more evident. In the South of the country, in the Aranguá, Itajái, Tubarão, Jacuí and low Uruguay Basins an enormous demand for water for the irrigation of rice plantations is the most visible example.

Noticeably, in consumption usage, the water that returns to the river has its quality altered and it is inferior to that which was withdrawn. Its dilution affects the quality of the entire water body. In the case of the use of water for agricultural purposes, the irrigation methods may be improved and, with proper handling, pollution resulting from sedimentation, fertilisers and agrochemicals, which are the focus of significant degradation of water resources today, may be minimised.

## 1.4. Navigation

Navigation may be considered the most overlooked among the demands for utilisation of inland water resources in the country. In the present state of affairs, river transportation plays an important role by lowering costs in general, integrating new areas of mineral, agricultural, cattle raising and industrial production, and by generating a regional development process. Besides its energetic efficiency, waterways offer low maintenance costs and provide a burden relief in relation to the expensive conservation of highways in tropical regions.

**Chart 4** shows a list of the main navigable courses in the country and the extension of stretches used for

**Figure 3 - Navigable Ways**

Source: Ministry of Transportation-STA/DHI this purpose. In **Figure 3** the main navigable courses in the country are identified.

### 1.5. Hydro-Energy Use

The outflow of water bodies, combined with certain nature conditions, enables the use of hydro-energy, the main variet of non-consuming use within Brazil since around 92 percent of the hydro-electric power produced in the country comes from water. Hydro-electricity shows some advantages as a result of its lower operational cost and, primarily, because it causes smaller impacts on the environment when compared to other varieties of energy

**Chart 4 - Main inland waterways in Brazil**

| Basin | Waterway/River | Navigable Stretch (km) | In Operation | Dyke/ Dam | Port Installations | Note: |
|---|---|---|---|---|---|---|
| I | Amazon | 3,600 | Y | | Y | |
| I | Madeira | 1,100 | Y | | Y | |
| I | Mamoré/Guaporé | 1,370 | Y | | Y | |
| I | Purus/Acre | (2,287+286) | Y | | Y | |
| I | Juruá | 2,464 | Y | | N | |
| I | Urucu | 530 (Coari Lake) | Y* | | N | |
| I | Tefé | >470 | Y* | | N | |
| I | Negro/Branco | (310+427) | Y | | N | |
| I | Japurá | 745 | Y | | N | |
| I | Içа (or Putomayo) | 358 | Y | | N | |
| I | Uatumã | 295 | Y | | N | |
| I | Tapajós | 110 | Y | | Y | |
| I | Xingu | 263 | Y | | Y | |
| I | Trombetas | 120 | Y | | Y | |
| I | Jarí | 110 | Y | | Y | |
| I | Guamá/Capim | (160+275) | Y | | Y | |
| I | Moju/Acará | (87+90) | Y | | Y | |
| 2 | Tocantins/Araguaia | 2,213 | Y | | Y | Design stage |
| 2 | Mortes | 425 | Y | | N | |
| 3 | Mearim | 400 | Y* | | N | |
| 3 | Pindaré | 217 | Y* | | N | |
| 3 | Grajaú | - | Y* | | N | Operates In high waters |
| 3 | Pericumã | 50 | Y* | Dam | N | Reversible (Floods and tides) |
| 3 | Parnaíba | 1,244 | Y* | 2 | N | |
| 4 | São Francisco | 1,371 | Y | 1 | Y | |
| 4 | Grande | 366 | Y | | N | |
| 4 | Corrente | 110 | Y | | N | |
| 6 | Paraná/Tietê | 2,400 (1,642+758) | Y | 10 | Y | |
| 6 | Paraguay/Paraná | 2,202 (3,442) | | | | |
| 8 | Lagoa dos Patos | 900 | Y | 3 | Y | |
| 7/8 | Ibicuí/Jacuí | | | | | Under appraisal |
| | Paraguay/Amazon Negro/Orenoco | Mercosur Integration | | | | Under appraisal |
| | Paraná/Araguaia | 7,000 | | | | Under appraisal |

*Seasonable navigation, especially in high waters.

generation.

Hydro-electric generation, while guaranteeing the production of 92 percent of the electricity consumed in Brazil, is equivalent to approximately 10 billion dollars a year, if the energy generation phase only taken into consideration. (Freitas,1998). According to January 2002 statistics, the Brazilian known hydro-electric potential is approximately 260GW (**see Chart 5**). Only around 22 percent of this total is in operation and there is still potential left to be used.

### 1.6. Natural Environment

Adequate portions of water should be reserved to maintain healthy ecosystems. Many times, in traditional planning and management, the natural environment requirements are not considered in a satisfactory fashion. Legislation should protect rivers by establishing outflow standards and minimum quality required, as well as by allocating water to the natural environment which might have previously been destined to big projects and users.

Besides sanitation, navigation, generation of energy, agriculture and natural environment, other demands should be emphasised such as industrial supply, recreation, animal consumption, landscape harmony and tributary dilution.

Problems such as viability of multiple purpose works, lack of financial resources for social relevant uses (sanitation, fishery, leisure, small irrigation, rural supply), regional imbalance and conflicts among local, regional and national interests should still be overcome through co-ordination and aggregation of efforts of several sectors interested in the use and control of water resources.

### 1.7. Critical Events

**Floods – Quality of water – Droughts – Desertification**

Whether in terms of water bodies, pollution or other high demands, there is no sufficient water in some areas to meet the demands of some sectors. This results in usage competition and conflicts. The conflicting scale varies from arguments among individuals to the lack of agreement among entire communities and, in some extreme cases, among cities and countries. However, not all problems are related to water shortage.

In more developed countries, where the sewage treatment problem has already been partially or totally resolved, the big problem of water pollution is the diffuse pollution caused by superficial draining in urban and rural areas. Besides diffuse pollution, Brazil also faces the problem of treatment of its polluting sources such as domestic and industrial sewage.Treatment solutions aiming at minimising or even eliminating pollution sources are well known solutions, whereas the structural techniques to minimise diffuse

**Chapter 5 - Brazilian Hydroelectric Power**

| Stage | Power (MW) |
|---|---|
| Remaining | 30,139 |
| Individualised | 65,356 |
| Total Estimated | 95,496 |
| Inventary | 49,076 |
| Feasibility | 37,079 |
| Basic Project | 9,305 |
| Construction | 7,407 |
| Operation | 61,720 |
| Deactivated | 12 |
| Total Inventoried | 164,600 |
| General Total | 260,096 |

Source: SIPOT (Information System on the Brazilian Hydroelectric Potential

pollution such as permeable paving, grassed hillsides, infiltration basins and marshy lands are not widespread yet.

The United Nations Convention to Combat to Desertification (CCD) defines desertification as the process of environmental degradation in arid, semi-arid and sub-humid dry regions as a consequence of anthropic actions. In this case, environmental degradation is understood as the degradation of soils, flora, fauna, water resources and the increase of poverty.

There are 18,5 million people living in the semi-arid region. Of this total 8,6 million are located in the rural zone. It is a region marked by traditional rural characteristics, with little or no access to the market, an enormous difficulty to absorb technology, habits which have been fixed through out generations and an extremely paternalistic relationship, with the State. It can be added that this dynamics reflects structural problems with high impact on the environment. The trend to over-explore natural resources in this region results from lack of income opportunities and access limitations to the market. This has an intermediate term effect on the quality of the environment and on the possibilities maintain ins the

**Chart 6 - Areas affected by desertification in Northeast**

| State | Total area (km²) | Affected area in absolute terms (km²) | | |
|---|---|---|---|---|
| | | Moderate | Serious | Very Serious |
| Alagoas | 27,731 | 6,256 | – | – |
| Bahia | 561,026 | 258,452 | 10,163 | – |
| Ceará | 148,016 | 35,446 | 16,366 | 26,993 |
| Paraíba | 56,372 | – | 8,320 | 32,109 |
| Pernambuco | 98,307 | – | 28,356 | 22,883 |
| Piauí | 250,934 | 86,517 | – | 3,579 |
| Rio Grande do Norte | 53,015 | 5,154 | 18,665 | 8,337 |
| Sergipe | 21,994 | 2,071 | – | 4,692 |
| TOTAL | 1,217,395 | 393,896 | 81,870 | 98,595 |

Source: MMA/SRH/IBAMA

The Brazilian areas which can be inserted in the desertification concept defined above are those which are part of the North-eastern semi-arid region, whose extension is approximately 858,000 km$^{2}$.. Some regions located outside the semi-arid which can also be included in the Convention's scope are those located in the Dry Polygon with an estimated extension of 1,083,000 km$^{2}$ , including municipalities in the north of Minas Gerais and Espírito Santo.

According to data supplied by SSRH/Ministry of the Environment, the areas showing extreme signs of degradation, the "Desertification Centres", are Gilbués – PI (in Piauí), Irauçuba – CE (in Ceará), Seridó, on the border of the States of Paraíba and Rio Grande do Norte, and Cabrobó – PE (in Pernambuco). Other similar environmental degradation processes have been identified in the country such as, the case of Alegrete, in Rio Grande do Sul, and the strong erosive processes which occur in Paraná, São Paulo, Rondônia and Tocantins. These are areas which undoubtedly present a very serious environmental deterioration picture, but which are not included in the Convention's concept.

population attached to the region. Subsistence cultivation, extensive cattle breeding and certain irrigated agricultural sectors can be highlighted in the arid and semi-arid northeastern region today.

Available studies indicate that the desertification process in the semi-arid region has been seriously compromising an area of 181,000 km$^{2}$ due to diffuse and concentrated impacts on the territory. **Chart 6** indicates that the seriously affected area has an extension of 98,595 km$^{2}$ – around 10 percent of the semi-arid portion, and that 81,870 km$^{2}$ of the territory are affected in a serious fashion. The remaining areas subject to antropic action – 393,897 km$^{2}$ – undergo moderate degradation. (**Figure 4**).

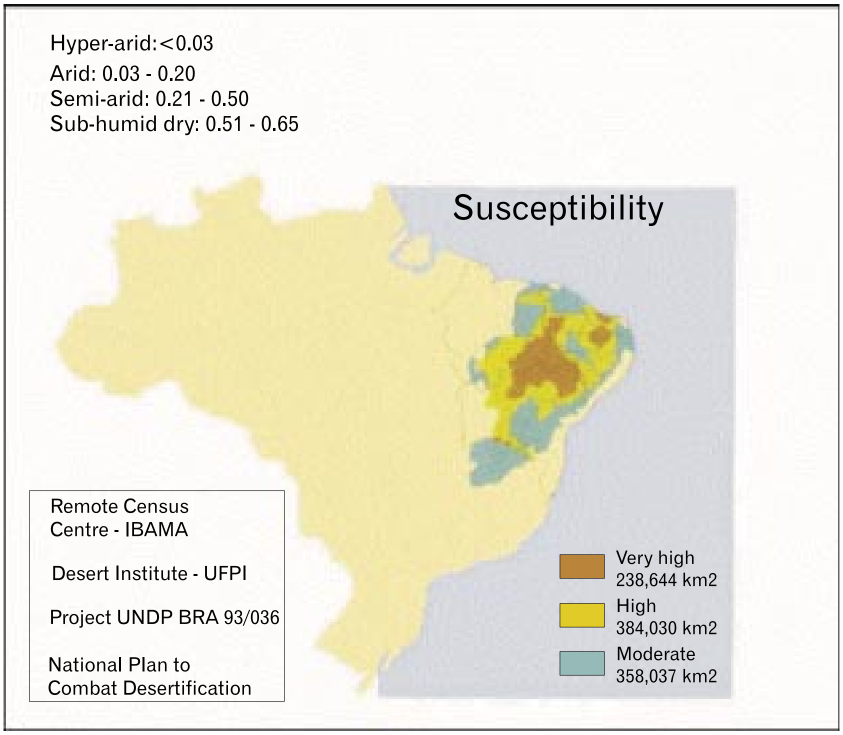
Floods are also a great problem in many parts of the world and result in significant material and human losses.

Considering that floods and droughts are mostly natural phenomena, it is necessary to define measures capable of providing a relationship with their effects. It is also important to ensure that human activities and changes in the use of the soil do not exacerbate these problems.

Sand and gravel extraction should also be cited as a critical hydrologic situation, as well as the remaining mineral activities which are rather spread out around the Brazilian territory, including prospecting.These practices, when carried out without the necessary knowledge, preventive measures or environmental recovery, affect water bodies not only by silting them up but also with physical and chemical pollution.

Pollution, whether scattered or focused, contributes to an accelerated eutrophication of lakes and reservoirs. The presence of nutrients such as phosphorus and nitrogen enables the proliferation of algae.

**Figure 4 - Desertification - affected areas**




Source: MMA / SRH / IBAMA

The combination of these factors leads populations to a state of extreme poverty. A migration process is then established in the search for more favourable survival conditions. In turn, this migratory process aggravates the infra-structure problems in urban centres.
Many irrigated areas show signs of salinity, which is a consequence of lack of investments in draining systems. For example, signs of salinity or soil density in approximately 30 percent of the area are present in the 600,000 irrigated hectares in this region.

Biodiversity destruction has been provoking a decrease in the availability of water resources through river and reservoir obstruction and the physical and chemical loss of soils. All these factors restrain the earth's biological potential. This not only reduces agricultural productivity but also causes problems to populations.

## 2. Underground Waters in Brazil

Underground water is the part of meteoric water-rain, fog and snow, mainly, which infiltrates and moves through the lands of a given water basin. However, once its displacement speed is very low (in terms of cm/day order), underground water flows towards rivers, supplying basic drainage, specially during rationing periods or droughts.

While moving through the interstitial or fissure porous environment, underground water is submitted to processes of natural purification in levels never achieved by conventional treatment methods. As a consequence, the alternative use of underground water for human supply is frequently cheaper and it is the main support for water businesses related to bottled water or water put in "pipe trucks"

### 2.1. From Wells to Underground Flow Systems

In General the traditional hydro-geological studies in Brazil comprise, the statistical analysis of data on well depths, water levels, flows and quality. This is true regardless of the fact that there is little technical or scientific consistence to that information.

However, the current experience in more developed countries shows the necessity to develop from well analysis or other punctual issues to the characterisation of the conceptual hydro-geological model and understanding of the underground flow systems in that area.

In this picture, it is nowadays known that the integrated management of available water in the water basin - physical management unit –transforms classical concepts such as *"Safe Yield"* – into merely theoretical ones; the water drawn cannot be higher to natural recharge aquifer rates concerned (Meinzer, 1923). Induced recharges by intensive use of aquifers, alter the underground flow systems, thus supporting the high increase of drawn underground volumes.

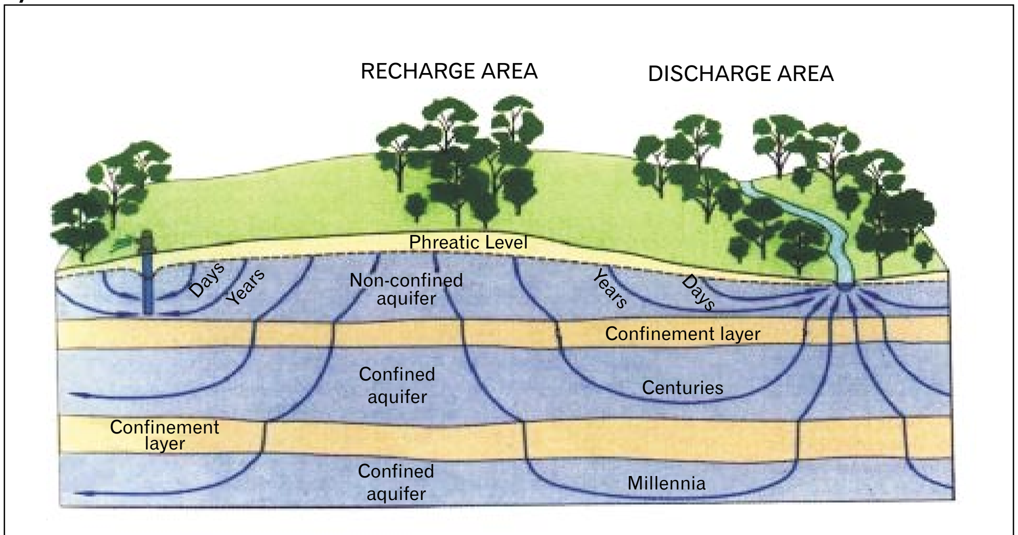
The integrated management of available water discards any discussions on the disagreement between the water and geological basins' physical limits, as well as overexploitation diagnosis based on the accentuated lowering of well water levels.

Thus, the application of analytical models, e.g., "Theis" (1935) and similar ones, or mathematical models, e.g., MODFLOW 2D or 3D and similar ones (USGS, 1997), shows that the whole water drawing from one or a group of wells inexorably configures the formation of lowering cones of underground water levels. However, drawing from the underground flow includes a wider supply front in relation to the infinitesimal dimensions of "current tubes" from the pre developmental phase.

As a result, superior water volumes to those expected may be drawn, according to the classic *"Safe Yield."* Concept. In addition, well pumping may engender larger interaction dynamics between neighbouring aquifer systems, expansion of natural or induced recharge and discharge areas, modification of hydro-geologic and geo-chemical of random or deterministic auto purification processes.

On the other hand, the water flow system in the underground water basin may include local, intermediate or regional dimensions, in which the period of ground water flow may take days, years, centuries or millennia respectively (**Figure 1**).

**Figure 1 - From the well to the underground flow systems**




Source: Adapted from the United State Geological Survey-USGS Circular 1139 - 2000

It is worth highlighting that, in regards to the integrated management approach of available water in a UGRHI-An Integrated Hydro-Resource Management Unit – the aquifer system may play various roles, e.g.; production, storing of water protected from pollutants and from intense evaporation processes, mainly of self purification, supply and the more efficient use of necessary water for the development of socio-economic activities in the area under consideration (Rebouças, 1996).

The underground flow system shows, therefore, that it is not possible to relate data to water level or quality data, for instance, from a well net of different depth and constructive and operational characteristics overall. It is enough to remember that, shallow wells draw water from the local flow, while deep wells draw water from the intermediate or regional flow systems.

Current knowledge indicates that in most cases the accentuated lowering of water levels in water wells results from badly located or badly built interference reception works. Thus, the over exploitation diagnosis, which is established by the water movement between recharge and discharge rates of underground waters, does not have a hydro geologic sense anymore.

## 2.2. Hydro Climactic Regime and Underground Water Recharge

The underground flow system approach makes it evident that underground water is the part which falls from atmosphere-rain, fog or snows and infiltrates in the underground. However, it is observed now that the importance of this recharge depends on the interaction of geological, structural, tectonic conditionings, of very complex environmental use and occupation, and of really varied climatic factors in space and time.

In this picture, rivers normally drain meteoric waters-rains, fog and snow-part, which flow over the land surface (**R**) and infiltrate and circulate (**I**) through the respective water basin underground.

Therefore, when the rivers of a certain area are perennial, it means that the recharge of underground waters from water basins is sufficiently important to supply them during the whole period in which there is no water precipitation in the atmosphere.

The "green drought" is reported locally and occasionally in the semi-arid northeast of Brazil. This means that part of the rain which infiltrates in the soil (I) supports the green explosion of the "Caatinga"; however, it is insufficient to meet the water needs of subsistance cultivation. The part which infiltrates more deeply will supply the underground water deposits in such a way that the rivers which drain their permeable sedimentary lands never dry out during long droughts. This is what happens with the Parnaíba and San Francisco rivers.

However, in the crystalline, metamorphic and practically water proof rock domain, where the most promising possibilities of underground water stocking are restricted to areas with fractured rocks and alluvial patches formed along the main rivers, the underground flow contribution is so modest that the water courses from water basins sculpted in these rocks virtually dry after the three to four month rainy period (Rebouças & Marine, 1970).

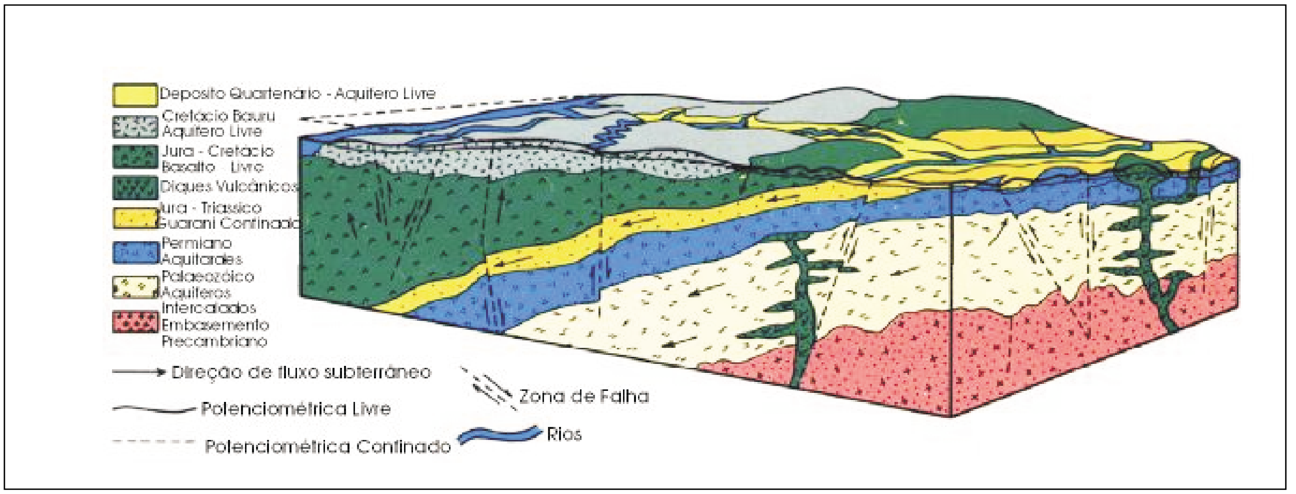
Due to lack of data monitoring from the underground stream and to little dominant hydrogeology knowledge in Brazil, the interpretation of recession branches of the river hydro grams – graphic representation of flows according to time- is the most consistent method available to evaluate effective recharges of underground water from water basins.

PLIRHINE - The Integrated Plan for Water Resources in the Northeast (SUDENE, 1980) indicates that temporary rivers' basic drainage in the semi-arid Northeast corresponds to medium sheets infiltrated varying from 11 mm/year (UP Jaguaribe) to 44 mm/year (UP Acaraú-Coreaú), with a regional average value of 26 mm/year (Rebouças, 1997).

On about 90 percent of Brazil's territorial extension, rivers are perennial, which means they never get dry. The basic drainage of these rivers indicates that the water tables infiltrating the respective water basins vary between 100 and 600 mm/year (Rebouças, 2001).

Therefore, the contribution of underground flows to basic river drainage in Brazil is estimated to be 3,144 km$^3$/year, or

**Figure 2a - Main types of aquifers in Paraná Basin**




Source: Rebouças - 1976, DAEE - 1988

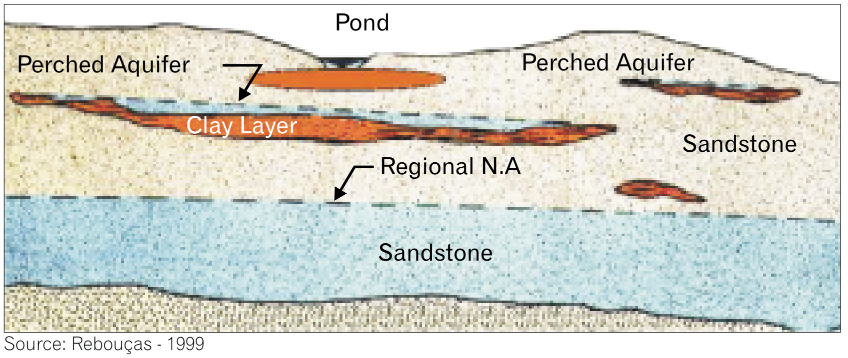
about 60 percent of its total long lasting average supply rate ( 5,610 km³/year). The use of only 25 percent of that underground water recharge rate would represent a superior offer to 4,000 m3/year per capita, for the provision of the 170 million inhabitants of Brazil 2002 (IBGE, 2000). It is worth noting that water supply analysis in the United Nations member countries shows that an amount between 1,000 and 2,000 m3/year per capita would be enough for modern comfort use and sustained development.

## 2.3. Types of Aquifers

When underground water is found under normal atmospheric pressure conditions, the aquifer *is said to be free or not confined* (**Figure 2a**).

It is worth noting that the ***freatic*** aquifer *is* a special kind of free underground water whose perforated or dug well water level is shallow *(from the Greek,* ***frea****, which means shallow.* That means the NA (Water Level) is less than 10 meters deep (**Figure 2a**).

**Figure 2b - Perched aquifers on sandy plateaus**




Source: Rebouças - 1999

Many aquifers in Brazil basically make up the topographic surface in the area where they are located. These areas include sandy coverings, blooming areas of underground water units of sedimentary basins, alluvia formed along the main rivers, dunes, rock mantle alteration off the based Pre-Cambrian geological age and in its aquifers fractured areas.

Among the main intermediate aquifers usually found in Brazil – semi-free and semi- confined or draining- the *suspended aquifer system* stands out. This is when the accumulation of underground water occurs above the regional or metric potential level (WL). This underground water is very frequent in plateau topography or in sandy plains in Brazil; e.g., in the Araripe Plain (border between Ceará, Pernambuco, Piauí), the Urucuia Group (border between Bahia, Goiás, Tocantins, Minas Gerais) and in the

Barreiras Group, sandy re-covering which exists along the Brazilian coast from Amapá to the State of Espírito Santo.

In this hydro-geologic context, the shallow water level (WL) from excavated depth in the plateau might be temporary, which means it dries out along the period when there are no rains or it disappears when a deep well is perforated in its surroundings. Thus, the deep or tubular well crossed the hydro -geologic substratum which supported the accumulation of shallow underground water, the *suspended aquifer* (**Figure 2b**).

### 2.4. Contamination Agents

Underground water is "hidden" under a layer of non saturated filtrating material of high purifying power. Due to local and occasional geological characteristics, the deepening of the well could be the solution for obtaining a larger flow and better quality of drawn water, while in other places this alternative may result in substantial reduction of obtained flows and worsening of its quality. Also, due to lack of appropriate foundation to the ringed space, sanitation stamp and other technical deficiencies such as constructive, operational, maintenance and abandonment of wells, there may be processes of crossed contamination caused by polluted waters from neighbouring or shallower layers.

In the areas of fractured aquifer rocks and alluvial patches of geological basis from the Pre-Cambrian Age in the semi-arid Northeast there are processes of climatic underground water salinisation similar to those which affect the waters stocked in dams (Santiago, 1984). Thus, based on the results of 500 analyzed samples, it is observed that only 37 percent present total dissolved solid content (STD) similar or inferior to 2.000 mg/L (Cruz & Melo, 1968; Rebouças, 1973).

However, the studies developed by EMBRAPA-CPTSA (2000) show that there are several alternatives for using brine generated by mineral processes of well-drawn waters, which draw the fractured rocky areas under the crystalline substratum water in the semi-arid Northeast. Among viable alternatives, the irrigation of forrage, which are of great economical and social reach in the development of caprine-raising, stands out.
Consequently, the use of water desalinisation agents in inverse osmosis processes has been growing in the last decade. In this case, the main problems faced result in:

**a)** lack of monitoring of the quality of water extracted from wells and which tends to improve after 2 - 3 years use as the intensive well pumping engenders greater renewal dynamics to the water drawn from the underground;

**b)** lack of equipment maintenance; and

**c)** lack of rational use of brine generated this way.

The construction, operation and disordered abandonment of wells, the chaotic forms of occupation of urban and rural environment, the non collection or inadequate deposits of garbage, which is produced in the cities mainly, the disordered implementation of service posts, cemeteries, the installation of buried or semi-buried tanks of dangerous products without proper consideration regarding corrosion risks-specially in a country where there is a great amount of rain and hot weather for most of the year are frequent agents which affect the good natural quality of underground water (Hassuda, 1997, Hirata, 1994, Hirata et al, 1997).

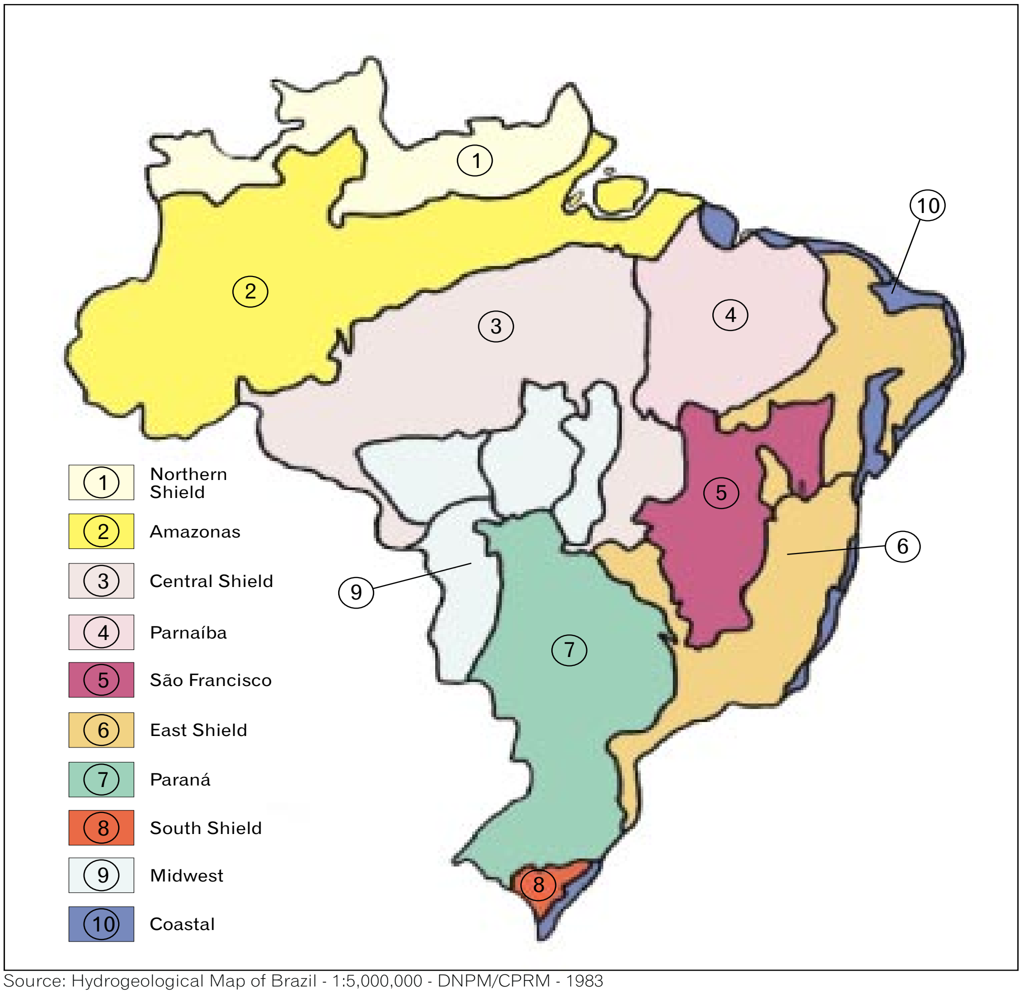
Among the agents of underground water contamination in Brazil, the nitrogen series (NH4, NO2 and NO3) stands out and is brought about by the chaotic dominant sanitation situation of our cities (Parissot, 1983, Pacheco, 1984, Mello, 1995, Cavalcante, 1998, Santos, 2000).

In addition, among the risks of binomial underground soil-water contamination in Brazil, the growing industrialization and development of agricultural activities with intensive use of chemical inputs-fertilizers, herbicides, pesticides results in, the existence of inorganic and organic synthetic chemical micro pollutants (Hirata, 1994). Among the most frequent, we emphasize the following:

**a)** **inorganic non metallic chemicals**, such as phosphorus, selenium, nitrogen, sulphur and fluorine;

**b)** **poisonous metals**, such as mercury, chrome, cadmium, lead and zinc;

**Figure 3 - Hydrogeologic Provinces in Brazil**




Source: Hydrogeological Map of Brazil - 1:5,000,000 - DNPM/CPRM - 1983

c) **synthetic organic compounds from the BTEX group** -benzene, toluene, ethylbenzene and xylene, aromatic compounds, phenols, several volatile organic chlorides, denser than water compounds -DNAPL's-Dense Non Aqueous Phase Liquids, or less dense than water-LNAPL's-Light Non Aqueous Phase Liquids, drained hydro carbonate leak from service positions mainly, among others. The fundamental physical difference of pollutant density has great implication on costs and methods of sample collection and on the monitoring of underground water quality. On the other hand, these compounds usually have different anthropic origins and affect public health in the ppb order content-parts for every billion and even of ppt-parts for every trillion, with mutating or carcinogenic effects (Rebouças, 1999).

However, the most preoccuping issue is that there are few laboratories in Brazil with phycal resources and, above all, human resources to determine these micro pollutants in lower patterns of water purity required for drinking water.

## 2.5. Hydro-Geological Provinces in Brazil

Nowadays, in the lit logic, tectonic and structural, geological complex Brazilian scenery, one may identify 10 domains where stockpiling conditions (porosity), flow (permeability) and natural recharge (infiltration of rains) are relatively similar. Such domains constitute the 10 hydro-geological provinces of Brazil (**Figure 3**).

In the case of water ground domains of primary interstitial porosities / permeability, there are two main types: alluvial sediments and dunes and sedimentary rocks.

In sedimentary basins, the deposits constitute layers or rocky bodies, relatively extensive and quite consolidated. The dominant aquifers in these areas are confined, and are currently drawn through deep local tubular wells (30, 50, 100, 150, 250 up to 3,000 m, mainly) and occasionally artesian wells. The waters of these aquifers are relatively protected against domestic, industrial and agricultural pollutants, with intensive use of modern chemical fertilizers, and good quality for domestic, industrial consumption and irrigation. In these basins one may find the largest underground water potentials in Brazil in terms of reservoir or recharge, resulting in the perennial situation of rivers which drain these areas.

In the extensive rocky domain of geological base and Pre-Cambrian age, there are two hydro- geological different contests:

**a)** In the 600,000 km2 of crystalline lands or similar Pre-Cambrian age, the dominant porosity / permeability characteristics present fissure type. The most promising possibilities of underground water accumulation are restricted to areas of fractured rocks and to alluvial patches, which are formed along the main rivers which drain the areas where these rocks appear.

**b)** In the semi-arid North-eastern Brazil, the experience indicates that the most important "water entrances" are crossed, in general, up to 60 meter depths (Rebouças, 2001). In addition, in that area the normal average of rain varies between 400 to 800 mm/year. However, rain is irregular, and sometimes the amount of rain in the week equals the average for a whole month, or the amount of rain in one month equals the average for a 6-7 month period. However, the normal average evaporation rate varies between more than 1,000 to 3,000 mm/year. Therefore, the correct, in hydrological average terms, is not to say that there is little rain in the semi-arid north-eastern Brazil, but that it evaporates a lot.

As a result, the gradual efficient use of the water available in that area has become a practice of fundamental importance in order to reach sustainable development conditions.

It is important to emphasize that under humid tropical climate conditions – pluviometer average from 800 mm/year to more than 3.000 mm/year, chemical processes of rock alterations are predominant and intense. As a consequence, a rock mantle is altered with thickness of up to 150 meters (50 m average), which covers almost four (4) million km2 of the Brazilian territory. In this scenery, porosity values and permeability of the interstitial type of altered rocky mantle increase depth gradually , being Sy = 5-15 percent and K = 10-4 and 10-5 m/s when in contact with the healthy rock. (Rebouças, 1988).

In general, the characteristics of dominant porosities / permeability of the interstitial type in the alteration mantle in this area develop to a fissure, in depths of up to 250 meters.

The annual recharge rates of accumulated underground waters in the alteration mantle, are mainly sufficiently important to supply their rivers' basic drainage during droughts.

Finally, there is the karstic province which corresponds to the geological domains of calcareous rocks, whose porosity, permeability or interstitial or fissure characteristics were locally and occasionally expanded by rock dissolution processes by meteoric water which infiltrates.

In alluvial deposits and dunes, underground waters are fundamentally healthy, free, freatic and really vulnerable. The use and occupation conditions of the

**Table 1 - Reserves of underground water in Brazil and most frequent intervals of well flows**

| Aquifer Domain | Area ($km^2$) | Main Aquifer System | Reserves ($km^3$) | Well Flow Interval ($m^3$/h) |
|---|---|---|---|---|
| Cropping substratum | 600,000 | Fractured Zones(PE) | 80 | <1-5 |
| Altered substratum | 4,000,000 | Altered and/or fractured rock mantle (PE) | 10,000 | 5 – 10 |
| Amazon Silty Basin | 1,300,000 | G. Barreiras (TQb)<br>F. Alter do Chão. (K) | 32,500 | 10 – 400 |
| São Luis-Barreirinhas Silty Basin | 50,000 | F. São Luis (TQ)<br>F. Itapecuru (Ki) | 250 | 10 – 150 |
| Maranhão Silty Basin | 700,000 | F. Itapecuru (Ki)<br>F. Cordas-Grajaú (Jc)<br>F. Motuca (PTRm)<br>F. Poti-Piaui (Cpi)<br>F. Cabeças (Dc)<br>F. Serra Grande (Sdsg) | 17,500 | 10 – 1000 |
| Potiguar-Recife Silty Basin | 23,000 | G. Barreiras (TQb)<br>F. Calc. Jandaíra (Kj)<br>F. Açu-Beberibe (Ka) | 230 | 5 – 550 |
| AL/SE Silty Basin | 10,000 | G. Barreiras (TQb)<br>F. Marituba (Km) | 100 | 10 - 350 |
| Jatobá-Tucano-Recôncavo Silty Basin | 56,000 | F. Marizal (Kmz)<br>F. S. Sebastião (Kss)<br>F. Tacaratu (SDt) | 840 | 10 - 500 |
| Paraná Silty Basin (Brazil) | 1,000,000 | G. Baurú-Caiuá (Kb)<br>F. S erra Geral (Jksg)<br>F. Botucatu-Piramboia-Rio do Rasto (Pr/TRp/Jb)<br>F. Furnas/ Aquidauana (D/PCa) | 50,400 | 10 - 700 |
| Various Deposits | 773,000 | Aluviões, dunas (Q) | 411 | 2 - 40 |
| Total | 8,512,000 | | 112,000 | |

Source: Rebouças - 1988, 1999.

environment fundamentally affect the quality of drawn waters, above all through shallow wells (3 to 10 m, mainly), nailed and dug.

## 2.6. Underground Water Potentials in Brazil

The data in table 1 indicates that permanent underground water reservoirs of main hydro geological contexts in Brazil vary from 80 km3 in the 600,000 km2 of semi-arid Pre-Cambrian age rock domain in the Northeast mainly; it reaches 10,000 km3 in almost 4,000,000 km2 of crystalline and metamorphic Pre-Cambrian based rocks, covered by an altered rock mantle on average 50 meters thick. The permanent total revenue of underground water in Brazil is about 112,000 km3, and about 90 percent of these waters are in sedimentary basins (Rebouças, 1988).

On the other hand, the most frequent supply rate obtained by already opened wells varies less than 1!!m3/h in underground water areas of fractured rocks, which are virtually water proof of geological base of Pre-Cambrian age of semi-arid Northeast, up to more than a thousand 1,000m3/h in sedimentary basins in humid climate conditions.

Considering the generalized level of these estimates, it is fundamentally important to carry out basic studies in the different hydro - geological contexts, in scales compatible to the problems to be solved and their complexities and magnitudes, to develop monitoring, and constitute basic hydro - geological databases which should be fed in a permanent way.

In Brazil, the hydro - geological potentials referred to in terms of specific capacity [(m3/h). m-1], in other words, the flow (m3/h) which is obtained of each well by lowering meter (m-1) of the respective healthy water level is presented in **Figure 4**.

It is observed, therefore, that underground water potentialities in the national territory are really varied. In the most promising domains, the specific capacities of wells vary from 5 to 10 and superior to 10 m3/h.m-1. In these areas, there is a possibility of obtaining flows from 250 to 500 m3/h in each well, with the lowering of 50 meters of respective static level or water level (WL).

needs to be operated, thus avoiding, the degradation of soil/ water binomial, as a consequence of the accumulation excess in the upstream section. The "superficial encroachment of the inverted Roman type arch" is a kind of dam whose function is to keep sediments and water flow. However, this type of water reception in the semi-arid Northeast has its application restricted to sectors where there is a relative production of sediments transported by waters of superficial drainage.

Thus, the volume produced by a well for 16 hours a day would be enough to supply between 20 thousand and 50 thousand people, with a rate of 200 l/day per capita.

In the crystalline rock contexts with thick alteration mantle, the specific capacities vary between 1 and 5 m3/ h.m-1. In other words, the exploited flows with up to 50 meters of lowering of WL of respective well, during 16 pumping hours/day, which would be enough to supply contingents of up to 10 thousand inhabitants.

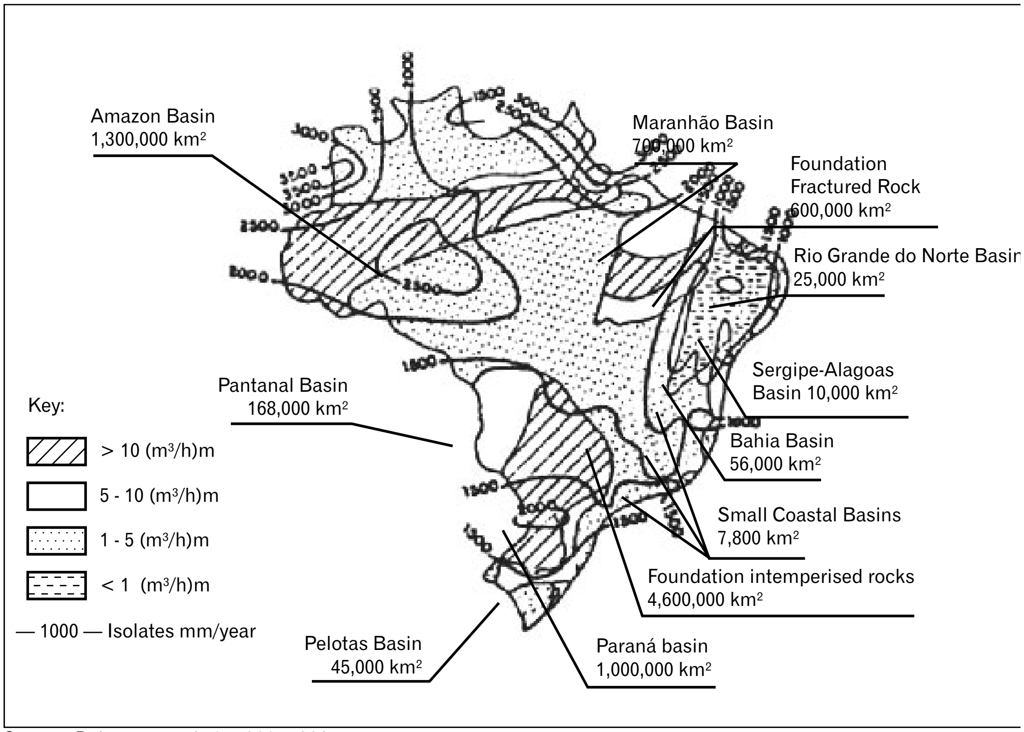
Just in the crystalline rock domain of the semi-arid Northeast, the specific capacities are inferior to 1 m3/h.m-1. However, the production of 0,5 m3/h, with lowering of the water level in the well (NE) of 20 meters and operating 16 hours a day would be enough to supply contingents of up to 1,500 people, with a rate of 100 l/day per capita.

The underground dam is another viable way of use and conservation of the water which flows through alluvia patches of the semi-arid northeast. Thus, the water that flows through the virtual dry rivers alluvia, is protected against the salinisation processes brought about by intense evaporation. However, just as a "garrotter" which is applied on an arm or leg to control a haemorrhage, the underground dam

## 2.7. The Quality of Underground Water

In general Underground water in Brazil has a quality that reflects the intensity of recharges and the geological/environment through which it flows. In the Brazilian territory there is an abundant pluviometer, high temperatures during almost the

**Figure 4 - Underground water potentials in Brazil**




Source: Rebouças - 1978, 1988, 1999

whole year, and a high geo biochemical reactivity. As a corollary, underground water presents good natural quality to human consumption since it is protected from contamination agents which degrade the rivers and other surface water bodies.

In crystalline rock domains, with thick alteration mantle and exuberant vegetation, the chemical elements that restrict the drinking quality of Brazilian underground water are mainly iron and manganese.

In sedimentary basins ages of, deposits range from the Silurian Period to the

Cretaceous period. During this long geological period (450 million years) the formation processes of deposits and paleo climatic environments were most varied – at times marine, somewhat deep, at times continental - of desert and humid climate.

In addition, during a good part of this period, there was intense tectonics which commanded the process of South Atlantic Ocean opening. Thus, successive marine transgression and regression periods which happened excessively affected the quality of underground water found in sedimentary basins. During transgression phases, deposits were formed in sea environment and the oldest sediments were saturated with salt water.

On the other hand, during the periods of sea regression, aquifers were washed by waters of meteoric infiltration that fallowed. As a consequence, the underground water of our main sedimentary basins, such as the Amazon, Maranhão-Piauí, Potiguar and Coastal Basins, mainly those whose deposits were flooded by the sea during transgression Cretaceous periods, usually only presents appropriate quality to human industrial consumption and irrigation, in their borders or in depths which were washed by subsequent infiltration waters.

On the other hand, in Brazil- the successive tectonic reactivations supported the intrusion of diverse dikes and the formation of sunk blocks –some “lifted up “graben”, others “horst.” These events compartmentalised sediment packages which were deposited, whose maximum thickness reaches close to 10 thousand meters.

It is worth noting that only in the Sedimentary Basin of Paraná, the base of the Underground Guarani Water Trans-Border System of Triassic Age (fluvial -latchstring) and Jurassic (air desert), there hasn’t been sea transgression ever since. During the Cretaceous and, above all, the Tertiary Period, dominant climatic conditions in the area were humid, causing abundant recharge rates, in such a way that the waters of the Guarani Underground Water System are fresh until the depth of 2000m, already reached by water production wells .

The most important structural lines of the tectonics which has affected the geological outline of Brazil are mapped in almost four (4) millions km2 of Pre-Cambrian age crystalline rocks. However, their extensions in the covered sectors by the most important sedimentary deposits are evidenced by the correlation of geological profiles of the already perforated deep wells and by data interpretation of geophysical prospecting - gravimetric methods, refraction seismic, electromagnetic and mainly electro- resistance.

However, it is observed that tectonics which happened after the Cretaceous period, originating the Andes for instance, is very important from the hydro-geologic point of view. It is known now, that this Neo tectonics is responsible for quantitative and qualitative characteristics of the underground water which is drawn by some deep wells already perforated in the sedimentary basins, as well as for the occurrence of hot waters, sources with varied chemical composition, for instance, One could also have, locally and occasionally, rich underground water in sulphate, iron, manganese, carbonate, fluorine or of varied composts because of the tectonics intensity, of recharges and of the pale environments of the geological domain concerned.

## 2.8. Demands and Current Uses

The technological progress of well and pump construction and the expansion of electric power supply have resulted in fresh underground water in the world in general and in Brazil in particular, accessible to technical and financial means.

In Brazil, it is estimated that about 200,000 wells are operational; however, without control of underground water drawing and use at in federal, as well as state level- it is difficult to characterise its use level. According to data from the last sanitation census, about 61 percent of the Brazilian population is self-supplied by underground water, 43 percent through tubular wells, 12 percent through water springs and 6 percent through dug wells (IBGE, 1991). Data from the 2000 census indicate that there was an increment of 191 percent in the offer of non treated water in the period from 1989 to 2000. This certainly means a wider perception than the alternative of underground water use for supply, and it is in general the cheapest , specially due to the fact that it does not need to be treated for consumption. Therefore, it

is already understood that the consumption of untreated water necessarily means that it is polluted.
In all metropolitan areas and large cities in Brazil, underground water has been used, drawn by uncontrolled tubular wells, also called artesian wells, for supplying industries, luxury hotels, hospitals, service stations, sports clubs and luxurious condominiums. (Rebouças, 1978).

In many cities of Brazil, it has become more frequent to find publicity of the existence of artesian wells in real estate enterprises. Cities such as São Luis (MA), Natal and Mossoró (RN), Recife (PE), Maceió (AL) and about 72 percent of the cities of the State of São Paulo, 90 percent of the cities of Paraná and Rio Grande do Sul, are supplied by wells (Rebouças, 1999).

In the Metropolitan Area of São Paulo (RMSP), it is estimated that 10,000 wells are operating to supply 95 percent of industries, luxurious hotels, hospitals, condominiums and clubs, mainly. Treated as an economical alternative, and a way of avoiding damages caused by frequent rationings or lack of regular water supply by official service (Rebouças et al. 1994). Lately, the State Water Company of São Paulo measures the discharge of about 2000 wells, to be able to charge a sewer tariff, and it has used an increasing number to supply RMSP populations, during this period of relative shortage in dams.

In addition, “bottled water” or “water tankylorry” business activity , drawing underground water from wells and sources, is located in their majority in urban areas or neighbourhoods. Records of mineral water sources in Brazil dates back to 1540.

The Mineral Water Code( Decree Law no. 7,841/45) establishes that bottled water is a mineral good and, as such, companies receive concession from the Federal Government for natural source or artificial-well exploitation and the consequent bottling of the product (industrialization). The volume produced in 1994 was 1,2 billion litres, reaching, in 2001 about 2 billion litres. On the other hand, Brazil is considered a privileged country, not only in relation to the quality of its waters, but also for the capacity of its underground water, estimating that the 170 companies in activity used less than 10 percent of flow installed capacity in 1994. However, consumption of less than 10 litres per person/year, places Brazil in a very distant position to the great water bottled consumers in the world, such as Italy and France, with more than 100 litres per person/ year, Belgium-with 95, Spain-with 68, and the United States, with 36 (ABINAM/DNPM, 1995).

The demographic transformation which has happened in Brazil during the last decades brought about an unusual growth of water demands in cities and degradation of its quality in rivers, in levels never before imagined. So, underground water rises in general as the cheapest supply for human consumption, mainly as it presents good natural quality and it may be drawn where the referred demands are, among other factors.

## 2.9. Legal and Institutional Framework

Historical data indicates that, at least, from the origins of Colonial Period (1500 - 1822), ground water was used in Brazil in an empiric and improvised way mainly, for human consumption. During the First Reign (1822-1831), in the Triple Regency (1831-1840) and the Second Reign (1840-1889), its use depended on a Central Authorization (Rebouças, 1976).

During the First Republic (1889-1930), the use of underground water was done without control, either on a Federal or a State level. Only under the Getúlio Vargas administration (1930-1945) the Water Rights Law was promulgated in Brazil, the Code of Waters, on July 10, 1934, composed of three books. Despite its almost 70 years of age, it is still considered by Legal Doctrine as one of the models of Brazilian Positive Rights , only book III-regarding the water powers and hydro-electric industries, received the necessary regulation. Due to lack of legislation regarding waters domains, books I and II of the 1934 Code, contain little doctrinal development in the sector.

The 1988 Federal Constitution modified in several aspects the wording of Code of Waters, dated from 1934. One of the most important changes accomplished was the extinction of private control of water, provided for in some cases in that legal document, in title IV IN PARTICULAR - UNDERGROUND WATERS –SINGLE CHAPTER , **ART. 96**.

*"The owner of any land may appropriate himself of waters which exist under the surface of his building, through wells, galleries, etc, as long as it doesn't harm existing uses nor flows or deviate of its natural course, public domain waters, public of common or private use. Single paragraph. If the use of underground waters which is mentioned in this article, harms or reduces public water or public of common use, or private, competent administration may suspend the referred work and benefits."*

Some aspects of the use and current conservation of underground waters, such as the license and granting of the well, the user and pollutant, were already foreseen in the 1934 Code of Waters (Art. 97 up to 101); however, they were never regulated.

Therefore, from the Constitution of 1988, all Brazilian waters became public domain. Another modification which was introduced by the 1988 Federal Constitution was the establishment of only two domains for water bodies in Brazil:

***(i)*** *the Federal Government domain, for rivers or lakes which bathe more than one federated unit, or which serves as border for those units, or between the Brazilian territory and neighbouring country or which they come from or for mutual understanding*

***(ii)*** *the states domain for surface or underground, fluent, emerging and in deposit water, except for the waters resulting from Government's works.* That definition doesn't exempt the process as a whole, in such a way that it does not consider the real separation of waters in the hydrological cycle .

Excessive drawing of underground water from a water basin may cause the disappearance of water springs and sources, pond drying, swamplands, river basin discharge reduction, displacement of sea overlapping and the emergence of different land problems. Another impact of disordered underground water drawing from a water basin concerns the reduction of soil humidity, which supports the development of naturally grown or covered vegetation.

# the state of forests



Approximately 550 million hectares of the 850 million hectares of the Brazilian territory are covered by native forests. Two thirds correspond to the Amazon Forest, and the remainder to the Cerrado, the Caatinga, the Atlantic Forest and associated ecosystems (MMA 2001).

The country is divided into five extensive geographical regions. The North Region – the largest – corresponds to the traditional Amazon, defined based on physiographic criteria; the Legal Amazon, on the other hand, is delimited in terms of policies and planning means, and it comprehends an area of 500 million hectares, corresponding to approximately 60 percent of the national territory. Except for deforesting-related data (changes in the forest cover), official statistics always refer to the traditional Amazon.
The remaining forest cover per region is presented in Table 1, grouped in two large formation groups: Dense Forest and Open Forest and Other. The dense tropical forest covers over 350 million hectares. Of these, 288 million hectares can be considered as potentially productive natural forests.

Open forest and other formations cover a little over 200 million hectares, of which 170 million hectares are potentially productive forests (Funatura, 1995 – Adapted by STCP).

In 2000, the United Nations Food and Agricultural Organisation (FAO) decennial survey determined that Brazil has 544 million hectares of native forests and 5 million hectares of planted forests which, when combined, give the country 64.5 percent of forest cover. The remainder of the Brazilian territory was converted to other land uses, including agriculture, cattle-ranching, urban areas and infrastructure – these uses are better addressed in the geopolitical and territorial context of the GEO – Brazil document.

Brazil's forest cover corresponds to 14.5 percent of the world's forest cover. And, while the global average of forest cover per person is 0.6 ha, with great variations according to different countries, the Brazilian average is 3.2 ha of forest per person. But there is great disparity from region to region.

**Table 1 - Area of natural forest in Brazil per region**

| Region | Forest Total Area $10^6$ ha | % over total | Potentially Productive Area $10^6$ Ha | % over total Forest |
|---|---|---|---|---|
| NORTH | 358 | | 310 | 86.59 |
| Dense Forest | 284 | 79.33 | 246 | 86.62 |
| Open Forest and Others | 74 | 20.67 | 64 | 86.49 |
| NORTHEAST | 73 | | 62 | 84.93 |
| Dense Forest | 11 | 15.07 | 6 | 54.54 |
| Open Forest and Others | 62 | 84.93 | 52 | 83.87 |
| MidWest | 95 | | 72 | 75.79 |
| Dense Forest | 48 | 50.53 | 34 | 70.83 |
| Open Forest and Others | 47 | 49.47 | 38 | 80.85 |
| SOUTHEAST | 22 | | 14 | 63.64 |
| Dense Forest | 4 | 18.18 | 1 | 25.00 |
| Open Forest and Others | 18 | 81.81 | 13 | 72.22 |
| SOUTH | 9 | | 2 | 22.22 |
| Dense Forest | 4 | 44.44 | 1 | 25.00 |
| Open Forest and Others | 5 | 55.55 | 1 | 20.00 |
| TOTAL | 557 | | 460 | 82.58 |
| Dense Forest | 352 | 63.20 | 288 | 81.81 |
| Open Forest and Others | 205 | 36.80 | 172 | 83.90 |

Brazil's forest cover corresponds to 14,5 per cent of the world's forest cover.
Source: FUNATURA 1995 - adapted by STCP

Crossing data related to the total forest area (**Table 1**) with data related to the 1996 population estimated in the Brazilian Institute of Geography and Statistics (IBGE – *Instituto Brasileiro de Geografia e Estatística*) 2001 Census makes it possible to visualise the estimates of forest cover per person, in terms of region.

**Table 2 - Total Brazilian Population (Inhabitants) 1970-2000**

| Year | 1970 | 1980 | 1991 | 2000 |
|---|---|---|---|---|
| Total | 94,508,583 | 121,150,573 | 146,917,459 | 169,590,693 |
| Urban (%) | 55.9 | 67.6 | 75.6 | 81.2 |
| Rural (%) | 44.1 | 32.4 | 24.4 | 18.8 |

Source: IBGE - Demographic Census - 1970, 1980, 1991, 2000

On the one hand, there is the North Region, which presents the highest relation, of 31.7 ha of forests per inhabitant, followed by the Midwest Region, with 9 ha per inhabitant. On the other hand, there are the most densely populated regions (**Table 2**), with a scarce forest area per inhabitant: 0.35 ha per inhabitant in the South Region, and 0.30 ha per inhabitant in the Southeast Region. The Northeast Region is in between, with a little over 1.6 ha of forest per inhabitant. The population data used for comparison were those of 1996 because they reflect a time relation more closely aligned with the remaining forest cover per region reported in 1995. If the population data used for comparison had been that of the 2000 Census, forest cover areas per inhabitant would be a little smaller, since the population grew during that period while the forest area was reduced.

Table 2 shows the evolution of the demographic density during the 1970-2000 period, per region. In 2000, the smaller regions - Southeast and South - had the highest population density: 78.2 and 30.7 inhabitants/km$^2$, respectively. The North Region, which occupies the largest portion of the Brazilian territory, presented the lowest population density: 3.3 inhabitant/km$^2$. In spite of this low population density, the Amazon has been presenting the highest rates of gross deforestation in the past few years in relation to the other regions in the country.

The forest has been historically seen as an obstacle for the establishment and development of human populations, creating a philosophical conflict for man. The Amazon is, beyond comparison, the region in which this dependence and this conflict have manifested themselves more explicitly.

Deforestation in Brazil began in the 16th Century in the Brazilian coast and was associated with sugar cane plantations and sugar-mill operations. It then moved inward, towards the country's inland, with the mining cycle initiated at the end of the 17th Century. It provided timber for the mines and it opened space for cattle-ranching, closely linked to this cycle.

Once the Brazilian coast was occupied, deforestation moved southeastward, with the introduction of coffee plantations. This type of culture occupied lands mainly in the State of Rio de Janeiro, in the Paraíba River Valley and the São Paulo Plateau, advancing, finally, towards the fertile lands of the northern State of Paraná. After that, it expanded towards the South Region, linked to the exploitation of the rich Araucarian forests. And, finally, during the second half of the 20th Century, deforestation reached the Amazon with the occupation frontier expanding towards the North Region, encouraged by the construction of long roads and great public and private colonisation projects.

In the South and Southeast Regions, the deforestation process is relatively stable, although there is still pressure to convert the remaining tropical forest areas located in the Atlantic slope. In the Northeast Region, pressure for the conversion of new areas comes from the demand for timber to be used as a source of energy. It should be noted, however, that the *Caatinga* forest formation has a great regeneration capacity.

During the decades of 1970-80, tax incentives granted for agricultural and cattle-ranching activities originated an extensive deforestation process in the Amazon Region, a process which continued even when the incentives ceased to be granted.

The Amazon historiography mentions the use of wood in the region, specially for the construction of civil and military buildings and boats, but until the 1960s, wood was really not a relevant product in the region from the economic point of view. Contrary to what happened during the sugar and the mining cycles, in which timber was essential for sugar-mill operation and mine construction, because of their inherent peculiarities the Amazonian products cycle was not associated with a demand for a large quantity of wood. And, until the construction of the Belém-Brasilia highway, regional agriculture did not exert alarming pressure on forest cover.

Wood only became the main extraction product in the Amazon Region from the 1970s on, with the construction of large roads. In 1980, the value of extractive wood represented 55 percent of the total value of regional extractive products at a time when vegetation extraction represented just 23 percent of the agricultural and cattle-ranching sector's regional income (SILVA, 1996).

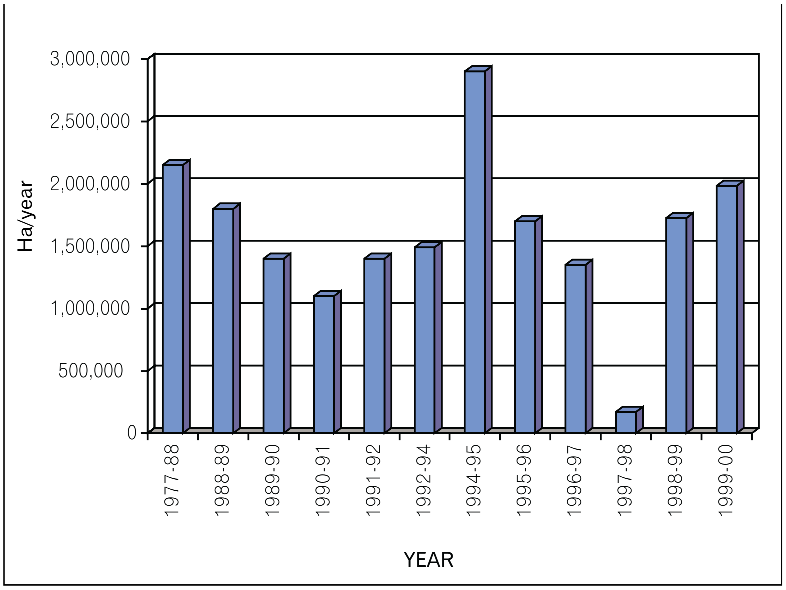
The direct impact of deforestation reflects on the reduction of forest cover; it has been influenced by human presence and past governmental policies in many ways and on different levels. They prioritised to alternative land uses inconsistent with the region's developmental vocation. **Figure 1** shows the reduction of forest cover in the Amazon during the 1977-2000 period (the series data can be found in Annex 2) (INPE 2002).

In the late 1970s and during the first seven years of the following decade, the gross deforestation rate in the Amazon was, in average, over 2 million hectares. In the late 1980s and during the first year of the following decade, there was a declining trend in the deforestation rate. During the 1990s, the rate reached 0.81 percent, in 1994/1995. Coincidentally, during this decade, due to the *Plano Real*, the country had the highest investment rates, indicating that there is a high correlation between deforestation and economic investment.

The average deforestation rate has been around 17,000 km$^2$ per year, and the removal of vegetation occurs more intensely around the "Deforestation Belt", a continuous stretch of land about 3,000 kilometres long and up to 600 kilometres wide, totalling approximately 1.7 million square kilometres (INPE, 1998). Additionally, between 1978 and 1994, about 75 percent of deforestation occurred within a stretch of 100 kilometres of extension along the region's paved roads (50 kilometres at each side). Between 29 and 58 percent of the forests within this stretch of land were deforested by 1991 (Alves, 1999; Nepstad et al., 2000; 2001).

During the second half of the 1990s, the rate decreased and remained relatively stable, except for the last year (1999), when it started to peak again, nearing the 2 million hectares level reached in the 1970s. IBGE's "Sustainable Development Indicators", published on June 19, 2002, showed that the

**Figure 1 - Average Gross Deforestation rate in the Amazan**




deforestation rate in the Amazon increased from 0.37 percent of the remaining area in 1991/1992 to 0.48 percent in 1998/1999. However, the Amazon Forest's preliminary monitoring report by satellite carried out by the National Institute for Space Research (INPE – *Instituto Nacional de Pesquisas Espaciais*) shows a reduction of 13 percent in the deforestation rate in the Amazon compared to 2001. According to this report, 43 municipalities are responsible for 70 percent of the deforestation registered in the 1998-2001 period.

Up until 1985, deforestation in the Amazon was strongly linked to the policies encouraging agricultural and cattle-raising activities. Thousands of hectares of forests were replaced by agricultural plots and pastures of little productivity. The idea that the civilising success in the Amazon should be based on agriculture - set in the first public policy for the region - would become the main guide of governmental actions in the sense of effectively populating the area for thirty years, that is, in the period extending approximately from 1955 to 1985.

At the national level, the mean deforested area per year in the 1990-2000 period was of 2.3 million hectares (**Table 3**), taking into consideration native and planted forests combined.
Increased deforestation had several impacts, among which the following can be emphasised:

**Table 3- Change in forest area in Brazil: 1990-2000**

| Type | Area 1990 (ha) | Area 2000 (ha) | Annual Change (ha) | % of annual Change |
|---|---|---|---|---|
| Natural | 560,798,000 | 538,923,000 | -2,187,500 | -0.39 |
| Planted | 6,200,000 | 4,982,000 | -121,800 | -1.96 |
| **Total** | **566,998,000** | **543,905,000** | **-2,309,300** | **-0.41** |

Source: FAO - 2000

- reduction in the forest potential capable of contributing towards the regional socio-economic development;
- reduction of biodiversity;
- increased carbon dioxide emissions;
- soil degradation; and
- loss of water quality.

Another impact directly derived from deforestation is the increased number of forest fires. From June to December 1998, 107,007 fire spots were registered in the Amazon; during the same period of 1999, there were 107,242 forest fires registered; in 2000, also from June to December, 104,122 fire spots were registered. And in 2001, there were 145,708 forest fires registered in the region (IBAMA-PROARCO, 2002).

The Brazilian Forest Code classifies the forests in three categories regarding their use:

- Permanent Preservation Forests;
- Restricted Use Forests; and
- Unrestricted Use Forests.

In the first case, the areas are untouchable as for the direct use of any of their resources - except when permitted by the Public Power due to social interest. In the second case, the use of forest resources is subject to restrictions specified in the federal legislation - for each region, and by state and municipal legislations - for each region, locality or species. And in the third case, the land owner has free use of the forest, although tree-felling depends on IBAMA´S Authorisation.

By defining these three forest categories, the law establishes preliminary zoning of the land use, once it makes the distribution of these categories in terms of property clear.

Up until the end of the 1960s, the main source of wood supply for the forest-based sector came from native forests. By the end of that decade, the area of planted forests corresponded to a little over 500,000 hectares. Nevertheless, the largest portion of the volume of wood originated from these forests was destined to the steel industrial park and to the generation of energy for locomotives. Except for the South, the country's forest industrial park was still very shy.

In 1965, the new Forest Code was

promulgated; in 1966, tax incentives for reforesting were established; and in 1967, the Brazilian Institute for Forestry Development (IBDF – *Instituto Brasileiro de Desenvolvimento Florestal*) was created. These three events marked the definition of a new Brazilian forest policy, that of large-scale reforesting.

Following the encouragement to reforesting programme, the Federal Government launched two other programmes in the 70s which would consolidate the Brazilian forest sector: the National Paper and Cellulose Programme and the National

Programme for Vegetal Charcoal-Based Steel Industry. The latter aimed at promoting self-sufficiency in the steel industry by using vegetal charcoal; the former, the country's self-sufficiency in cellulose and paper. These three programmes have enabled the consolidation of the forest-based industry, already established in the 1980s. Concomitantly, tax incentives were granted for conversion of forest lands in the Amazon, bringing the wood processing industry using native qualities to the region.

The forest-based sector, which turns over approximately 300 million cubic metres of roundwood per year (**see Table 4**), is structured in five large sub-sectors:

- cellulose and paper;
- mechanically processed wood;
- furniture and furniture components;
- vegetable charcoal; and
- firewood for domestic consumption, grain drying and varied energetic purposes.

These sub-sectors are supplied by forest raw material originated from planted and native forests (deforested areas or those under forest management). However, there is a sub-sector – extraction – whose economic results are not aggregated to the forest-based sector statistics as a whole. The available statistics from the vegetation extraction sector annually appropriate the physical production of 53 products and the value of this production based on the price paid to the producer, raw material *in natura*, therefore.

The forest-based industry is composed of 255 cellulose and paper plants belonging to 220 companies and distributed among 16 states; about 7,000 primary and secondary wood processing units, mostly in the Amazon; 110 steel industries using vegetal charcoal, mainly concentrated in the State of Minas Gerais; 13,500 furniture and furniture component industries, of which: 10,000 are micro businesses (up to 15 employees), 3,000 are small businesses (between 15 and 300 employees) and 500 are medium businesses (over 150 employees), most of them located in the Southeast and South Regions (BRACELPA, 2002, ABIMOVEL, 2002, SBS, 2002; STCP, 2002).

The Brazilian forest sector presents significant importance and a contribution to providing better dynamics to the country's economy. Although expressive at the national level, the economic response is still far below its potential. In Brazil, forest exploitation and its chain of production, industrialisation and trade annually generate a revenue of over US$ 28 thousand million, which represents approximately 4.5 percent of the Brazilian GDP. This sector reached the position of second largest industrial exporter in the country. With an annual surplus of US$ 4.5 thousand million, it pays a net value of US$ 4.6 thousand million in taxes, and it uses over 6.7 million people as labour force, both directly and indirectly.

The set of products generated by forest sector distinct sub-sectors – extraction included – is originated from a native and planted forest resource base. Planted forests are mainly composed of Eucalyptus and Pinus species, while native

**Table 4 - Consumption of roundwood in Brazil - 2000**

| Source of consumption | $10^3$ $m^3$ | Total % |
|---|---|---|
| Cellulose and Paper | 32,000 | 10.7 |
| Charcoal | 45,200 | 15.1 |
| Industrial Power | 29,000 | 9.7 |
| Mechanical Processing | 60,110 | 20.1 |
| Wood for several power purposes | 132,408 | 44.3 |
| **Total** | **298,718** | **100.0** |

Note: *Included: Agglomerate, Fiber Plate and MDF
Source: ABRACAVE, STCP, ABIPA, ABIMCI, BRACELPA, SBS, FAO - 2001

forests are composed of six great classes of vegetation formations, according to IBGE: Tropical Rain Forest (dense, open and mixed), Seasonal Forest (semideciduous and deciduous), Amazon White-Sand Woodland (*Campinarana*), Savannah (*Cerrado*), Steppe Savannah (*Caatinga*) and Steppe – described in Annex 1.

In 2000, the Brazilian production of roundwood was the world's third largest production, accounting for 300 million $m^3$. The national production was only smaller than that of the United States (about 400 million $m^3$) and China (about 320 million $m^3$).

The consumption of roundwood in 2000 is presented in **Table 4**, distributed among large consumer sources. It can be noted that the paper and cellulose sub-sector consumed approximately 11 percent of the wood produced during that year; vegetable charcoal accounts for 15 percent; mechanically processed wood (boards, laminates, plywood and panels), 20 percent; industrial energy, about 10 percent. Finally, the firewood sub-sector, with varied energetic means (mainly domestic consumption and grain drying) absorbed 44 percent of the wood produced during that year.

The expansion of the occupation frontier to the Amazon from the 1970s on generated a great supply of native forest wood, which caused a radical change in the configuration of the mechanically processed wood sub-sector's production. **Table 5** historic series allows a clear observation of the changes. While there was a gradual reduction in the Araucarian wood supply, there was also a growing increase in the offer of Pinus offer. But the changes in the profile of sawed wood production really occurred due to an increased offer of leafy trees, which in 2000 presented the equivalent of the triple of the coniferous tree wood production, while in 1971 the volumes were practically equivalent.

Table 5 - Brazilian production of sawn timber, per source ($10^3$ $m^3$)

| Year | Total Leafy | Coniferous | | | Total of Sawn Timber |
|---|---|---|---|---|---|
| | | Araucaria | Pinus | Total of coniferous | |
| 1971 | 3,440 | 3,505 | 0 | 3,505 | 6,945 |
| 1972 | 3,000 | 3,515 | 0 | 3,515 | 6,515 |
| 1973 | 3,115 | 2,975 | 0 | 2,975 | 6,090 |
| 1974 | 3,735 | 2,980 | 0 | 2,980 | 6,715 |
| 1975 | 4,550 | 2,755 | 0 | 2,755 | 7,305 |
| 1976 | 5,315 | 2,865 | 0 | 2,865 | 8,180 |
| 1977 | 5,905 | 2,655 | 0 | 2,655 | 8,560 |
| 1978 | 6,355 | 2,600 | 15 | 2,615 | 8,970 |
| 1979 | 6,450 | 2,030 | 55 | 2,085 | 8,535 |
| 1980 | 7,580 | 1,800 | 130 | 1,930 | 9,510 |
| 1981 | 8,140 | 1,280 | 200 | 1,480 | 9,620 |
| 1982 | 8,650 | 1,020 | 335 | 1,355 | 10,005 |
| 1983 | 8,905 | 630 | 385 | 1,015 | 9,920 |
| 1984 | 9,290 | 660 | 520 | 1,180 | 10,470 |
| 1985 | 9,330 | 410 | 700 | 1,110 | 10,440 |
| 1986 | 9,730 | 320 | 940 | 1,260 | 10,990 |
| 1987 | 9,530 | 395 | 1,235 | 1,630 | 11,160 |
| 1990 | 10,930 | | | 2,800 | 13,820 |
| 1991 | 12,200 | | | 3,500 | 15,700 |
| 1992 | 12,410 | | | 3,480 | 15,890 |
| 1993 | 12,620 | | | 3,720 | 16,340 |
| 1994 | 12,830 | | | 3,780 | 16,610 |
| 1995 | 13,230 | | | 3,950 | 17,180 |
| 1996 | 13,650 | | | 4,050 | 17,700 |
| 1997 | 14,250 | | | 4,250 | 18,500 |
| 1998 | 14,000 | | | 4,200 | 18,200 |
| 1999 | 14,400 | | | 4,500 | 18,900 |
| 2000 | 14,850 | | | 4,790 | 19,640 |

Source: STCP, ABIMCI, ABPM, SBS

As for the market for forest products, in spite of being one of the world's largest wood producers, Brazil has a modest position in the global market. According to FAO data (**Table 6**), Brazilian exports of forest-based products corresponded to US$ 5.2 thousand million in 2000, in a market turning over about US$140 thousand million per year. Nevertheless, this amount put the country in the twelft position in the forest products export rank. On the other hand, the country imported US$ 1 thousand million in the same year, ranking in the twenty-sixth position among importers. The profile of exports (**Table 7, excluding furniture**) shows that cellulose, paper and wood were the main items exported.

Table 6 - Export and import of forest products in Brasil - 2000

| Category | World position | Value (1,000 US$) | % World Total |
|---|---|---|---|
| Export | 12 | 5,218,431 | 3.70 |
| Import | 26 | 1,003,481 | 0.66 |

Source: FAO - 2000

Mahogany (*Swietenia macrophylla*), the country's most expensive wood, is an endangered species due to intensive and illegal extraction. The management plan is potentially one of the most effective tools for the sustainable use of mahogany in the region. One of the alternatives under study at IBAMA is a partnership with the National Indian Foundation (FUNAI – *Fundação Nacional do Índio*) to protect the illegally extracted mahogany in indigenous reserves and to avoid disloyal competition is to teach correct and sustainable ways for wood use to the indigenous peoples themselves.

Mahogany exploitation was forbidden in October 2001. Unfolded in boards for export and trade it is worth up to US$ 1,500 per cubic metre abroad. Transformed into furniture or other

**Table 7 - North Region - 2000**

| States Affected in 2000 Flood | Municipalities Affected | Dead | Injured | Affected / Unsheltered |
|---|---|---|---|---|
| Acre | 1 | – | – | 1,.304 |
| Amapá | 1 | 1 | 111 | 6,.384 |
| Roraima | 1 | – | – | 180 |
| Rondônia | 3 | – | – | 165 |
| Amazonas | 1 | – | 3 | 4,748 |
| **Total** | **6** | **1** | **114** | **12,781** |

Source: State Co-ordination of Civil Defence - CEDEC (only data informed to SEDEC/MI)

artefacts, it can reach up to US$15,000 per cubic metre. According to IBAMA, there were 22,263,989 m³ of mahogany logs and 3,417,043 of processed wood seized in 2001, totalling 25,681,032 m³ of mahogany wood. The environmental devastation caused by tree removal is too intense, reaching the point of destroying about 50 metres around each tree. Annually, over 120,000 m³ of mahogany coming from Latin America enters the international market, of which 76,000 m³ – or 60 percent of the global trade – are imported by the United States. According to data by the Trade Records Analysis for Fauna and Flora in International Commerce (TRAFFIC; 2000), the United States imported mahogany from eight Latin American countries in 1998, and 95 percent of these imports came from Brazil. Illegally exported mahogany will not enter the United States, according to an informal agreement among IBAMA – through its president – the U.S. Assistant Secretary of State and a dozen environmental NGOs whose headquarters are in the United States. The strategy is to set up a rigorous inspection at ports and to forbid the unshipping of all mahogany load from Brazil without a permit from IBAMA.

The long period of production, the extension and accessibility of forest areas, the extended time frame for return of the capital invested and the need for the creation of social services are characteristics of forest activity. Such characteristics end up transferring the responsibility over the direct administration of part of the forest resources, on one hand, and inspection and control over the use of the remaining part in the hands of

private owners, on the other, to the government, at its different levels. Compliance with these responsibilities, associated with the protection of the environment as a whole and, consequently, compliance with relevant legislation, requires institutions which are technically sound, materially equipped and administratively agile. The set of Brazilian public institutions involved with the subject (whether in the federal, state in the municipal sphere) have not been fully complying with these requirements. Neither has the direct administration of the conservation units been satisfactorily conducted during the past three decades, nor have the inspection and control over the use of the forest resources in the hands of private owners been adequate.

The institutions in charge of the co-ordination and execution of the environmental policy in Brazil have been presenting difficulties in expediting the forest resources management proceedings, for it can be noted that there is a significant increase in resource use, command and control actions; in the establishment of the conservation units, mainly in what concerns land delimitation and regularisation; in the creation of norms and regulations almost exclusively directed at restricting the use of forest resources, when it should consider the accumulated knowledge (technical, scientific and communal) on the best way to appropriate the forests assets and services on behalf of the communities' well-being.

The volumes of industrial wood, per segment of consumption and supply source (native and planted forest), are presented in **Table 8**. The data show that the paper and cellulose sector today is entirely supplied with wood originated from planted forests, mainly of Eucalyptus and Pinus species. Therefore, this is a sub-sector which does not exert pressure on the remaining native forests. The vegetalcharcoal-based steel industry has 3/4 of its raw material supply originated from planted forests, and products, mainly by industries in the region.

The complementary nature of forest activities in relation to cattle-raising activities should also be stressed, since it is one of the few economic alternatives that the rural producer has during drought periods, which are frequent in the Brazilian Northeast.

The diagnosis of the Forest Sector in the States of Paraíba, Rio Grande do Norte, Ceará and Pernambuco has identified a strong relation of dependence between regional development and forest resources. Most of the States in the Northeast Region present a reasonable rate of forest cover, and they can maintain this situation for a long time. However, the social effect of this rate is more worrisome, once 60 percent of the energy used by the Northeastern population to cook their food comes from firewood.

**Table 8 - Consumption of industrial timber in logs in Brazil - 2000 ($10^3$ $m^3$)**

| Product | Native | Planted | Total | % native |
|---|---|---|---|---|
| Cellulose and paper | 0 | 32,000 | 32,000 | 0.0 |
| Charcoal | 11,800 | 33,400 | 45,200 | 26.1 |
| Industrial wood | 16,000 | 13,000 | 29,000 | 55.2 |
| Sawn | 34,000 | 15,100 | 49,100 | 69.2 |
| Blade and Plywood | 2,050 | 3,960 | 6,010 | 34.1 |
| Restored Panels* | 0 | 5,000 | 5,000 | 0.00 |
| **TOTAL** | **63,850** | **102,460** | **166,310** | **38.4** |

*included: Agglomerate, Fiber Plate and MDF
Source: ABRACAVE, STCP, ABIPA, ABIMCI, BRACELPA, SBS - 2001

**Table 9 - Participation of wood in the energy matrix and industries dependent on forest resources in four states of the Northeast Region - 1993**

| State | Energy Matrix (%) | Industry (%) |
|---|---|---|
| Pernambuco | 23 | – |
| R.G. do Norte | 24 | 40 |
| Paraíba | 41 | 26 |
| Ceará | 32 | 28 |

Source: Project UNDP/FAO/IBAMA/BRA/87/007 IBAMA - 1998

the remainder still comes from remaining native forests. Since this sub-sector's industries are largely concentrated in the State of Minas Gerais, it exerts pressure mainly on native forests in the States of Bahia and Goiás, once the Forest Law in Minas establishes serious restrictions on the use of firewood material from native sources.

There are no recent studies on the Northeast Region, but data from 1993 show that firewood and vegetal charcoal are responsible, in average, for 30 percent of the energy matrix in the States of Pernambuco, Paraíba, Rio Grande do Norte and Ceará. In the State of Paraíba, it is the most used energy source, even more than electricity and petroleum by-products, accounting for a percentage of 41 percent of the energy matrix. In the States of Ceará, Rio Grande do Norte and Pernambuco, forest-based energy is second (IBAMA, 1998).

Biomass accounts, in average, for 35 percent of the energy used by the industries in the states, and firewood is the primary source (**Table 9**). For that reason, the future situation of the trade balance in the region's states is alarming, should this energy source be replaced (IBAMA, 1998).
It is undeniable that biomass-originated energy has a low cost which, associated with its capacity for renewal, contributes to increasing the demand for forest

As it was previously observed, the volume of wood destined to varied energetic means (mainly domestic consumption and grain drying) represents, at the national level, 44 percent of the annual Brazilian production of roundwood. Therefore, this is a pressure over the forest originated from participants (rural population and productive agents of the agribusiness) external to the productive forest activity.

The main impacts of forest production activities are associated with unsustainable practices of access to and use of forest resources, lack of adequate technologies, insufficient specific sectorial policies, dissonance between forest policies and other policies (agricultural, agrarian, industrial, environmental, etc) and the fragility of the institutions in charge of the subject– ranging from quantitative and qualitative insufficiency of material and human means, unstable budgets, insufficient wage levels, poor interinstitutional interaction, connection and administrative discontinuity to diverse political interferences.

The resulting direct impacts are reflected in inadequate forest exploitation, with poor use of firewood material; damage to the forest and remaining trees; losses to natural regeneration; and damage to the fauna, due to the overexploitation of some forest species which produce food.

On the other hand, unsustainable practices cause excessive pressure on some forest species due to selective exploitation, harming restoration of the stock level and the regeneration of higher commercial value species. This also leads to the underuse of potentially commercial volumes, generating unsatisfactory economic outcomes. Depending on the degree and form of exploitation, these unsustainable practices can jeopardise parts of ecosystems and even entire ecosystems.

At the end of the millennium, modern extraction in the Brazilian Amazon is a set of economic activities by organised

**BOX – Extraction reserves**

**The extraction activity has been a constant factor in the economic history of Brazil. Brazil inherited its name from the extraction of "Brazil Wood" (*Caesalpínia eclimata*), one of the first resources extracted from the Atlantic Forest. During the second half of the 19th Century, the occupation of the Amazon region was motivated by extraction, specially when approximately 400,000 households from the Northeast Region settled there to search for rubber (*Hevea brasiliensis*), the growing demand for which in the United States and Europe required a fast increase in production. This was the so-called "rubber cycle", which had its peak in the turn of the 20th Century and fell into decay around 1920.**

**During World War II, rubber extraction was again promoted and thousands of households from the Northeast Region were transported to rubber forests. When the war was over, the government sought to maintain a policy to promote rubber extraction with financing lines for trading and processing. Rubber extraction has always been related to the extraction of nuts (*Bertolletia excelsa*), which happens in the same areas, the first, in the less rainy period (from May to November), and the latter in the more rainy period (December to March).**

**For 20 years – from 1965 to 1985 – Brazil put in practice a policy of occupation of the Amazon and expansion of its agricultural boundaries, de-structuring the existing extraction in several regions, such as in the State of Pará, where the richest Brazil-nut forests in the country were cleared, or in the State of Rondônia, where rubber and Brazil-nut forests disappeared in the areas surrounding the BR 364 road. Several extraction areas also disappeared in the States of Mato Grosso and Maranhão, where the babassu palm (*Orbygnia martiana*) is mainly explored. In the State of Acre, in the municipalities of Rio Branco, Sena Madureira, Plácido de Castro, Senador Guiomard, Xapuri, and Brasiléia, many rubber groves were transformed into cattle pastures or abandoned. On the other hand, considerable land extensions where rubber-tappers lived were purchased by the Federal Government for Agrarian Reform plot distribution. On that occasion, many rubber-tappers were expelled and started to look for new areas. Thus, they settled in abandoned rubber groves or in government-owned land.**

**The conflicts between farmers and rubber-tappers attracted the attention of the public, specially after the death of the Brasiléia Rural Workers' Union Chairman, Wilson de Souza Pinheiro, in 1978, and the murder (committed by farmers) of Xapuri Rural Workers' Union Chairman, Chico Mendes, in 1988. In 1985, rubber-tappers had their First National Meeting in Brasilia, and then requested the end of rubber forest colonisation and that those lands be given to them as concessions, so extraction could be maintained. Such request also aimed at the land issue and the protection of the forest against deforestation threats to implement cattle-raising activities.**

**This rubber-tapper meeting is the historical mark that made official the request for the creation of "Extraction Reserves"official. It is also important to emphasise that in 1985 the National Plan for Agrarian Reform was launched in Brazil and attention was called to the issue. The proposal for the creation of Extraction Reserves was interpreted as "Agrarian Reform" by extraction workers.**

**From the first meeting of rubber-tappers, the National Institute for Colonisation and Agrarian Reform – INCRA (*Instituto Nacional de Colonização e Reforma Agrária*) was again concerned about the problem. Then the agency proposed as a solution, through Administrative Rule no. 627 of 30 July 1987, the creation of the Extractive Settlement Project – PAE (*Projeto de Assentamento Extrativista*) as a solution. Until April 1994, 10 extractive settlement projects were created: five in the State of Acre, three in the State of Amapá and two in the State of Amazonas, totalling 889,548 hectares. The Federal Government also made progress by making Extraction Reserves legal at the environmental national policy level, enabling their creation through Law no. 7,804 of July 18, 1989, ruled by Decree no. 98,897 of January 30, 1990. According to that legislation, the institution responsible for reserves is the Brazilian Institute for the Environment and Renewable Natural Resources – IBAMA.**

social groups, which does not exclude technology incorporation, nor product transformation and value-adding. The view of "Multiple Use of the Forest" includes agricultural and pastoral farming, extraction and forestry activities, reaching not only productive processes, but also transformation and commercialisation processes. Therefore, there is not an extractionactivity involving the collection of one product only. This search for new economic alternatives is the main characteristic of modern extraction and, among them, the addition of value on extraction products has deserved a special attention, by primary processing at production sites.

The large diversity available in the forests makes management and extraction of products and services viable, with economic possibilities such as timber, phytotherapy products and cosmetics, fauna management, fishing potential, forest seeds, ecotourism, craftsmanship, environmental services (generation and purification of water, carbon dioxide absorption...). There are already extractive activities of products such as: rubber, Brazil nut, assai, palm heart, peach palm, cupuaçu (*Theobroma grandiflorum*), rice, banana, cassava flour, bean, corn, sweet potato, yam, vegetables, fruits (avocado, sweetsop, Barbados cherry, bacaba (*Oenucarpus bacaba*), cocoa, hog plum (*Spondias lutea*), cashew, coconut, guava, graviola (*Annona muricata*), orange, lime, mango, nance (*Byrsonima crassifolia*), watermelon, milpesos palm, umari (*P. paraensis*), annatto (*Bixa orellana*), uxi (*Endopleura uchi*)), chicken, ducks, pigs, cattle, game meat, craftsmanship, honey, copaiba (*Copaifera Langsdorffii*), andiroba (*Carapa guianensis*), vine, straw, firewood/ wood for fences, corrals, chicken yards, pigpens, canoe utensils.

These products obtained by the 2,900 households living in the extractive reserves generated from 1995 to 1999 a revenue of R$41,750,081.00 or R$239.00 per household/ month (National Centre for the Sustainable Development of Traditional Populations CNPT 1999).

From the acknowledgement that non-timber extractivism is one of the safe alternatives for the use and conservation of Amazon natural resources, and that rubber is the product with greatest economic and social interconnectivity, TECBOR was created. This project proposes an alternative technology for Amazonian rubber production and it was designed by in a partnership involving the University of Brasília Chemistry Laboratory – UnB/LATEC, the National Centre for the Sustainable Development of Traditional Populations – IBAMA/CNPT (UNDP Project BRA 95/ 029), the Secretariat for the Co-ordination of the Amazonian Affairs – MMA/SCA, the National Council of Rubber-tapers – CNS and the Amazon Working Group – GTA (UNDP Project BRA 96/012).

This technology allows the rubber-taper to prepare a processed product, using simple techniques and materials, which do not require electricity nor harm human health or the environment, but result in an already processed product within their own household unit, avoiding middle-men and the processing plant. The final product is the Liquid Curing Leaf (FDL - *Folha de Defumação Líquida*) type, which is already an industrial raw material. Among the advantages of this technology, the producer associations (means by which the rubber is sold) emphasises the co-operation mood that increases community organisation. The FDL technique also offers good technical characteristics and advantages of its industrial use. The increase in income may make rubber-tapers' permanence in the forest viable, so they can preserve their activity area as well as local genetic resources and their own culture. TECBOR Project's goal is to reach the most distant groups of rubber-tapers who have few income options and are settled mainly in the Amazon, in difficult financial conditions due to the low demand for national rubber.

The resulting emissions of fossil fuel burning generate, for example, immediate local impacts resulting in breathing problems, destruction of plantations and material deterioration. These same emissions also contribute to the aggravation of problems felt in a global scope such as the increase of the greenhouse effect. Similarly, the emission of some gases also contributes to the aggravation of problems such as the decrease of the ozone layer, a problem with global effects.

## 1. Main Atmospheric Pollutants and their Impacts on Living Beings

Thermal plants, petrol refineries, steel industries and cement factories emit great amounts of gases into the atmosphere. Automobiles also throw an infinity of quite harmful gases into the atmosphere, as for example, carbon monoxide and dioxide, sulfur dioxide and the gaseous hydrocarbonates.

In short, atmospheric pollutants are substances that, in result of their abnormal concentrations, can turn the air dangerous to living beings' health, harmful to fauna, to flora or to materials. They may appear straight into the atmosphere, from the emissions of these substances, or indirectly, through chemical reactions in the atmosphere. Such reactions loccur due to the concentration increase of certain gases.

The pollutants cause degradation of air quality when present in amounts superior to the absorption capacity of the environmental. Thus, the amounts of pollutants present in the air pay direct influence in its quality. However, at local level, the magnitude of their emissions is not the only decisive factor of air quality. The interaction between the pollutants and the atmosphere, considering the meteorological variables which will influence in the dilution capacity of these pollutants in the air, also contributes to the definition of air quality level in a region.

There is a quite high group of gases that, under certain conditions, may be classified as pollutants, or that may contribute to its formation. Among those which cause the greatest environmental problems in the atmosphere, at local extent, the carbon monoxide (CO), sulfur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), troposphere ozone ($O_3$) and particulate materials should be pointed out.

Carbon monoxide is a gas that originates mainly from the incomplete combustion of fossil fuels. The main sources are automobiles because optimum combustion conditions are not always obtained. This gas is classified as of systematic suffocation, because it is a substance which harms the oxygenation of tissues. High levels of carbon monoxide are related to mental confusion, reflex damage, unconsciousness, brain functions stop and, in extreme cases, death (CETESB 1999).

Sulfur dioxide originates mainly from processes in which there is oil fuel burn, coal burn and in Diesel engines. In the living beings, high levels of the gas cause breathing discomfort, and the aggravation of breathing and cardiovascular problems, as well as it may lead to the formation of acid rain, causing several effects on the environment (CETESB 1999).

Nitrogen dioxide mainly comes from combustion processes in vehicles, in industries and in thermal plants, which use oil fuel or natural gas. In living beings, high gas concentrations are associated to problems such as asthma, bronchitis and low resistance to breathing infections. High concentrations of nitrogen dioxide may also lead to the formation of acid rain (CETESB 1999).

Troposphere ozone is not emitted directly into the atmosphere; being produced photochemically by solar radiation on the nitrogen oxides and volatile organic compounds. Therefore, it originates mainly from automobile exhaust gases and from industrial pollution, and found in larger concentrations in urban areas. The gas is also a consequence of vegetation burns when, its concentration rises, reaching high levels, particularly in regions such as the Amazon.

Ozone is a gas that presents several functions, according to the altitude it is at. In the troposphere it behaves as a toxic gas, which in high concentrations is harmful to living beings and to man in particular, causing eye irritations and a series of breathing problems. Besides, high concentrations of ozone can also result in damages to plantations and to the natural vegetation (KIRCHHOFF 1989).

**Box 1**

- **Studies developed in São Paulo indicate a 30 percent increase in the number of deaths caused by respiratory diseases in children under the age of five. This could be related to an increase of 75mg/m3 in the concentration of nitrogen dioxide (WHO, 2000).**

- **Also in São Paulo, a study developed by the State Secretariat of Health in partnership with the University of São Paulo and the Technology and Environmental Sanitation Company of the State of São Paulo (CETESB), demonstrated that 10 percent of hospital stays for respiratory diseases for children and nine percent of deaths for the elderly are related to the high atmospheric concentrations of particle material (FREITAS, 2002).**

- **The estimated number of deaths caused by problems stemming from atmospheric pollution in the world is around three million. This number represents five percent of the total of 55 million deaths that occur annually in the world. (WHO, 2000).**

- **In some populations around 30 to 40 percent of asthma cases and 20 to 30 percent of all respiratory illnesses are related to atmospheric pollution (WHO, 2000).**

- **In some populations, a reduction of 20 percent in air pollution in the air in closed environments could reduce the mortality rates related to severe respiratory infections by at least four to eight percent. (WHO, 2000).**

Under the denomination "particulate material" the pollutants are joined by "total suspension particles", " inhalable particles " and "smoke." They are particles of solid or liquid material, which are suspended in the air in the form of dust, fog, aerosol, smoke, soot etc. The main sources of these substances are thermoelectric plants, steel industries, burnings, diesel vehicles, cement factories and some branches of the chemical industry. The resulting effects from the increase of these pollutants concentration include breathing problems such as asthma and bronchitis. Besides, such pollutants may cause damages to vegetation, reduction of visibility and soil contamination (CETESB 1999).

## 2. The Ozone Layer Reduction Problem

During the 70's and 80's, several studies alerted for a possible reduction of the ozone layer, and consequent increase in the ultraviolet radiation incidence. At the beginning, the problem was diagnosed in the Southern Hemisphere, particularly over the Antarctic, where a large rarefaction ("hole") in the concentration of ozone was identified. Subsequently, the same phenomenon was observed over the Arctic[1]; however, in smaller intensity.

In Parallel, studies demonstrated that certain substances produced by man and which contained chlorine (Cl) and bromine (Br), when in contact with the stratospheric ozone, contributed to its exhaustion. The main groups of such substances are the CFCs, the molecules at which would be degraded by solar radiation in high atmosphere, releasing chlorine atoms, which, would then react with the ozone, destroying it.

Other ozone destructive substances are the haloes, carbon tetrachloride, methyl chloroform, hydrofluorocarbons (HCFCs), hydro bromofluor carbons, brome chloromethane and methyl bromide. Such substances are widely used in air-cooling systems, as aerosol propellants, in foam production and use of solvents, and in equipment for fire extinction, among other uses.

In order to avoid worsening the problem, in 1977, the United Nations Program for the Environment (UNPE) co-ordinated a meeting of specialists from several countries. In 1981, UNPE created a work group with the main objective of establishing bases for the organisation of a global convention, aiming at fighting the causes of ozone layer reduction. The Vienna Convention, as it became known, was held in 1985 and it was ratified by approximately 30 countries, which were committed to adopting appropriate measures to protect human health, and the environment from the negative effects of the ozone layer reduction. The adoption of a series of tools was also established, aiming at facilitating the co-operation in research, and information exchanges on the production and consumption of ozone

[1] In these regions the cold atmosphere and the presence of polar clouds that retain a certain amount of reactive substances make the problem more serious, as discussed in the following text. These substances are particularly those that contain chlorine and bromine. The destruction of the polar ozone layer is accelerated by atmospheric circulation that transports these substances from the tropics to the poles.

destructive substances.

The Vienna Convention created the bases for discussion and negotiations that followed until the signature of the Montreal Protocol on Substances which Destroy the Ozone Layer in 1987. The Montreal Protocol, in particular, defined a list of substances with ozone layer destruction potential (SDOs or Controlled Substances) and it established deadlines for the reduction of production, commercialisation and consumption of such substances. Besides, developed countries committed themselves to facilitating the access of developing countries to substances and alternative technologies that do not harm the environment, co-operate in the promotion of research and facilitate information exchange.

Since 1987, the Montreal Protocol has been going through adjustments and it has been incorporating amendments based on annual meetings (Meetings of the Parties), among which, London (1990), Copenhagen (1992), Vienna (1995), Montreal (1997) and Beijing (1999) are highlighted. Based on these meetings, increments have been made to the list of Controlled Substances, and alterations have been promoted within the deadlines for the elimination of production, commercialisation and consumption of these substances. It is also worth pointing out the creation of the Multilateral Fund for the Implementation of the Montreal Protocol (MFMP) in 1990, which was established to promote technical and financial help to developing countries, based on contributions from developed signatory countries.

Besides directly affecting the living beings, eventual reductions in the stratospheric ozone concentration may also cause alterations to the Earth's temperature and in the atmospheric gas circulation pattern. The combination of these effects influences the ecosystem balance, which may even result in negative aspects for plantation productivity.

## 3. The Greenhouse Effect Increase Issue

Since the beginning of the 20th Century, human possible influence on the climatic system has been observed, but mainly since mid 50´s, scientists have been collecting evidence and publishing articles which relate the increase of the atmospheric concentration of GHG (largely due to the gross increase of demission flow, due to human activities) to the of the planet in the average temperature increase; in other words, to global heating and other alterations in the climatic system. However, only from the 80's, climatic change would raise the attention of a larger and significant number of scientists in the international community.

In fact, by the end of that decade, the concern on the possible change in the climatic system operation pattern was intensified, and consequently, in June 1988, the World Conference on Atmospheric Changes, "The Changing Atmosphere: Implications for Global Security," held in Toronto-Canada, during which the adoption of an international convention on climatic change was suggested.

A historical landmark was the institutional innovation brought by the United Nations Program for the Environment (UNPE) and by the World Meteorological Organisation (WMO), when creating, in November 1988, the Intergovernmental Panel on Climatic Change; a work group in charge of backing up, technically and scientifically, the negotiations of this treaty.

The need of such panel was based on the acknowledgement of the enormous complexity of climatic system, the high risk raised by climatic change and the need of an objective source of technical, scientific and socio-economic information on causes and impacts of climatic changes, as well as possible response measures, including the comparison of costs and benefits of action against inaction. This panel, globally known as IPCC (Intergovernmental Panel on Climate Change), is constituted of scientists from several countries and knowledge areas, and organised in three working groups, which work on three different but complementary fronts, besides a “task force” on the greenhouse effect gases. The first group, known as Working Group I (WGI), studies the scientific aspects of the climatic system and climate change. The second - Working Group II (WGII) assesses the vulnerability of humanity’s and natural systems to climate changes, their positive and negative consequences and the necessary adaptation options to these consequences. The third group or Working Group III (WGIII) analyses the limitation possibilities of GHG emission and of climate change mitigation and its consequences, measured from a socio-economic point of view.

During May 1992, and February 1991, representatives from more than 150 countries met five times to negotiate the convention text. On May 9, 1992, the UNFCCC- *United Nations Framework Conference on Climate Change* [2] was approved in the United Nations Headquarters, in New York. Some days later, at UNCED - United Nations Conference on the Environment and Development (which took place in Rio de Janeiro in 1992, and for this reason is known as Rio-92), 154 countries and the European Economic Community signed the Convention, which had Brazil as the first signatory country.

The UNFCCC was implemented on March 21, 1994, 90 days after the presentation of the fiftieth ratification held at national level, which demanded the parliament’s approval. In Brazil, the was ratified by the Congress on February $28^{th}$, 1994, and was implemented 90 days after this date, in other words, on May 29 of the same

year. Until the conclusion of this work, 186 countries had become Parties of the Convention.

The Conference of the Parts (COP), the supreme agency of the Climate Convention, composed of all signatory countries, had its first session in 1995, in Berlin. In the Conference Parties third meeting, which took place in Kyoto, in December 1997, the Kyoto Protocol was adopted. At that time, developed countries committed themselves to reducing their collective emissions of greenhouse effect gases, 5.2 percent on average, in the period from 2008 to 2012, regarding the emissions in 1990. In the following conferences, held in Buenos Aires (1998), Bonn (1999) and the Hague (2000), the Buenos Aires Plan of Action, agenda was discussed and they tried to conclude it, which regarded the complementary regulation of a series of articles from the Kyoto Protocol, including the so-called flexibility mechanisms. The Rescheduled Session of COP 6, which took place in Bonn, early 2001, as well as the COP 7, held in Marakesh in November of the same year, achieved the conclusion of the referred agenda, and opened way so that the Kyoto Protocol could be forwarded by the Parties to their national Congresses, for ratification.

The Main GEG, also of human origin are the carbon dioxide ($CO_2$), the methane ($CH_4$) and the nitrous oxide ($N_2O$), the Chlorofluorocarbons (CFCs), Hydro fluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulfur Hexafluoride ($SF_6$), the atmospheric concentrations of which have been increasing seriously, due to certain human activities.

[2] According to Pereira (2002), the term framework means “The work of framing, or completed construction” - and that, therefore, it transmits a continuity idea in a process/work . In this specific case, it concerns the climate regime negotiation. It is worth observing that the term “quadro” , used in the official translation into Portuguese (the Science and Technology Ministry and the External Relation Ministry) does not mean this idea.

## 4. Brazil and the Climatic Change Convention

Due to the size of its economy and population, Brazil can be classified as an important GEG originator. However, the UNFCCC principle of common, but differentiated responsibilities must be remembered, and also the division among the Parties – Annex I and Non Annex I, which determines that industrialised countries should take the initiative in fighting the problem, and recognising the right of developing countries, such as Brazil, to increase its emissions in a first moment, due to its small responsibility on the problem. Besides, considering its own specificities, Brazil has low levels at emission of GHG per GDP and / per capita / -it. It is important to point out that Brazil is one of the countries which most contribute to fight the aggravation of climate change global risks, considering the heavy weight of renewable sources in its energy matrix, and highlighting the predominant participation of hydroelectric generation and of programmes like PROÁLCOOL, thanks to which the country has been avoiding the emission of great amounts of greenhouse effect gases into the atmosphere.

Brazilian emissions of all *Greenhouse Gases* - GHG. will be published in the inventory of human by emission source and of removal by drain. This work is co-ordinated by the Science and Technology Ministry (MCT), and it is part of the National Communication, a commitment made at the level of the United Nations framework conference on Climatic Change.

**Table 1 - $CO_2$ Emissions by light vehicles**

| Emissions | Without allowing for the renewable share | | | Allowing for the renewable share | | |
|---|---|---|---|---|---|---|
| mil t $CO_2$ | Gasohol | Alcohol | Total | Gasohol | Alcohol | Total |
| 1990 | 18105 | 11382 | 29487 | 15237 | 0 | 15237 |
| 1991 | 20324 | 11828 | 32153 | 17105 | 0 | 17105 |
| 1992 | 21806 | 10962 | 32768 | 18352 | 0 | 18352 |
| 1993 | 24634 | 11459 | 36093 | 20732 | 0 | 20732 |
| 1994 | 29380 | 11372 | 40752 | 24726 | 0 | 24726 |

Source: http://www.mct.gov.br/clima

The emission calculation methodology in the Brazilian inventory is based, in general, on the methodology defined by IPCC. Several specialists and institutions of the energy, industry, forest, farming and residue treatment sectors, located in all regions other country, participate in this work. Some groups have already concluded their work and the preliminary results are available in the MCT / *web site*. Other works are being finalised.

The deadline for the presentation of the National Communication of Brazil has already passed, and the reasons given by the MCT for this delay are related to the country's large territorial extension, and the insufficiencyof financial resources supplied of the Convention level, for carring out the inventory. Besides, IPCC methodologies aften do not apply to the Brazilian specificities, which forced some Brazilian specialists to develop more detailed methodologies.

In cases where the preliminary results of the inventory's were still not published, one has to count on the literature available, although precarious and temporary. That information will provide an idea of the relative importance of each source.

The inventory is separated into six modules, which correspond to the structure of calculations adopted in IPCC methodology:

- Use of Energy,
- Industry,
- Solvents,
- Agricultural and Cattle - ranching Sector,
- Change in Land and Forest Use, and
- Residue Treatment.

CO2 is the main greenhouse effect gas because it is emitted in larger amount in relation to the other; therefore, most of the studies focus on the problem of that gas concentration. It is noticed now, however, a greater effort towards the effects of CH4, which mainly result, from the decomposition of organic matter; and of $N_2O$, where emissions the effects of which come from the use of nitrogen fertilisers and

[3] For further information see http://www.ivig.coppe.ufrj.br/arquivos/f-efeito percent20estufa.pdf

from some industrial processes. A study carried out by COPPE/UFRJ, for the Rio de Janeiro Municipal secretariat for the Environment in 2000[3], shows the energy use possibility of methane produced in the leakage deposits and garbage landfills, from its direct incineration. This initiative is important because, although the emissions of methane are smaller than the CO2 ones, a tonne of this gas has Global Warming Potential (GWP) 21 times higher than a tonne of CO2. Besides, the energy use of CH4 contributes to the reduction of the electric power deficit risk in the system.

**Figure 2 – CO2 emissions from fossil fuels in the energy system**

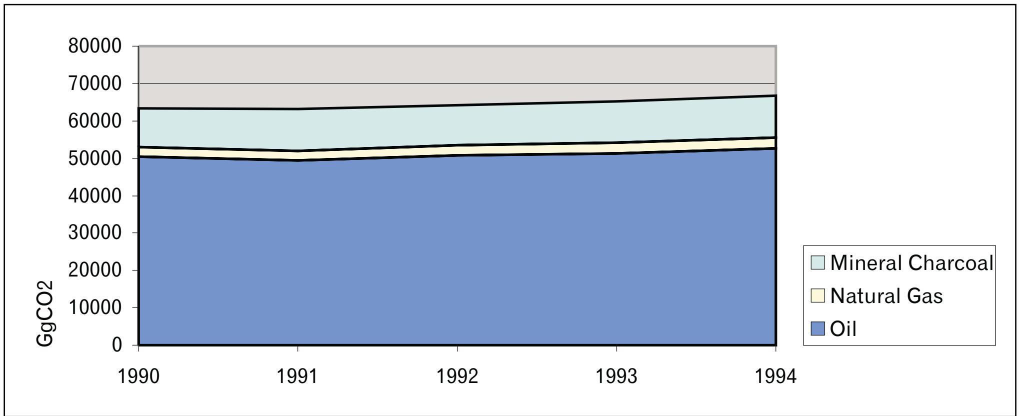
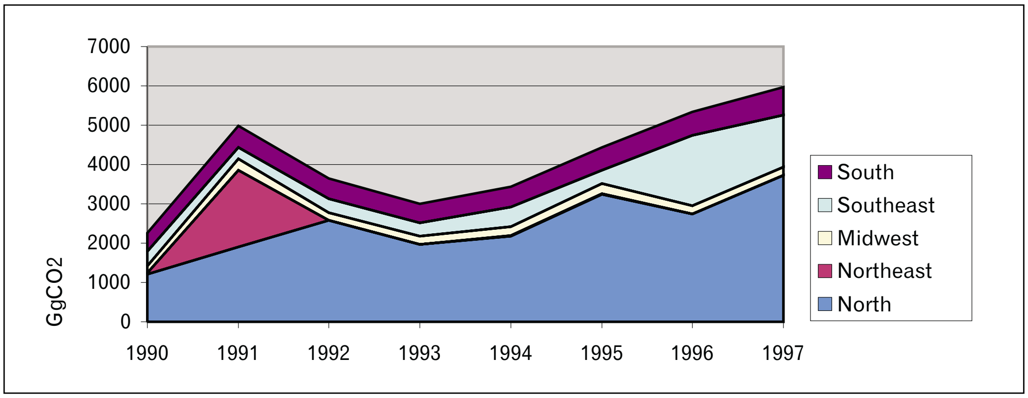



**Figure 3 - CO2 emissions from thermoelectrics per region**




## 5. Emissions Due to Energy Use

Concerning $CO_2$ emissions from energetic origin, the Country presents a favourable picture, thanks to the structure of its energy matrix, in which the renewable sources prevail. As a consequence, Brazil presents one of the smallest emission rates from the energy sector, in relation to the global GDP .

In **Figure 2**, the introduction of fossil types of energy is shown for periods between 1990-94[4], extracted from the MCT emission inventory. Subsequently, in **Figure 3**, the thermoelectric emissions are shown. Another renewable source that has been losing ground in the energy matrix, and consequently, resulting in the increase in the emission of movable sources year after year is the alcohol. This source was used as a substitution strategy of gasoline with alcohol, decided during the petroleum crisis in the 70's, to reduce the dependence of its imports. The Alcohol Programme (PROÁLCOOL) had such impact, that in late 80's, alcohol car sales represented 90 percent of total sales, and about 5 million alcohol vehicles circulated in the Country (ROSA et al 2000). Further ahead, still in this study, the PROÁLCOOL will be seen in more details.

**Table 1** displays $CO_2$ emissions from light vehicles for the gas-alcohol and for hydrated alcohol, considering the emissions of renewable energy, and subsequently, discounting those emissions between 1990 and 1994. The calculation of the alcohol anidro part contained in the gas-alcohol indicates that 84.16 percent of the $CO_2$ emissions come from gasoline.

It is possible to place alcohol in a more general planning in fluid fuel and in transportation sector, so that it may even be used in public transportation, relieving the pressure of diesel in the structure of the Brazilian Refinement and in the atmospheric pollution in large cities (ROSA et al 2000). Diesel oil is for the transportation sector a more important source of greenhouse

[4] For further information see http://www.ivig.coppe.ufrj.br/arquivos/f-efeito percent20estufa.pdf

effect gas emission than gasoline. Regarding carbon dioxide, heavy vehicles generate about 50 percent more than light vehicles. **Figure 4** displays the $CO_2$ emission level from the burning of that fuel, in 1990-94. A significant increase of emissions in that period is noted.

In relation to the industry's emissions, the data are still not available in the Brazilian inventory, except for the chemical industry. However, it is also possible to observe in that sector the loss of renewable sources space, such as the case of vegetable charcoal in metallurgy. This fuel enables the production of cast iron and high quality steel, due to its low impurity level. With charcoal, coke is still substituted as a reducer, thus avoiding over three million tC of $CO_2$ a year in the Country (ROSA et al 2000).

It is good to point out, however, that there is a strong introduction of fossil types of energys in the last few years in the energy matrix. That is mainly due to the recent restructuring of the electricity sector which tries to attract private capital for the construction of new plants. Thus, technologies that do not demand high initial investment and that have a quick return are favoured, which is the case of the natural gas thermoeletric plants. So renewable sources of energy, such as hydroelectric power stations are losing ground, causing an increase of $CO_2$ semissions from energetic origin.

The harmful atmospheric pollution effects on human health are extremely serious, mainly in developing countries such as Brazil. Although there is a series of difficulties for the quantification of the effects, studies show that, mainly in urban areas of the Country, it contributes to the rising or aggravation of problems such, as premature deaths, breathing diseases and several other diseases. Frequently, it is also associated to learning difficulties and behavioural problems (WHO 2000).

The atmospheric pollution also causes a series of other effects on nature. Acid rain, for example, caused by the emission of determined gases, causes the acidification of lakes and rivers, modifications in soil pH, degradation of trees, modifications in the necessary nutrients for the growth of plants and the deterioration of manufactured materials and structures (LA ROVERE 1995).

### 6. Emissions Due to Soil use Changes

The results of the inventory that are related to changes in soil use have not yet been completely made available by the MCT. Only the works on the variations of biomass stock in planted forests, and biomass emissions stocked below the soil are present in the MCT web site. With the lack of official results, one may look for scientific literature on changes in soil use. As already mentioned, this study will be limited 1970s to the deforestation issue.

Since early, a fast change of the vegetable covering has been observed both in forest areas, and the Cerrado. From 1978 to 1988, according to INPE data, the annual deforested area in the Amazon was 2,113 thousand hectares. The high rate of deforestation was object of severe criticism in the international context. The criticism on the Brazilian public policies in the Amazon lead the federal government to stop in 1987 and 1988 all incentives to agriculture and cattle - ranching activities offered in the area. At first, the suppression of government incentives was considered quite effective, due to the sharp fall in the deforestation rate in the years subsequent to the action (HURRELL 1992).

However, it may be observed in the figure that there is actually a cyclical evolution of deforestation. This can also be affected by fluctuations of the external wood demand (SEROA DA MOTTA 1996), by economic crisis or by meteorological issues (HURRELL 1992).

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Source: http://www.mct.gov.br/clima

In Brazil, there are two types of economic instruments used to control deforestation: forest fees and tax compensations. Since 1968 Minas Gerais State has applied, a fee on forest products. This is an example of the successful deforestation control in Brazil. However, itis difficult for the Brazilian for the Institute Environment and Renewable Natural Resource (IBAMA) to manage

**Figure 4 - CO2 emissions from heavy vehicles**

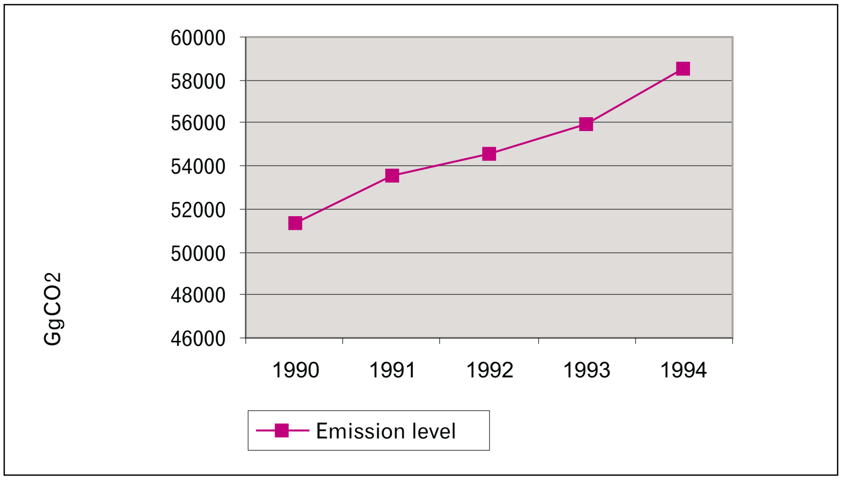



Table 2 - Deforestation in the Amazon and $CO_2$ emissions

| Period | Deforestation (thousand ha/year) | Emissions ( Millions $tCO_2$/Year) |
|---|---|---|
| 1978-1988 | 2113 | 543-931 |
| 1989 | 1786 | 458-785 |
| 1990 | 1381 | 356-609 |
| 1991 | 1113 | 286-491 |
| 1992 | 1379 | 356-605 |
| 1993-1994 | 1490 | 381-656 |
| 1995 | 2906 | 744-1280 |
| 1996 | 1816 | 466-799 |
| 1997 | 1323 | 341-583 |
| 1998 | 1738 | 447-766 |
| 1999 | 1726 | 444-759 |

Source: La Rovere - 2000

forest fess at federal level (SEROA OF MOTTA 1996).
The tax compensations for the limitations in soil use were implemented in the states of Paraná, São Paulo, Rio de Janeiro and Minas Gerais. SEROA DA MOTTA (1996) observes that, in the case of Amazon boundary areas, the application of fees is very difficult, due to the dimension of the territory, lack of infrastructure and low population density. Tax compensation, on the other hand, involves low administrative costs and creates incentives to those engaged in preservation measures.

The deforestation in the Amazon Region has been occurring mainly in the states of Mato Grosso, Pará and Rondônia. Those areas of expansion of agricultural boundary present a great vegetation diversity. They are forests, and Cerrado areas. In this last case, the carbon content is lower than 70 tons of carbon by hectare (tC/ha).

That variety explains the difficulties of preparing the national inventory. A wide range of controversial data is found in the literature. The first estimates by REIS (1992) use a strip of biomass volume between 270 to 400 tonnes of wood by hectare in the Amazon. Considering the composition of wood in approximately 50 percent of carbon, it is considered a strip between 135 to 200tC/ha.

Those numbers have already had several reviews. In more recent work, inferior values of carbon content by hectare were adopted. Even the IPCC Report (2000), for instance, adapts an average value of 120tC/ha to tropical forests. In the present work, the emissions are only indicated in order of greatness. A strip of 70 to 120tC/ha of emissions by deforested area was considered. The table below presents the estimates from INPE (National Space Research Institute) on the annual deforested area in the Amazon and the carbon emissions estimates a year, due to deforestation.

It is important to remember that these estimates aim to supply an order of the phenomenon greatness only. A more refined study is being corried out for the National Communication, mentioned previously. That study includes estimates on the biomass volume in the Amazon based on aerial photographic images done in the 1970s. That methodology compares the current deforested areas, obtained by satellite images, and the photographic images from the 1970s.

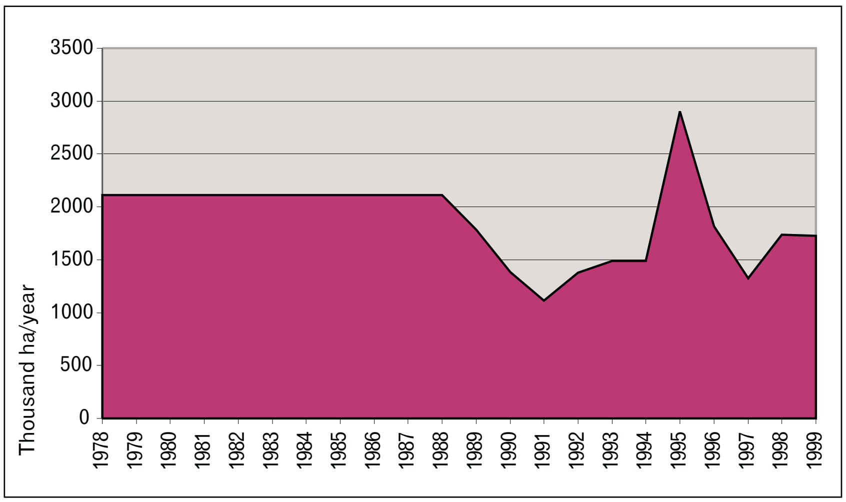
## 7. Relative Participation of Emission Sources

The comparison of the main emission sources of greenhouse effect gases is harmed by the unavailability of trustworthy data on emissions, due to the use of the land. In spite of that problem, the comparison is done here, changes in for information purposes only . Even using low emission coefficients, due to the soil use, it is observed that this source is the main responsible for emissions in Brazil.

The deforested annual area presents a determined stability. The annual average, in the 1990s, was about 1,600 a thousand ha/year, a value which was not too different from the ones observed in the last years of the decade, according to data from INPE presented in **Figure 5**.

**Table 3** presents the emissions of $CO_2$ from the main sources. The lowest emission coefficient for the changes in soil use was considered. In spite of this, the emissions due to changes soil use are observed to be the most important ones. Nevertheless, it has also been observed that the emission growth rates from energy sources ar higher than the emission growth rates due to deforestation.

**Figure 5 - Deforested area in the Amazon**




Source: INPE - 2000

**Table 3 - Relative share of sources of emission of $Co_2$**

| Year | Soil Use (Millions $tCO_2$) | % | Energy (Millions $tCO_2$) | % | Total (Millions $tCO_2$) |
|---|---|---|---|---|---|
| 1990 | 355 | 64% | 202 | 36% | 557 |
| 1994 | 382 | 62% | 236 | 38% | 619 |
| 1998 | 446 | 59% | 312 | 41% | 758 |

Source: La Rovere - 2000

## 8. What Brazil is doing to Fight the Problems Observed in the Atmosphere

In Brazil, the emission problem and the atmospheric pollution issue, mainly in large cities, are quite serious. Those problems are generated by movable sources (vehicles) and fixed sources (industries and energy transformation).

The transportation sector contributed significantly towards the emission of atmospheric pollutants in the Country. In addi tion to that, mainly in metropolitan regions, the problem has been increasing a lot. Some of the main reasons are:

- the high participation of road transportation, for both cargo and passenger
- the little incentive to public transportation use ;
- the cooling of use of vehicles alcohol, and;
- the increase in the number of vehicles.

In relation to the fixed sources, the main problem elapses from the burning of fossil fuels in industries, resulting in the emission of particulate material and of $CO_2$ among others.

In spite of the relatively reduced number of plants, the problems resulting from that activity are not, mainly in North and South regions. In the North of the Country, Diesel and other fuel soil thermoelectrical plants prevail, while in the South there is a concentration of charcoal thermoelectric plants.

# the State of Activities in Marine and Coastal Areas



Over the past few years, Brazil's maritime and coastal areas have been suffering considerable environmental degradation generated by the growing pressure on its maritime and continental natural resources, as well as by these ecosystems' limited capacity to absorb the resulting impacts. The major environmental impacts on Brazil's Coastal Zone are: introduction of nutrients; habitat alteration or destruction; sedimentation changes; overexploitation of fishing resources; industrial pollution, mainly caused by persistent pollutants; and the introduction of exotic species.

Along the coast, a number of different ecologically important environments can be found, such as mangrove swamps, dunes and cliffs, bays and estuaries, reefs and coral reefs, beaches and wild coasts, inter-tidal plains and other ecologically important environments. The main remaining spots of Atlantic Forest are also to be found in this area, including its biggest continuous area around the Serra do Mar mountain range, spread over the states of Rio de Janeiro, São Paulo and Paraná. The occurrence of mangrove swamps is also very expressive along Brazilian

coast (between 10,000 and 25,000 km$^2$) extending from the State of Amapá in the North along most of the coast, bordering estuaries, lagoons and bays down to Laguna, in the State of Santa Catarina, the southernmost occurrence of this ecosystem in the Western South Atlantic. The mangrove swamps have an important function for marine biotic reproduction, promoting a balanced interaction between the sea and the land.

The coastal plains formed by the juxtaposition of coasts are an important feature of Brazilian coast, particularly in the southern and southeastern regions, where one can find beaches, frontal dunes, coastal cordons and inter-cordon areas known as "*restingas*".

Due to their characteristics and attributes, these environments are used for oil extraction, ports, agriculture, agribusiness, aquaculture, carcinoculture, mineral extraction, vegetable extraction, extractivism, livestock farming, fishery, reforestation, salt-work plants, recreation, urbanisation and preservation areas (ecosystems).

Population growth and development are the main causes of the environmental changes observed in Brazil. As a developing country, Brazil needs to grow at a fast rate so as to provide for people's basic needs. Therefore, exploitation of natural resources and industrial production have an important role in supplying resources to the domestic market and achieving commercial surplus. The environmental costs associated to development are very high, especially in the absence of an effective environmental control system.

Some areas around big urban centres along the Brazilian coast are source of concern in regard to environmental degradation. Many bays and estuaries have had their natural habitats threatened by pollution and exploitation of natural resources.

Due to Brazil's colonial history, it was originally occupied from the coast towards the hinterlands. The first populated areas appeared along the coast and then spread towards the west. This led to a greater population density in the coastal zone, a fact that has remained true ever since. However, the population distribution was very uneven at first, with great concentrations alternating with nearly uninhabited areas. This picture has changed over the past few years, when those least populated zones attracted many new inhabitants. As a result, the population along the coast grew to more than 70 million people, whose lifestyle has a direct impact on the coastal environment.

Brazilian marine and coastal environments offer many opportunities for economic and social activities including fishery, agriculture, exploitation of mineral resources, etc. Also, the coast of Brazil has an enormous recreational value and has become the work and leisure destiny for a significant part of the country's population.

This entire natural and cultural heritage is, however, at risk. The current environmental degradation process affecting the coastal zone has produced a state of imbalance that is very hard to revert, especially around big urban centres.

## 1. Pressure on Marine and Coastal Environments

Half of the Brazilian population lives less than 200 km away from the sea, a fact that has a direct impact on the environment. Brazil has 9 metropolitan regions, 5 of which are along the coast: Fortaleza, Recife, Salvador, Rio de Janeiro and Belém, which is in an estuary area. The coastal economic activities account for around 70 percent of Brazil's GDP.

The Brazilian coastal zone is characterised by its extension and great variety of species and ecosystems. In terms of area, the coast is 7,300 km long (8,500 km long if one considers the exact coastal outline).

As it is a region full of contrasts, Brazilian coastal zone constitutes an excellent field for applying different environmental management strategies. Some areas present intense urbanisation, relevant port and industrial activities and large-scale tourist industry, as the metropolises and coastal centres located around estuaries and bays. These areas were very important for the occupation of Brazil due to their offering a natural protection for the first settlers.

On the other hand, there are a number of low-populated areas and very environmentally important ecosystems that are becoming prey to accelerated occupation. Preventive actions have to be taken in order to guide new economic dynamics (such as tourism and holiday homes) and their effects on the use of spaces and respective resources. There are some common elements to both cases, i.e., the multiplicity of the problems, the frailty of the environment and the complexity of its management. There is also a great demand for training and mobilising the many parties involved, which can be achieved through integrated actions aimed at redirecting national public policies affecting that region.

The population growth is the main form of pressure on the marine and coastal environments. The need for building land and infrastructure, the dependence on natural resources to feed the population and the need for fresh water are some of the problems connected to population growth, especially around big cities. The current trend points towards an increase of the coastal population, which will result in aggravated problems related to population growth. Building on highly sensitive areas such as dunes, estuaries, mangrove swamps, etc. represent, together with the increase of agricultural and urban activities, an element of degradation for natural environments caused by organic pollution, sedimentation and deterioration of natural habitats.

In addition, the ships present in these areas may affect the environment through oil leaks and discharge of ballast water, worsening the quality of the water around ports and harbours.

Domestic sewers are an inevitable consequence of human settlements, and it is possible to obtain an estimated amount of the sewage produced from the GNP. The growing occupation of coastal areas and the appearance of great urban centres along the coast have resulted in a dramatic increase of nutrients and other deleterious matters released into the environment, including pathogenic organisms. The coastal population is expected to grow even more, as it has over the past decades. It is, therefore, fundamental to establish adequate strategies to manage and reduce the impacts of such growth on the environment and on human health.

### 2. Habitat Fragmentation (erosion, sedimentation and siltation)

Considering Brazilian coast's geomorphologic classification, a relative rise in the sea level is not usually seen as a possible cause for erosion. Nevertheless, erosion is growing in different areas along the coast. Most geomorphologic studies have focused on inherently unstable and dynamic areas, such as bays and sand bars at river mouths (MARQUES, 1987: MUEHE and ALBINO, 1992), or areas affected by engineering works. They do not link the erosion found in these areas to the rise in the sea level. Still, lack of sediment supply, increased storm intensity, local tectonic movements and human interference may also contribute towards erosion.

The situation of Brazilian coast is described below, according to the various geographical regions:

### SOUTHERN /SOUTHEASTERN COAST

In the 1,530 km-long coastline of southeastern Brazil, the coast orientation changes in several places, affecting wave regimes, sediment movements along the beaches and regional ocean circulation. It is possible to observe some signs of erosion despite little human interference in these areas. In other places, intensive sand extraction from dunes, beaches and tide channels have contributed to a deficit of sediments, thus making these areas more vulnerable to rises in the sea level.

In the Southern Region, the 1,310 km-long coastline is formed by narrow coastal plains along the northern coast, with small beaches separated by rocky spits. In the State of Paraná, erosion and sedimentation processes can be observed. Alterations in the coastline were also observed, but only in areas expected to be unstable, such as estuary mouths, for instance.

Lagoons account for 15 percent of all coastal zones in the world. Along the coast of the State of Rio de Janeiro, particularly rich in lagoon systems, sewage and dams have seriously reduced the dimensions of such water bodies.

The Guanabara Bay, located in that state, has been suffering from very high siltation processes, with the following environmental consequences:

**a)** Rise of the seabed, hindering navigation;

**b)** Altered circulation and flows of internal currents, affecting coastal vegetation (mangrove swamps) and fishing areas;

**c)** Silting of mangrove swamps, changing tide floatation due to the advance of the coastline and possibly affecting this important ecosystem in the near future;

**d)** Suspension of thin material in the water column (turbidity), which acts as a barrier for sunrays and prevents the biota from performing photosynthesis, consequently diminishing the quantity of oxygen in the water.

In the lowlands known as *Baixada Fluminense*, intense sedimentation causes siltation in streams, rivers and channels, often resulting in chronic floods. In order to combat these floods, it is necessary to implement a global action focused on the bay as a whole. Dragging simply acts as a palliative, as the material removed today will return tomorrow through erosion.

### NORTHEASTERN COAST

This region's 3,480km-long coastline has many cliffs suffering from erosion in the states of Ceará, Rio Grande do Norte and Paraíba.

The city of Recife is located on two river mouths in a lowland area and crossed by a great number of channels. It suffers from coastal erosions, floods, insufficient drainage and high population density, in addition to a tendency towards a rise in the sea level, with serious consequences for the environment, as follows:

**a)** The coastal plain's low altitude forms large areas that are naturally prone to temporary floods, generating sanitation, traffic and urban development problems. The situation would be much aggravated by a rise in the sea level. In fact, part of the city centre already floods during exceptionally high tides or periods of intense river flow.

**b)** The gradual expansion of the city along estuaries and lagoons towards mangrove swamps causes serious problems during the rainy season. Lack of urban planning, inadequate infrastructure for industrial plants and uncontrolled human occupation of these lowlands increase potential risks factors in the event of a rise in the sea level.

**c)** Recife has a long history of coastal erosion, particularly around the city of Olinda. Seawalls and buttress dams were built in order to protect the city. The interruption in the coastal transportation of sediments led to the erosion of the beaches immediately to the north of each buttress dam, which led to the construction of other dams. The cumulative effects of erosion extending from the dams towards the sea extend 30 km towards the north of Olinda.

**d)** When comparing 1975 and 1984 ortophotomaps of the whole coastal area, it is possible to observe up to 25-m retrogradation of certain coastline segments.

**e)** The beaches lost their sedimentary balance due to the dams built along the rivers, repeated dragging of the Recife Harbour (located on the Capibaribe river estuary), and sand extraction from the mouths of the Jaboatão and Doce rivers. In addition, the presence of beach sandstone prevents sand from moving from the internal continental platform to the beach, especially after a storm, when part of the sand moves towards deeper areas.

**f)** It has been proved through measurement that the relative sea level is rising. HARARI and CAMARGO (1994) observed a rise of 5-6 mm/year in Recife between 1948 and 1986, which could be related to neotectonic settling, for example (MAGNO, 1989).

Recife seems to be sinking, and a 1-metre rise in the relative sea level in that city would actually correspond to a smaller rise in the global level of the oceans. The physical effects of floods and erosion are assessed quantitatively, whereas their social and economic consequences are considered from the qualitative point of view.

Along the southern coast of the State of Bahia, several coastal strips between the mouth of the Jequitinhonha River and the southern borders of the state were found to be suffering erosion. The causes of such erosion were associated to diverging zones leading towards the actual leeway. These were generated by the dispersion of wave rays or the occurrence of shade-zones for waves from southeast to south-southeast (the most energetic), making the northeastern waves more effective. The sediment deficit in these diverging zones seems to be the cause of erosion in the southern part of the coastal plain, associated to the Jequitinhonha river mouth, as well as the active cliffs between Ponta do Corumbau and Prado, and in the Itaquera region.

In other coastal tracts, erosion is associated to regions where there is accentuated intensification of the potential for drift. Other areas suffering from erosion are:

- Coastal strip between Coroa Vermelha and Ponta Grande;
- Southern part of Ponta da Baleia; and
- Caçumba Island.

Coastal erosion is associated to an essentially natural phenomenon: the relative rise of average sea level. However, the result of human intervention on the coast (insufficient sediments, dismantling of dunes, asymmetric sediment distribution caused by buttress dams) accelerate this process, contributing towards a high percentage of coastal erosion.

The silting process in a given water basin is closely connected to erosion processes, since the latter supply the matter which, once transported and settled, will generate siltation. Therefore, siltation is a direct consequence of erosion.

The retraction of the coastline constitutes a serious threat to most coastal cities nowadays. An estimated 70 percent of all coastlines in the world are suffering from erosion.

The main environmental impacts on the Brazil's Coastal Zone are associated to: introduction of nutrients; habitat alteration or destruction; sedimentation changes; overexploitation of fishing resources; industrial pollution, mainly caused by persistent pollutants; and the introduction of exotic species. On a global scale, the eutrophication deriving from the introduction of excessive anthropic nitrogen, the contamination produced by domestic sewage and the alterations in sediment flows probably represent the greatest risks to the health of marine environments (GESAMP, 2001).

### 3. Human Health and Quality of Life

According to the Brazilian Institute of Geography and Statistics (IBGE – *Instituto Brasileiro de Geografia e Estatística*), in 1999 seventy nine point percent of the Brazilian population had access to running water, 64.6 percent to sewage systems, and 79.9 percent to rubbish collection. These figures sound expressive at first, but a closer look will reveal alarming disparities among different regions: whereas 78.3 percent of urban residences in the Southeast had access to sewage systems, this number dropped to only 7.3 percent in the North Region.

The 9 million inhabitants of the Guanabara Bay produce 18.6 $m^3$ of gross sewage per second. Every day, 470 tonnes of organic waste, 64 tonnes of industrial waste, 0.3 tonne of heavy metals, 7 tonnes of oil and 6 tonnes of domestic rubbish are thrown into the sea. The main sources of pollution are the 6,000 factories, 52 of which account for 80 percent of this type of pollution. Some companies are investing in depollution of the bay; still, others find it easier to capitalise/accumulate profits and socialise/share losses (CETEA). In the whole urban expansion scenario, only 20 percent of the coastal population have access to sewage collection and treatment systems.

If we apply the data collected by the Guanabara Bay Depollution Programme to the rest of the coast, an estimated 145 $m^3$/sec of sewage are released, which is equivalent to 3,655 tonnes per day of BOD (biological oxygen demand).

In the Guanabara Bay alone, approximately 13,000 tonnes of rubbish are produced every day, 4,000 tonnes of which are not even collected, but rather discarded in wastelands, rivers and canals.

Pata from the Brazilian Association of Environmental Entities (*ABEMA - Associação Brasileira de Entidades do Meio Ambiente*) show that 80 percent of all sewage in Brazil is discarded directly into the rivers, ocean, lakes and spring areas with no previous treatment. This process pollutes and contaminates the country's water resources, including water tables and, consequently, the water extracted from wells. Water pollution directly affects people's health and is the main cause of several diseases including diarrhoea,

hepatitis, typhoid fever, mycosis, otitis, conjunctivitis, allergies and intestinal parasites. Children, elders and other people with low resistance levels are the most susceptible to developing diseases or infections after having swum in or had contact with contaminated water.

The phytoplankton (microscopic seaweed) is responsible for the sea's primary production, i.e., oxygen production. If it grows and develops "normally", all other links of the food chain are nurtured. Sewage, both industrial and domestic, represents one of the main threats to marine life and to the people who live on the coast. The organic matter contained in the sewage fertilises the phytoplankton, causing it to grow. Microscopic life grows disorderly and harms other sea organisms, taking their space, oxygen and nutrients. One of the best known examples of these phytoplankton booms is the red-tide caused by the proliferation of dinoflagellate, a type of phytoplankton able to produce toxic substances that can kill herbivores. Pollution may reach the marine environment drastically and quickly, causing the plankton to die immediately. Alternatively, a phenomenon called bioaccumulation may occur, i.e., the living organisms might retain some of the toxic substances, which are then passed on to the other links of the food chain and will finally reach human beings. This is a very slow process, but it may ultimately lead to death.

Sewage also discards into the ocean a series of noxious organisms such as bacteria, viruses and larvae. Half of the dry weight of human rubbish is formed by bacteria, particularly faecal coliforms, used as indicators for beach pollution levels. At least 30 percent of Brazilian beaches have more faecal coliforms than the maximum level accepted (www.ambientebrasil.com.br).

Concerning the rubbish, 90 percent of all waste collected is taken to open dumps, 50 percent of which are located next to rivers, lagoons, the sea or environmental preservation areas. The situation is even worse in many of these dumps due to the presence of hospital waste mixed to ordinary rubbish.

According to results obtained from the Ministry of the Environment's Coastal Management Programme (Gerco - Gerenciamento Costeiro/MMA), the Brazilian coast receives over 3,000 tonnes of liquid pollutants every day. Preliminary results indicate that this waste is mainly formed by industrial and domestic sewage. Among the industrial waste, approximately 130 tonnes of highly toxic pollutants are discarded every day. Four states receive the greatest volumes of industrial toxic elements: Rio de Janeiro, Bahia, São Paulo and Espírito Santo. In Rio de Janeiro, 119,600 tonnes of industrial waste is discarded in the ocean, 64,000 of which are toxic. In Bahia, the numbers are 95,501 and 51,128, respectively.

The sources of pollution discard their waste in estuaries, coastal lagoons, bays and the ocean. The quantity of industrial waste thrown into estuaries is even higher than that discarded in the oceans. As for the toxic industrial waste, the bays suffer the most. It was also observed that the most vulnerable coastal ecosystems such as estuaries, coastal lagoons and bays are the primary destination of these pollutants.

## 4. Maritime Trade

Port activities have to be included here, for 13 major Brazilian ports (Belém/PA, Itaqui/MA, Aratu/BA, Vitória-Tubarão/ES, Rio de Janeiro/RJ, Sepetiba/RJ, Angra dos Reis/RJ, São Sebastião/SP, Santos/SP, Paranaguá/PR, São Francisco do

Sul/SC, Porto Alegre/RS and Rio Grande/RS) are located at or intimately connected with Brazilian metropolitan areas.

Most Brazilian ports do not have the adequate structure for environmental management, neither for day-by-day control of residues and other environmental impacts, nor in regard to contingency plans for accidents, nor in relation to port expansion and modernisation projects.

In Vitória, capital of the State of Espírito Santo, the Tubarão Port Complex gives access to deep draught vessels. It is one of the great sources of pollution of the area, releasing sewage, oil and mineral transport residues. It also has the greatest movement of goods in the country and the greatest release of ballast water from both coastwise and transcontinental ships.

A large quantity of water species has been brought to Brazil, and taken to other places around the world, in the ballast water. The growing transfer of noxious organisms has had disastrous effects on marine ecosystems, human health, biodiversity, fishing activities and marine cultivation. It has become a global problem due to the ecological and economic impact caused by the invasion of exotic species in various ecosystems.

According to the Brazilian Navy Directorate of Ports and Coasts (DPC - Diretoria de Portos e Costas da Marinha do Brasil), Brazilian ports' movements reach 400 million tonnes per year, which is significant in global terms. Around 40 million tonnes of ballast water are thought to be discarded every year.

Some of the species introduces in Brazil are the *Charybdis hellerii* crab found in All Saints' Bay, in Salvador, Bahia, and in Guanabara Bay, in Rio de Janeiro; the *Limnoperna fortunei* bivalve introduced in the Guaíba Lake, in the State of Rio Grande do Sul and also found in one of the Itaipu Hydroelectric Power Plant's units in April 2001; the *Isognomon bicolor* bivalve, and the *Nephthea curvata* and *Tubastraea coxima* corals, fond in the Lakes Region and in the Ilha Grande Bay.

## 5. Tourism

Nowadays, tourism represents one of the main vectors for the occupation of Brazilian coast. This occupation occurs especially through holiday homes, weekend or seasonal tourism, and resorts aimed at international tourism.

This type of tourist industry combined with real estate speculation has been causing serious and sometimes irreversible environmental damages to the coastal environment.

Ill-planned tourism has decharacterised the coastal strip. Public access to the sea has been denied with the construction of condominiums and holiday resorts, as well as the establishment of private beaches and badly planned land delineation projects.

In addition to the fact that such expansion lacks planning and control and incorporates highly relevant environmental areas (dunes, mangrove swamps, etc.), it also transfers to new areas part of the environmental hazardous vectors that are typical of great urban centres, such as: contamination of aquifers, bodies of water and beaches, removal of green cover crops and soil, interference in marine sedimentation, etc. Among all occupation vectors, this is the most threatening to the integrity of protected ecosystems.

Traditional fishery activities have also been changing due to the construction, operation and maintenance of artificial canals and marinas. In most cases, they lead to the destruction of important environments for other economic activities, such as mangrove swamps, coastal channels and beaches, not to mention the fact that they deny free access to the coast, which is ensurep by Brazilian law.

The tourist flow can be used to demonstrate the pressure exercised on the coastal zone. Approximately 2 million foreigners come to Brazil as tourists and most of them are South Americans. Domestic tourism presents figures far more impressive than these, with an estimated 50 million Brazilians travelling around the country. This activity accounts for 3 percent of Brazil's GDP.

One fourth of the Brazilian population live on the coastal plains, spread over more than 500,000 km$^2$. This high population density is a constant source of pressure on the environment, land and marine natural resources, landscapes and biodiversity. The causes of this pressure are urban expansion, growth of productive sectors and plants, expansion of holiday and leisure areas and other sorts of human activities.

Those who suffer the greatest losses among the traditional population are artisan fishermen, whose source of subsistence is destroyed by pollution and decharacterisation of beaches, wild coasts and mangrove swamps. Many times, they are forced to move to other areas and abandon their traditional activity.

## 6. Discharges into the Sea

According to Agenda 21, marine environmental degradation may result from various sources. In average, 70 percent of sea pollution comes from the land, 10 percent from maritime transport and 10 percent from discharges into the sea. However, the magnitude of these interactions may vary according to the size of water basins, sediment collectors and polluting residues over vast areas.

According to O. Vidal and W. Rast, around 80 percent of sea contamination is caused by human activities on the land, such as urbanisation, agriculture, tourism, industrial development, discharge of untreated sewage, industrial waste and lack of coastal infrastructure.

The oceans receive a significant part of all pollutants thrown into the rivers, in addition to urban and industrial rubbish produced near the coast.

Similarly, the pollution caused by domestic sewage and industrial waste affects estuarine ecosystems, especially mangrove swamps, a fact which contributes to the drop in fishery outputs. Petrochemical and chlorochemical complexes are present at most large estuaries and throw heavy metals and oil residues into mangrove swamps and the continental platform. The environmental threat posed by these pollutants will depend on different national or regional conditions. The final destinations of polluting agents are estuaries, coastal lagoons, bays and the ocean.

**Figure 1 - Main pollutants, emission sources and their effects**

■ **Organic material (BOD)** ← sewage → Dissolved oxygen reduction
- sewage ↑ -Collection system and pits; -Industry and drainage of landfill
- Dissolved oxygen reduction ↓ Harm to sea life; Bad smell

■ **bacteria** ← sewage → Acute illnesses

■ **nutrients** ← sewage → Eutrophication and outbreak of fish destructing algae
- sewage ↑ - agricultural draining

GERCO's report informs that over three thousand tonnes of liquid pollutants are discharged in various points along the Brazilian coast every day, in addition to large quantities of industrial and organic waste. Four states receive the greatest volumes of industrial toxic elements: Rio de Janeiro, Bahia, São Paulo and Espírito Santo.

The humid and coastal areas in the Northeast have been suffering a high degree of environmental degradation. The effluents thrown into the ocean through underwater sewage pipelines cause serious problems because they are discharged in an area known by local fishermen as the "Great Mud"(*"Lama Grande"*), the main shrimp habitat around the city of Maceió, capital of the State of Alagoas.

In Bahia, 95,501 tonnes of industrial waste is discarded in the ocean, 41,128 of which are toxic. The All Saints' Bay is, in fact, contaminated with mercury. In Rio de Janeiro, the toxic contamination numbers are 119,600 and 64,000, respectively. Every day, 500 tonnes of organic sewage, 50 tonnes of nitrates and heavy metals, and 3,000 tonnes of solid residues (sand, plastic, cans and other rubbish) are discarded into the Guanabara Bay. Important industrial and agricultural activities concentrated in Rio Grande and Pelotas, in the south of Brazil, also contaminate the *Laguna dos Patos* estuary, in addition to the pollution produced by port activities in that state.

Criciúma, Imbituba and Tubarão present the most serious pictures of water pollution, associated to the presence of important sources of chemical and organic pollution, such as hog raising, agribusiness (wine, coal, flour, oil, leather, pottery, food and fishery, and fertiliser) and domestic sewage. Coal extraction and processing is the main source of pollution, and it directly affects the Tubarão river waters, placing this system among the three most polluted in the State of Santa Catarina (Santa Catarina, 1997, Sanchez et al. 1998).

## 7. Oil Extraction

Oil and gas extraction fields are spread all over the Brazilian coast, from the State of Rio Grande do Norte down to Paraná, but most production, transport and stocking activities are concentrated in the southeastern region. The Campos Bay, on Rio de Janeiro's continental platform, accounts for about 70 percent of the country's oil production, which is loaded onto oil tankers through oil pipelines.

Inaugurated in 1969 in São Sebastiao, in the State of São Paulo, Petrobrás's Almirante Barroso Maritime Terminal (TEBAR- Terminal Marítimo Almirante Barroso) is subordinated to "Central and Southern Ducts and Terminals" (DTCS - Ductos e Terminais do Centro Sul). It is the most important maritime terminal in Brazil, transporting over 60 percent of all oil and oil products in the country. In 2000, 678 ships operated at TEBAR (total delivery = 44.2 million $m^3$), an absolute record of operations at that unit and a clear indication of the growth of oil activities in Brazil.

Oil extraction along the Brazilian coast constitutes, at the moment, one of the greatest pressures on the country's coastal and marine environments. The end of Petrobrás's prospecting monopoly enabled an unprecedented increase in terms of explored areas and practically put the whole Brazilian coast at auction. However, the environmental costs associated to these activities have not been properly considered or evaluated by Brazilian environmental agencies. For example, the effect of seismic activities on fishery resources and marine ecosystems has not been studied in depth. From the environmental point of view, though, actions related to seismic studies, prospecting and extraction are not the most dangerous parts of the oil industry. In fact, environmental problems are usually caused by transport, stocking, refinery and consumption of oil products. There are few accidents involving the 656 maritime oil wells, 64 fixed platforms and 10 floating systems, especially when compared to the number of incidents that have taken place while loading and unloading oil and its products at the nine terminals operated by Petrobrás in Brazil. Among the factors that contribute to increasing the risk of accidents, one can certainly mention the ageing of the world's fleet (about 3,000 ships have been in use for over 20 years), and the poor professional training given to the crew. In spite of numerous laws protecting the marine environment, many companies and outfitters operating in that sector prioritise immediate profits and act irresponsibly towards the environment.

Also, while washing their tanks at high sea, the ships discharge huge quantities of oil into the ocean, frequently generating so-called black tides. Although this kind of operation is prohibited, those who choose to do it are protected by the fact that it is very difficult to thoroughly inspect the whole coast.

## 8. Oil Pollution

The environmental impact caused by oil leaks along the Brazilian coast has been a permanent threat to the integrity of coastal and marine ecosystems. With the increase of oil production, many accidental oil spills and leaks were reported during low- and medium-risk routine operations (191 accidents between 1974 and 1994, and 18 from 1995 to 1998), contributing to the chronic pollution of nearby areas. Most of these accidents were caused by ships. In the case of small-scale leaks ($< 1m^3$), the affected areas are those near the origin of the spill. On the other hand, large-scale accidents ($>1000m^3$) tend to spread all over the coast of the State of São Paulo up to the southern coast of Rio de Janeiro.

What is most worrying in this picture is the fact that oil accidents have been assuming catastrophic proportions. Between 1975 and 1992, for instance, only two big accidents involving oil spills took place: in 1975, a cargo ship spilt 6,000 tonnes of oil in the Guanabara Bay and, in 1983, 3 million litres leaked out of the Bertioga pipelines, in the State of São Paulo. Since then, though, 35 major leaks were reported all over Brazil, affecting important rivers or the sea itself, and also polluting several beaches and causing serious environmental damages.

**The main leaks reported over the past 10 years were:**

- July 1992 — 10,000 litres of oil leaked in a spring area by the Cubatão river;
- May 1994 — 2.7 million litres of oil polluted 18 beaches on the north of the State of São Paulo;
- 10 March 1997 — A Petrobrás pipeline connecting the Duque de Caxias Refinery, in Rio de Janeiro, to the DSTE Terminal, on Ilha D'Água, broke and causing a 2.8 million oil spill in the Guanabara Bay mangrove swamps;
- 21 July 1997 — A substance called FLO, used to clean and seal equipment, leaked into the Cubatão river (Petrobrás);
- 16 August 1997 — 2,000 litres of oil reached five beaches on Ilha do Governador, in the State of Rio de Janeiro (Petrobrás);
- 13 October 1998 — A one-metre crack in the pipeline connecting the São José dos Campos Refinery to the Guararema Terminal, both in São Paulo, discharged 1.5 million litres of oil into the Alambari River. That pipeline had had no maintenance for five years (Petrobrás);
- 6 August 1999 — 3,000 litres of oil leaked from Petrobrás pipelines at the Reman Refinery and reached the Cururu channel and the Negro river, in the Amazon. The environmental damages have not been recovered yet.
- 24 August 1999 — At Petrobrás's Repar Refinery in Curitiba, in the State of Paraná, 3 cubic metres of schist naphtha / nafta de xisto (a product containing benzene) leaked and forced the refinery to interrupt its activities for three days due to the strong smell released;
- 29 August 1999 — Less than a month later, a new leak happened at Reman, in the Amazon, discharging at least 1,000 litres of oil into the Negro river (Petrobrás);
- November 1999 — A defect in the Carmópolis oil field, in the State of Sergipe, caused oil and bleach to leak into the Siriri river, completely destroying all fishing activities in that place (Petrobrás);
- 18 January 2000 — A Petrobrás pipeline connecting the Duque de Caxias Refinery to the Ilha d'Água Terminal caused a 1.3 million oil spill in the Guanabara Bay. The oil slick spread over 40 km$^2$. A study carried out by COPPE/UFRJ (Co-ordination of Post-graduation Programmes in Engineering of the Rio de Janeiro Federal University) and disclosed on 30 March concluded that the leak had been the result of Petrobrás's negligence, for the original projects technical specifications had not been followed;
- 28 January 2000 — Problems in a Petrobrás pipeline between Cubatão e São Bernanrdo do Campo, in the State of São Paulo, caused the leak of 200 litres of diluting oil, fortunately controlled at the Serra do Mar before it could reach the Cubatao river drinking water spring areas;
- 17 February 2000 — The São José dos Campos refinery overflowed and spilt 500 litres of oil into the channel between the refinery and the Paraíba river (Petrobrás);
- 11 March 2000 — Approximately 18,000 litres of raw oil leaked in Tramandaí, in the State of Rio Grande do Sul, while they were being transferred from an oil tanker to the Almirante Soares Terminal. The

accident was caused by a rubber connection in the fuel transfer system that broke and resulted in a 3-km-wide oil slick at the Jardim do Eden Beach (Petrobrás);

- 16 March 2000 — The Mafra, a ship belonging to the National Oil Fleet, spilt 7,250 litres of oil in the São Sebastião channel, in the northern coast of São Paulo. The product overflowed from an oily residues reserve tank on the left side of the stern. Cetesb fined Petrobrás R$ 92,700;
- 26 June 2000 — A new 1-km-long oil slick appeared near Ilha d'Água, at the Guanabara Bay. On this occasion, 380 litres of fuel were thrown into the ocean by the Cantagalo, a ship at Petrobrás's service. The accident happened while the ship was discharging ballast water into the ocean;
- 16 July 2000 — Four million litres of oil were discharged into the Barigüi and Iguaçu rivers, in the State of Paraná, after an expanding joint broke in a pipeline at the Presidente Getúlio Vargas Refinery. Petrobrás took two hours to detect the accident, which became the largest environmental disaster provoked by Petrobrás in 25 years;
- July 2000 — Fernandez Pinheiro, near the city of Ponta Grossa: a train belonging to Latin-America Logistics Company (ALL - Companhia América Latina Logística) was transporting 60,000 litres of diesel when it derailed. Part of the fuel burnt and the rest flowed into a nearby stream;
- July 2000 — Fernandez Pinheiro, near the city of Ponta Grossa (one week later): a train belonging to Latin-America Logistics Company (ALL - Companhia América Latina Logística) was transporting 20,000 litres of diesel and petrol when it derailed. Part of the fuel burnt and the rest flowed into a permanent environmental preservation area. Ibama fined that company R$ 1.5 million;
- 23 September 2000 — Morretes: a train belonging to Latin-America Logistics Company (ALL - Companhia América Latina Logística) was transporting sugar and soybean chaff when it was derailed, spilling 4,000 litres of fuel into the Caninana stream;
- November 2000 — 86,000 litres of oil leaked from a Petrobrás tanker and polluted several beaches in São Sebastião and Ilhabela, in the State of São Paulo;

- January 2001 — An accident with a ship called Jessica caused over 150,000 barrels of fuel to leak at the Galapagos Archipelago;
- 16 February 2001 — Another Petrobrás pipeline leaked 4,000 thousands litres of diesel into the Caninana stream, which is a tributary of the Nhundiaquara, one of the main rives in that region. This leak caused severe damages to the local mangrove swamps and also contaminated the local flora e fauna. Ibama prohibited all fishing activities until the month of March;
- 14 April 2001 — An accident with a Petrobrás lorry on Road BR-277, between Curitiba and Paranaguá, caused the leak of almost 30,000 litres of oil into the Padre and Pintos rivers;
- 15 April 2001 — An oil known as MS 30, which is an asphalt emulsion, leaked and reached the Passaúna river, in the town of Araucária, in Curitiba metropolitan area;
- 20 May 2001 — A train belonging to Ferrovia Noroeste derailed and leaked 35,000 litres of diesel in an Environmental Preservation Area in Campo Grande, in the State of Mato Grosso do Sul;
- 30 May 2001 — A Petrobrás pipeline broke in Barueri, in the State of São Paulo, and caused 200,000 litres of oil to leak. The oil spread over three luxurious properties in the local Tamboré Condominium and reached the Tietê river and the Cachoeirinha stream;
- 15 June2001 — The Galvão Construction Company was fined R$ 98,000 or the leak of LPG (liquefied petroleum gas) from a Petrobrás pipeline at km 20 of Castelo Branco Motorway, one of the main roads in the State of São Paulo. The accident happened while the company was working for the state government, and generated a fine applied by Cetesb;
- 11 August 2001 — An oil leak spread over 30 km along the beaches of the State of Bahia, between Buraquinho and Costa do Sauípe. The oil comes from Arab sources;
- 15 August 2001 — 715 litres of oil leaked from the Princess Marino, a ship anchored at the Ilha Grande Bay, in Angra dos Reis, Rio de Janeiro;
- 20 September 2001 — A gas leak was observed at Petrobrás's Pitanga Station, 46 km from Salvador, in Bahia. The leak contaminated 150 m of a mangrove swamp;
- 5 October 2001 — A ship was unloading oil at a Petrobrás's monobuoy 8 km off the coast when 150 litres of oil leaked towards São Francisco do Sul, on the north of the State of Santa Catarina;
- 18 October 2001 — Norma, a tanker belonging to Transpetro, a Petrobrás subsidiary company, was transporting naphtha when it hit a rock in the Paranaguá Bay, in the State of Paraná, and leaked 392,000 litres of that product, contaminating a 3,000 $m^2$ area. The accident also caused the death of a diver, Mr. Nereu Gouveia, 57, who had dived to evaluate the conditions of the hull.

## 9. Habitat Loss and Biodiversity – Exotic Species

The most evident impacts of the fast and ill-planned occupation of Brazilian coastal strip on the marine and coastal environment are:

- destruction of ecosystems, deforestation and threats to land and marine biodiversity;
- rise in the levels of pollution caused by the discharge of solid and liquid waste on the soil, and in rivers, bodies of water and sea;
- coastal degradation caused by intense extraction of sand, mangroves and vegetation, land and sea erosion, and destruction of landscapes;
- reduced availability of fresh water due to increased demand, excessive use of underground water reservoirs, and lowering of of the water table.

The great Brazilian mangrove swamps, for instance, are being destroyed by urban and industrial pollution, a situation that is aggravated by the fact that they are in an interior sea where the water flow is very slow. In addition, they are threatened by the pollution caused by petrochemical and chlorochemical complexes, present at most large estuaries along the coast.

Looking more closely at the northeastern region of Brazil, one of the main factors for mangrove swamp degradation is the discharge of a sort of alcohol waste called "vinhoto" from local alcohol plants, which kills large quantities of fish and crustaceans. Besides, the insecticides and fungicides used for sugarcane cultivation are also discarded into the water.

The significant reduction of mangrove swamps and the disfigurement of important estuary and bay complexes have been reducing the habitat and increasing food competition and predation among many species, thus contributing to the acceleration of the death rates. In addition, the recent use of mangrove areas for aquaculture has significantly reduced the area of these ecosystems.

Another relevant factor for the reduction of biodiversity along the Brazilian coast is the recent introduction of exotic species brought in ballast water, on ship hulls and on oil platforms. The many cases previously observed and described demonstrate very clearly that these species will soon replace native species in their habitats, thus reducing the associated genetic pool.

# the State of Fishing resowrces: Fish extraction and Agua Culture



## 1. Potentialities

The environmental conditions of the waters of the sea along the Brazilian coast are basically determined by three currents:

**a)** the North Brazil Current, which flows towards the Northeast;

**b)** the Brazil Current, which flows southwards, both resulting from the South Equatorial Current, which comes from the African coast and branches off in the mentioned directions when it reaches Brazil, near João Pessoa, in the State of Paraíba; and

**c)** the Falklands Current (**Figure 2**). The first two have similar characteristics (high in temperature and salinity, and poor in nutrient salts). These parameters, together with the deep thermocline in the areas covered by the currents, do not allow the nutrient salts to reach the tropic zone and favour primary production, with a consequent low productivity of the sea in these regions. The Falklands Current is characterised by its low temperature and salinity. It penetrates the coastal region of Rio Grande do Sul and reaches parallel 34-36° S, where it joins the Brazil Current and forms the Subtropical Convergence. This current presents a high concentration of nutrient salts.

The productivity of the North is high thanks to the Amazon River, which pours a great volume of fresh water with high levels of suspended land material. When this material deposits on the river estuary's continental platform, it helps to make the coast of the states of Pará and Amapá particularly productive, especially in deep waters. The Northeast, on the other hand, due to the predominant characteristics of the Brazil Current, presents low productivity of fishery resources. In the Southeast and South, the influence of the Falklands Current water mass, and the resurgence or the penetration of the South Atlantic Central Water – SACW enable larger fish abundance, especially up to the Cabo Frio region. The resurgence occurs as a result of the combination of different factors, such as changes in direction of the Brazil Current, seabed topography, and the effect of predominant winds in the area.

The dominant tropical and subtropical characteristics contribute to determine the absence of large stocks, which explains the concentrated fishing efforts on those few species that allow, in terms of concentration and potential, a sustainable and profitable economic activity.

The first attempts to estimate the potential of marine and estuarine fishery along the Brazilian coast were made by Laevastu (1961) and Richardson (1964). These attempts serve only as indicators of more promising fishing areas and resources. In fact, Hempel (1971) provided more detailed and precise data (an estimated total of $1{,}725 \times 10^3$ tonnes per year) (Paiva, 1996). Yesaki (1971) dealt only with demersal fish resources along the coast of Brazil. The estimates presented by Neiva & Moura (1977) and Dias-Neto and Mosque (1988) distinguished regions and environments (pelagic and demersal). Both focused on the resources up to the depth of 200 m and suggested a total potential varying between $1{,}400 \times 10^3$ and $1{,}700 \times 10^3$ tonnes per year. The South and North were predominant, whereas the Northeast had a minor participation.

With a view to providing missing information on potential resources all over the Exclusive Economic Zone - EEZ, the "Programme for Assessment of Sustainable Potential of Living Resources in the Exclusive Economic Zone" (*REVIZEE – Programa de Avaliação do Potencial Sustentável de Recursos Vivos na Zona Econômica Exclusiva*) was established as a result of the main goal to be achieved by the IV Sectorial Plan for Marine Resources (PSRM), in effect from 1994 to 1998. The V PSRM, valid from 1999 to 2003, maintained the Programme in its action strategies as a "priority research" line (CIRM, 1999).

Despite the limited productivity of Brazilian EEZ, there are some signs of new resources that, even if restricted in terms of income, may open up new working fronts for the diversification of fishery efforts (MMA/IBAMA, 2001). However, preliminary information indicates that, although it is possible to increase national fishery, Brazil is unlikely

**Figure 1 - Sea Current of the Brazilian coast**


Source: modified - Matsuura - 1995

to get any indicative result of the presence of very large stocks.
Besides the potential for production, Brazil also possesses a great market potential for aquicolous products. Despite this potential, Brazil's participation in the world market has been historically low, especially considering that it has 12 percent of all fresh water in the world, 3.5 million km$^2$ of Exclusive Economic Zone, 8,400 km of coast, in addition to favourable climate, diversity of aquatic species, internal and external markets with unsatisfied demand, available support infrastructure and other extremely favourable conditions (Bernardino, 2001).

The greatest and most important fluvial basins in Brazil are the Amazon, the Paraná, the São Francisco, the Northeastern and the Eastern basins (Menezes, 1972; Paiva, 1983; Petrere, 1989). However, they still lack basic information on fish philogenetic relations, and their reproduction, feeding and growth habits. The simple taxonomic description and studies on life cycles have been limited to bigger and commercially important species (Petrere, 1994). There are few references to the fishery potential of continental waters (for the Amazon basin, the estimate is from 425 to 1,500 thousands tonnes/year) (Petrere et al, 1992). In regard to great hydroelectric dams, Paiva (1976) estimates that the fishing potential of the 46 biggest Brazilian dams reaches 123,091 tonnes/year. As to the northeastern reservoirs, the potential estimated catches were 130,000 tonnes per year, as a whole (Paiva, 1983).

Regarding aquaculture, this activity basically depends on local ecosystems, which must be balanced in order to enable this activity. It is vital to understand that environmental preservation is part of the productive process. From this point of view, the impact of aquaculture on ecosystems is very important for the evaluation of its sustainability, for a modified ecosystem reacts to the production system and can directly affect its viability.

In Brazil, aquaculture involves 98,557 producers, spread over 78,552 hectares (an average area of 0.80 hectares/property). The average production is 1.46 tonnes/ha (Bernardino, op. cit.). The heterogeneity of production systems turns global average into a performance indicator that has little power to explain the situation. However, these data indicate that Brazilian aquaculture, except for the carcinoculture sector, is mainly supported by small producers. Far from being a problem, this fact can be faced as positive, since most great producers of cultivated aquatic organisms in the world are countries whose production is based on small properties (Valenti, 2000).

As to the number of cultivated species, contrarily to what happens in the main producing countries, where a reduced number of species are cultivated, at least 62 species have been commercially or experimentally used in Brazilian aquaculture, including fish (51), crustaceans (5), clams (4), amphibians (1) and seaweed (1) (Bernardino, op. cit.). On the other hand, he continues, the generation and adaptation of appropriate technology to the different cultivated species demands complex observational and experimental work, made up of inter-relations that must be studied in detail in regard to all links of the productive chain. This will only occur through selection of the priority species, available laboratory infrastructure, qualified human resources and well managed regional aquaculture programmes.

Brazil has the best comparative advantages of the world to develop marine carcinoculture in a sustainable and competitive form. In 1997, the production reached 3,600 tonnes in an area of 3,548 hectares. It came in 18$^{th}$ among all producing countries, participating with only 0.5 percent of the world production. In the year 2000, Brazilian production reached 25,000 tonnes in a 6,250-hectare area, i.e., a 594 percent increase in production compared to only 76.2 percent in area. This happened over four years and led Brazil to contribute with 3.1 percent of the world production, occupying the 8th place in the world rank. The northeastern region is particularly productive. In 1996, its productivity was 906 kg/ha/year; in 2000, it reached 4,000 kg/ha/year; and in 2001, some companies that are already using more intensive technology are obtaining 8,000 to 10,000 kg/ha/year productivity (Bernardino, op. cit.). It is important to highlight the fact that this productivity is extremely high for shrimp cultivation, even when comparing with the most traditional producers. This fast advance is a result of several factors, such as the introduction, in 1993, of the white shrimp (*Litopenaeus vanamei*), the production of high quality feeds, the improvement of cultivation techniques, the improved quality of the post-larvae, and the availability of propitious areas (BNB, 2001 and Madrid, 2001).

An integrated form of responsible development of aquaculture has also found its way in the culture of bivalve molluscs, despite its recent introduction in Brazil. The production of mangrove oysters (Crassostrea rhizophorae), Pacific oysters (Crassostrea gigas), and lions-paw scallops (Nodipecten nodosus) began in the late 70's, 80's, and 90's, respectively. The national mussel production in 2000 was 2,500 tonnes and the oyster production was 1.3 million dozens. In the specific case of mussels, the national cultivated production in 1990 was only 120 tons, whereas today Brazil is the greatest American producer. The State of Santa Catarina is the one that best represents this sector: there are 1,050 producers, organised in 18 associations and 4 co-operatives (Proença, 1999).

The diagnoses and prospects that derive from the studies on Brazilian aquaculture demonstrate that this will be one of the most important activities in the next few years, thus contributing to the development of competitiveness and sustainability of Brazilian agribusiness. These data, added to the vastness of its territory, make Brazil the country with the greatest potential for aquaculture fishery (Castagnolli, 1996).

## 2. Extractive Marine Fishery

In Brazil, fish is one of the four biggest sources of animal protein for human consumption. Additionally, the last estimates indicate that this activity is responsible for the generation of 800,000 direct jobs, not to mention the approximately 300 industrial companies engaged in catching and the processing fish. However, official indicators only consider such aspects as small production support infrastructure, industrial park, fishery marketing and distribution, and labour force to be involved in national extractive fishery. They claim this activity is hardly expressive in the country's socio-economic context. Still, in terms of generating jobs and food for a contingent of Brazilians who live on the coast and near rivers, the real importance of this activity can be verified (actually, fishery is one of the few activities that absorbs man power with little or no qualification, both rural and urban – representing, in some cases, the only job opportunity for certain groups of individuals, especially among the socially excluded population). These facts demonstrate that Brazilian fishery is a basic component of Brazilian socio-economy.

In regard to maritime fishery in Brazil, it can be classified according to its purpose or economic category as follows: amateur fishery, subsistence fishery, artisan or small-scale fishery, and industrial fishery.

**Amateur fishery** is practised throughout the Brazilian coast for tourism, leisure or sport, and the product of the activity cannot be commercialised or industrialised. Subsistence fishery is performed with the objective of obtaining food; it has no commercial purpose and uses rudimentary techniques (Dias-Neto & Dornelles, 1996).

**Artisan (or small-scale) fishery** includes both subsistence catches, associated to obtaining food for the participants' families, as well as the essentially commercial fishery. It can also be a seasonal alternative for those who are engaged in agricultural practices during part of the year - fisherman/farmer (Dias-Neto & Dornelles, 1996). Diegues (1983) claims that artisan or small-scale fishery has its bases on the family unit, or on a neighbourhood group. One of its characteristics is the fact that the producers own their means of production (nets, hooks etc.).

Diegues (op. cit.) subdivides business/industrial fishery in two sub-categories: one is developed by ship owners, and the other is the actual business or industrial one. Business fishery developed by ship owners is characterised by the fact that the actual proprietors of the fishing boats and equipment – the ship owners – do not participate directly in the productive process, which is delegated to the captain of the boat. The vessels are bigger in size and range than those used by small-scale fishermen, and demand a certain division of tasks among all members of the crew – master, cook, ice-man, machinist, fisherman, etc. Besides their propeller engines, they also have certain fishery support equipment, which requires some formal training for certain specific functions. These devices, however, do not replace completely the know-how of the fishermen, particularly the master, who uses it in the same way as small-scale producers, the social group he usually comes from. Just as in small-scale fishery, labour is paid according to the share system, although there may be some complementary forms of payment for certain jobs. In industrial fishery, the company owns both the boats and the equipment. It is organised in different sectors and, in some cases, it vertically integrates catching, processing and marketing. The boats are equipped not only to sail, but also to perform some of the fishing tasks, such as launching and collecting of nets, and, in some cases, processing the fish on board, which does not happen in artisan fishery. Although the labour force is mostly recruited from small-scale fishermen and ship owners' crews, they usually need specific training to operate the machinery that substitutes, more thoroughly, traditionally obtained know-how. It is common practice for workers to receive monthly or weekly wages, although these only serve as a basis, since the share system still predominates. In this case, though, the shares are calculated on the global value of the production.

Long-term variations, both in marine and in fresh water environments, consist as one of the greatest threats to fishery sustainability. Such changes directly affect the production, especially recruiting, and disturb the management systems, since scientists are unable to distinguish climatic impacts from fishery ones (Walters & Parma, 1996). In this regard, the FAO (1995) presents several examples of increase in fish populations reported from the late 70's until the mid-80's, pointing out that they seem to constitute a very broad and uniform view of numerous marine ecosystems spread over different oceans.

Concerning Brazilian fishery, there is no deep and comprehensive research about these relations, but only a few studies of isolated cases, as in the case of the lobster and the sardine in marine environment. Rossi-Wongtschowski et al. (1996) presented some hypotheses on the possible causes of the Brazilian sardine population fluctuations in terms of regional phenomena, long-scale climatic changes, and other aspects related to fishery itself.

The serious situation of marine extractive fishery results from the difficulties in renewing fish stocks, or from overfishing the main national fishery resources, as in the case of the pink shrimp (South/South-east) and the sardine, respectively. These problems started during the 70's, as Silva (1972) and Diegues had already mentioned (1983). Some more recent analyses indicate that over 80 percent of the main stocks have reached their maximum levels of exploitation, which means they are beyond their maximum level of sustainability. Some have even reached a phase of depletion or recovery due to the pressure of fishing efforts applied on them (Dias-Neto & Dornelles, op. cit).

A synthesis of the situation of the most important estuarine and marine resources for Brazilian fishery is given below:

**a)** the pink-spotted shrimp of the northern coast (*Farfantepenaeus brasiliensis and Farfantepenaeus subtilis*) is responsible for the main fisheries of the North Coast of Brazil. It presented a growth trend up to 1987, when 10,037 tonnes were caught (gross weight) and the number of boats in operation reached 250 (the maximum allowed). From then on, there was a decreasing tendency, except for the years of 1993 and 1994. The 1999 production was 5,089 tonnes (gross weight). Up to 1996, this was considered the only resource successfully managed by the State. Nowadays, there are good chances that this resource is in a phase of overfishing in recruiting (Dias-Neto & Dornelles, op. cit.; IBAMA, 2001). The other types of shrimp found in the Northeast (*Litopenaeus schmitti, Farfantepenaeus subtilis* and *Xiphoepenaeus kroyeri*) are captured along the northeastern coast, particularly in estuaries and bays (Dias-Neto & Dornelles, op. cit.). Over the past five years, the total production of the nine states of the region varied from 15,295 tonnes in 1995 to 16,428 tonnes in 1999 (IBAMA, op. cit.).

**b)** lobsters (*Panulirus argus* and *Panulirus laevicauda*) are the most important fishery resources in the Northeast. The production of these resources presented a growth trend up to 1979, when it reached 11,032 tonnes. In 1980, the production dropped to about 8,000 tonnes, followed by a highly unstable period that lasted until 1989. In 1983 and 1986, the production reached critical levels: 5,000 tonnes and 4,440 tonnes, respectively. From 1986 to 1991, the production saw a recovery, reaching 11,059 tonnes (Dias-Neto & Dornelles, op. cit.), and a posterior decrease, with about 6,000 tonnes in 1998 and 1999 (IBAMA, 2000). These resources have been suffering from high levels of overfishing in isolated areas, which leads to unstable fishing results and a broad range of uncertainties concerning the sustainability of its uses.

**c)** The pargo (*Lutjanos purpureus*) is, in historical terms, an important fishery resource in the Northeast and, more recently, in the North. The production grew up to 1967, but decreased in three following years. Then, in 1971 it started increasing again until 1977, when the production reached 7,547 tons. From then on, the production remained around 5,000 tonnes up to 1984, when it dropped once more. In 1988 and 1990 the production was only about 1,600 tons. In that period, the resource began to face overfishing, or even total collapse (Dias-Neto & Dornelles, op. cit; e Paiva, op. cit.). From 1991 to 1999, the production presented a significant tendency to recover, reaching a record in 1999: 9,790 tonnes (IBAMA, op. cit.). The production behaviour over the past few years may have resulted from the combination of two factors: recovery of the resource in overexploited areas, and expansion of the total area of capture. The increasing participation of young people in the activities, however, has been reason of concern among specialists.

**d)** the mud crab (*Ucides cordatus*) is considered one of the most important components of mangrove fauna, and it can be found all along the Brazilian coast from Oiapoque (State of Amapá) down to Laguna (State of Santa Catarina) (Costa, 1979; Melo, 1996). The most extensive mangrove ecosystems are in the states of Maranhão and Pará (Schaeffer-Novelli et al, 1990), and both states contributed with about 50 percent of the total controlled production of mud crab in the North and Northeast in 1998 and 1999. The average production was 9,700 tonnes; during the same period, the Southeast and South produced only 632 tons, in 1998 (IBAMA, op. cit.).

**e)** the Brazilian sardine (*Sardinella brasiliensis*) is the main industrial fishery resource in the Southeast and South of Brazil (22° to 29° S). The production peak reached 228,000 tonnes in 1973, when the fleet totalled about 200 boats. In the following years, the catches varied from 90,000 tonnes to 140,000 tons, but in 1987 the production started to decline, reaching only 32,000 tonnes in 1990 (Saccardo & Rossi-Wongtschowski, 1991; IBAMA, 1993a, 1994b; Cergole, 1995; Rossi-Wongtschowski et al., 1995). From 1994, the production started growing again, reaching 118,000 tonnes in 1997, with a slight decline in 1998 (82,000 tons) and a drastic drop in 1999 (25,000 tons) (IBAMA, 2001). Studies carried out over a 21-year period (1977-1997) identified two periods in which the stocks were most favourable (1980-1984 and 1989-1994) and unfavourable (1985-1989 and 1995-onwards). The year of 1997 seems to be the beginning of a new unfavourable period, ending up in an extremely low production in 1999. Ten-year cycles, involving favourable and unfavourable periods, are clearly identifiable in relation to the Brazilian sardine. A similar phenomenon is observed in California and Japan (Cergole et al, in press). However, the present crisis is considered the most serious instance of resource depletion.

- In the Souheast and South, the most important fishery resources are the demersal fish, particularly the white-mouth croaker (*Micropogonias furnieri*), the Argentine croaker (*Umbrina canosai*), and the striped weakfish (*Cynoscion guatucupa). C. striatus*), the king weakfish (*Macrodon ancylodon*) and pink pargo (*Pagrus pargus*). In a lesser degree, we find elasmobranchs such as the tope shark (*Galeorhinus galeus*), the angel shark (*Squatina spp*) and the viola (*Rhinobatus horkelli*) (Haimovici et al, 1996; Vooren et al, 1990). The production of the four first species in the states of São Paulo, Santa Catarina and Rio Grande Do Sul grew up to 1977, when it reached 53,669 tonnes. From then on, it presented some fluctuations and a severe drop in 1988, when the production was only 24,934 tonnes. After that, it started to recover, but never reached 50,000 tonnes again (Dias-Neto & Dornelles, op. cit.). The production of the last five years has varied between 30,000 tonnes 40,000 tonnes (IBAMA, op. cit.). According to GPE, the four main species have been fully exploited or even overfished since 1984.

- Commercial shrimp fishery in the Southeast and South of Brazil is directed at the following species: pink-spotted shrimp (*Farfantepenaeus brasiliensis and F. paulensis*) white shrimp (*Litopenaeus schmitti*), seabob shrimp (*Xiphoepenaeus kroyeri*), Argentine prawn (*Artemesia longinaris*) and Argentine red shrimp (*Pleoticus muelleri*). Fishery of *Farfantepenaeus* genus shrimps is practised on two population extracts: the industrial segment acts on reproductive adults in the continental platform, and the artisan segment on the younger populations in estuaries and bays (D'Incao, 1991). The other species are shrimps whose lifecycles only take place in the ocean (Valentini et al, 1991b, 1991c; D'Incao, op. cit.). Amongst the shrimps, the most important economic resource is the pink-spotted shrimp (Valentini et al, 1991a). The volume of catches effected by artisan fishery dictates the behaviour of the total production. The highest production was 16,629 tonnes in 1972, and one of the worst years was 1994, with only 2,072 tonnes (IBAMA, 1995a). The total 1998 production of the pink-spotted shrimp in the Southeast/ South was the lowest of the historical series (only 1,901 tons), and in 1999 it was 2,143 tonnes (IBAMA, op. cit.). The situation of this resource is considered critical (Dias-Neto, 1999a). The seabob shrimp is captured in the southeastern and southern regions of the State of Espirito Santo and in the State of Santa Catarina. The behaviour of the total production of this resource shows a growth trend up to 1973 (13,954 tons), with some decreases and a recovery leading to the new record, reached in 1982 (15,580 tons). From then on, a period of fluctuations was observed, with a decreasing tendency up to 1991 (4,657 tons). It recovered again after that, reaching 7,119 tonnes in 1997. The 1999 production was only 4,116 tonnes, the lowest in thirty years (IBAMA, op. cit.). The situation of this resource is considered preoccupying (Dias-Neto, 1999a)

- Tuna fishery in Brazil is one of the most complex because of the variety of catching methods used and the number of different species involved. Besides, it is practised all along the coast (Dias-Neto, 1996). The most important species are: the skipjack tuna (*Katsuwonus pelamis*), the yellowfin tuna (*Thunnus albacares, T. alalunga, T. atlanticus*), the swordfish (*Xiphias gladius*), the seabream coryphene (*Coryphaena hyppurus*), the mackerel (*Scomberomorus cavalla*), the serra Spanish mackerel (*Scomberomorus brasiliensis*), the Atlantic sailfish (*Istiophorus albicans, Makaira nigricans* and *Tetrapterus albidus*) and several species of shark, amongst others. Tuna fishery in Brazil has shown modest development if one considers that the activity was initiated in the late 50's, and in 1995 Brazilian production was 30,000 tonnes, i.e., 5 percent of the total catches in the Atlantic and adjacent seas, as demonstrated by official ICCAT statistics (IBAMA, 1998a). Although the 1996 and 1997 figures show an expressive growth in production, Brazilian participation in the total Atlantic catches is still very modest (IBAMA, 1997). The total 1998 and 1999 production, including dogfish, was 44,236 tonnes and 39,262 tons, respectively (IBAMA, 2000 and 2001). According to ICCAT, the most important species are either fully exploited or overfished in the South Atlantic, except for the skipjack tuna (Dias-Neto, 1999a).

## 3. Conflicts over the Use of Resources

It is important to mention the conflict and competition between artisan and industrial fishery. The State's historical position in relation to the conflicts tends to favour capitalist entrepreneurs, either by clear omission in this fight between two different and antagonistic segments, or by prioritising economic aspects over class conflicts, thus strengthening the entrepreneurs' control of small producers. The State, through induced strategies, invested massively in big companies and caused capital concentration to increase. It also ignored the wealth and complexity of small producers' endogenous organisational models and stressed dual aspects - old versus modern - in independent spheres of activities, considering small fishermen as reactionary, uncultured and predatory individuals, seen as incapable to assimilate the technological standards expected by the State and the industrial bourgeoisie (Loreiro, 1985).

In the Southeast and South, the tuna fleet fishing on skipjack tuna engaged in live bait fishery, triggering a series of conflicts with local artisan fishermen and tourists. This sort of fishery started in the late 70's and quickly developed during the 80's. Trawlers using fishing nets initially captured the live bait. Later, small fleets specialised in capturing and

selling bait also started to appear. On account of the parallel trade in surplus bait, this activity was forbidden and the tuna boats were obliged to capture their own baits. Small nets were adapted to the fleet, which started to attack abundant shoals of small pelagic fish, but always in sheltered regions. At the time, Brazilian sardines were elected the best live bait, for they were the most abundant and had excellent survival rates. Anchovies were more fragile and needed more careful handling after being captured, since they died very easily. With the recovery of sardine stocks between 1993 and 1996, the pressure against live bait fishery diminished, but today, due to the new crisis, criticisms and conflicts are back.

Especially in the last decade, artisan fishery in the Lagoa dos Patos estuary and the Mirim-Mangueira lagoon complex, in the State of Rio Grande Do Sul, has suffered from clear drops in fish stocks and severe difficulties for fishery and fishermen. The reasons for this situation have been the use of predatory equipment and accentuated fishery efforts, as well as the presence of fishermen from other regions intensely exploiting the environment in the area, where they only stayed for short periods. Management actions have been successfully implemented in the area (CEPERG/IBAMA, 2001).

## 4. Fishery Distribution Marketing

The marketing process of artisan fishery is dominated by an intermediary network that includes individual resellers, generally community members specialised in buying and selling fish, as well as representatives from big companies that buy and finance production. As the surplus of this trade is reduced and irregular, internal accumulation of capital is very difficult, which makes the producers dependent on this source of financing in the form of advance payments, opening of credit accounts at food, ice and oil supply points, as well as fishing supplies shops (Diegues, op. cit.).

Dias-Neto & Dornelles (op. cit.), when analysing Brazilian exports and imports between 1985 and 1994, observed that the former presented an overall tendency to decrease, despite natural fluctuations. The figures dropped from 62,130 tonnes in 1985 to 35,561 tonnes in 1994. The revenues varied from US$ 176 million in 1985 to US$ 168 million in 1994. The exports in 1998 and 1999 were 31,635 tonnes and 36,361 tonnes, respectively, while the revenues were US$ 121 million and US$ 137 million, showing, therefore, a light recovery in the last year (IBAMA, 2000 and 2001).

As for fishery imports, those authors noticed that they presented a strong tendency to increase in volume, growing from 38,624 tonnes in 1985 to 157,462 tonnes in 1994. The values presented similar trends, (from US$ 45 million in 1985 to US$ 229 million in 1994). The 1998 and 1999 data showed that the growth trend continued, despite the drop observed in the last year. The amounts reached 197,366 tonnes and 168,960 tons, while the values were about US$ 433 million and US$ 288 million, respectively (IBAMA, 2000 and 2001).

## 5. Continental Extractive Fishery

The situation of continental fishery in Brazil is analysed below according to each water basin:

**a)** The Amazon Basin has been analysed by several authors (Bailey & Petrere, 1989; Merona, 1990; Saints & Blacksmith, 1999; Isaac & Ruffino in IBAMA, 2000). It is particularly heterogeneous in terms of space and time, has high levels of specific diversity and high yield. Commercial fishery is followed up in a 100 to 1,000-km radius of great urban centres, revealing that this sort of fishery involves a great number of species (Bailey & Petrere (1989). The species captured vary according to time and space, but the most frequent ones are: the South American silver croaker (*Plagioscion squamosissimus*), the great cichlids, especially the peacock bass (*Cichla Ocellaris*), the prochilods, particularly *jaraquis* (*Semaprochilodus insignis* and *S. taeniatus*), the *curimatã* (*Prochilodus nigricans*), the anostomids and hemiodonts, and the black pacu or *tambaqui* (*Colossoma macropomum*) (Petrere, 1978, 1978 b, 1982; Bailey & Petrere, 1989). The only fresh water species targeted by industrial fishing is the laulao catfish (*Brachyplatystoma vaillanti*), found only in the Amazon river estuary and exported to the south of the Brazil and abroad.

In the specific case of the laulao catfish, the greatest production occurred in 1977 (28,829 tons), after which a tendency to decrease was observed, with some fluctuations, up to 1992, when the production was only 7,070 tonnes (Dias-Neto & Dornelles, op. cit.). The 1999 production was 22,087 tonnes (IBAMA, op. cit.), and this resource is considered to be experimenting a phase of recovery after a period of intense overfishing.

There is also ornamental fish production, especially in the Negro river basin, where most specimens captured are exported (United States, Germany and Japan), with the strong predominance of the cardinal tetra (*Paracheirodon axelrodi*). Reservoir fishing is mostly done by professionals and has a variable specific composition, especially at the beginning of exploiting activities, after which it becomes gradually dominated by the peacock bass (*Cichla monoculus*). Studies on the "status" of Amazon fishery resources have considered them under-exploited as a whole (Bailey, 1981; Petrere, 1983; Welcomme, 1990), despite some localised or specific risks. Bailey & Petrere (1989) report a decline in the capture of bigger species near the main urban centres. The depleted stocks of some species found in Manaus is demonstrated by Bittencourt (1991), to whom fishery in this region has nearly reached the maximum level of sustainable production. Bailey & Petrere (1989) believe that the extinction of certain species, even in the case of overfishing, is unlikely to happen if environmental conditions are maintained. However, increasing anthropic occupation in the Amazon has become a risk to fishery stocks and revenues in this region. The effects of this occupation on the environment are: disturbances related to construction of dams, mineral prospecting and deforestation

**b)** In the Northeastern Basin, the Parnaíba River (362,000 km²) is an important fishing region between the states of Maranhão and Piauí. Artisan fishery activities in the meadows of the lowlands known as "baixada maranhense", influenced by the Pindaré, Grajaú and Mearim rivers, are highly seasonal as these lakes dry almost completely in the summer. During the ebb tide, the following fish are captured: *curimatá* (*Prochilodus lacustris, P. cearensis, P. argenteus*), *pescada* (*Plagioscion sp*) and *piaus* (*Schizodon sp, Leporinus sp*), mainly with circular nets. The productivity is relatively low, varying from 50-250 kg/ person/year (Paiva, 1973, 1976). The most important fishery resources captured in public reservoirs in the Northeast from 1977 to 1986 were the Nile tilapia (*Tilapia niloticus*, 26 percent), the *Piauí pescada* (*Plagiosion squamosissimus*, 22 percent), shrimps (*Macrobrachium spp*, 11 percent), common peacock bass (*Cichla ocellaris*, 10,9 percent) and *common curimatã* (*Prochilodus cearensis,* 6,4 percent) (Paiva et al, 1994).

**c)** In the Paraná River Basin, fishery resources also present a considerable degree of heterogeneity. In the basin's freer stretches[1], one finds bigger migratory species such as the speckled catfish (*Pseudoplatystoma corruscans*), the *dourado* (*Salminus maxillosus*), the *barbado* (*Pinirampu pirinampu*), the *piaparas* (*Leporinus elongatus and L. obtusidens*), the spotted pim (*Pimelodus maculatus*) and, more recently, the *armado* (*Pterodora granulosus*) (Petrere & Augustin, 1993). The first two are predominant. In the basin's higher stretches, the main fishery resources are the South American silver croaker (*Plagiosion squamosissimus*), the spotted pim (*Pimelodus maculatus and Iheringichtyhys labrosus*), the *curimbas* (*Prochilodus lineatus*), small caracids (*Astyanax spp, intermedia Moenkhausia*) and wolf fish (*Hoplias malabaricus*) (Torloni et al, 1991; Etal Correa, 1193; Carvalho Jr et al, 1993 a,b, Moreira et al, 1993). In the Itaipu reservoir, about 50 species are caught, 5 of which contribute with 78 percent of the annual output (1,600 tones): Highwaterman catfish (25 percent), *curimba* (19 percent), South American silver croaker (16 percent), *armado* (14 percent) and *cascudo-preto* (*Rhinelepis aspera*)(4 percent) (Augustin et al., 1993b). The fishery output data and composition reveal that:

- the great migratory species, seen as "noble" in commercial fishery, had poor stocks in the basin's higher segments;

[1] River stretches with no dams.

- reservoirs endowed with free stretches in their higher courses, and/or with large lateral tributaries, keep an exploitable stock of medium-sized migratory species;
- the basin's free stretches still hold considerable stocks of great migratory species (Augustin, 1993).

**d)** Fishery in the São Francisco Basin counted with approximately 26,000 fishermen in 1985 (Planvasf, 1989) and the estimated production during this period was 26,100 tonnes (Sato & Godinho, in press). In the free stretches of the basin, the dominant species were the great migratory fish, such as the speckled catfish *(P corruscans*), the *curimatã* (*Prochilodus marggravii*), the *dourado* (*Salminus brasiliensis*) (Sato & Godinho, in press). Although they are relatively important in the Sobradinho reservoir, the migratory species, with exception of *curimatã*, are inexpressive in the Três Marias reservoir, where medium-sized inexpensive sedentary species dominate (Augustin, 1993). The São Francisco Basin has a total of 11 dams and one flooded area that corresponds to about 23.3 percent of all the dammed area in the whole country (Planvasf, 1989; Sato & Godinho, in press). This fact is very important if one considers the preoccupying state of ichthyofauna conservation in this basin, particularly in relation to stocks of reofílic species

**e)** In the East Basin, from the mouth of the São Francisco river down to the extreme south of Santa Catarina, 285 species were listed, 95 percent of which are endemic (Bizerril, 1994). This basin has the biggest urban concentrations in the country, a fact that heavily affects this important ichthyofauna. Its rivers, as the Paraíba, the Doce and the Jequitinhonha, are comparatively short, and the main fishery resources are the wolf fish (*Hoplias malabaricus*) and some types of catfish (*Pimelodidae*) (Petrere, 1989).

**f)** Finally, we must mention the High Paraguay Basin, where professional and sport fishing activities are traditional and focus essentially on great migratory fish, such as the tiger catfish (*Pseudoplatystoma fasciatus*), the speckled catfish (*P.corruscans*), the *pacu* (*Piaractus mesopotamicus*) and the *curimba* (*Prochilodus lineatus*). Half of the fish production is exported to other regions, mainly to the State of São Paulo. The estimated catches were 7,505 tonnes in 1983 (Petrere & Augustin, 1993). Silva (1986) believes, however, that illegal fishery in the State of Mato Grosso do Sul corresponds to about 50 percent of the official figures. Ferraz de Lima (1993) believes that the fishing activity may be compromising the basin's stocks.

Conflicts between different groups of fishermen over continental fishery resources are mentioned by Augustin et al (1994) after the creation of the Itaipu Reservoir in the mid-80's, in the High Paraná River, on the border between Brazil and Paraguay. According to this author, a group of fishermen known as "*barrageiros*" (dammers), who had high fishing capacity (great amount of fishing devices) and operated on a temporary basis (1 to 2 years) in recently-created reservoirs, were financed by great fish-markets from the State of São Paulo. There was a series of conflicts between these markets and local fishermen and their associations.

## 6. General Behaviour of the Production

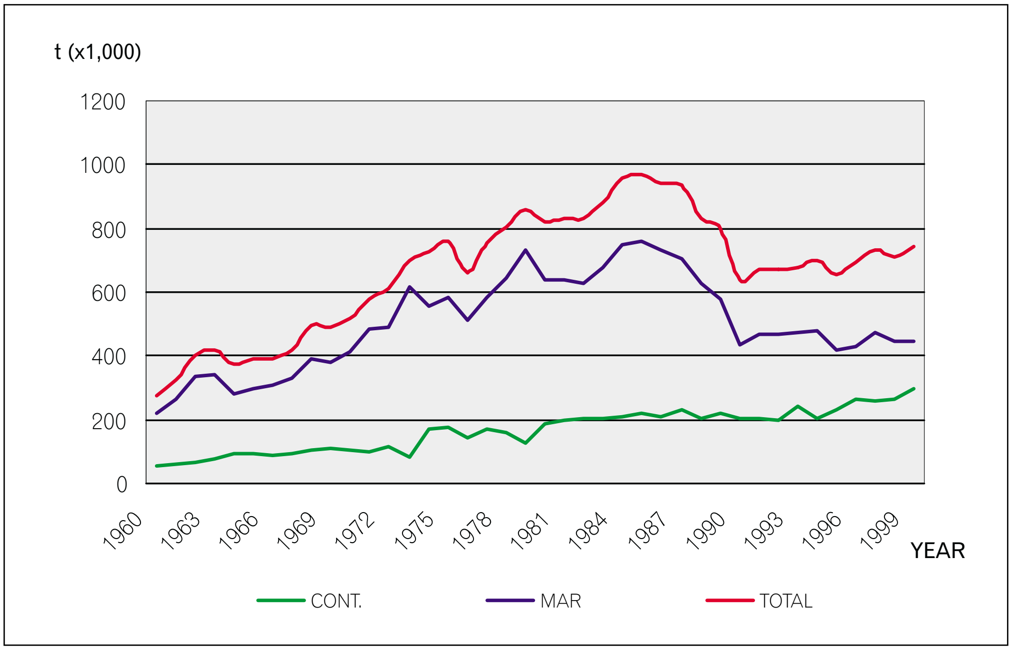
The available official historical series on national fish production between 1960 and 1999 shows a growth trend up to 1985, when it reached about 971,500 tonnes, 760,400 tonnes of which (78 percent) deriving from maritime waters and 221,100 tonnes (22 percent) from the continental environment. From then on, a continuous decrease was registered until 1990, when the production was only 640,300 tonnes, out of which 435,400 tonnes (68 percent) and 204,900 tonnes (32 percent) had been captured in marine and continental waters, respectively. The last years of the series seem to point towards a tenuous recovery, with a total production of 744,600 tonnes in 1999, 445,000 tonnes of which (60 percent) from the sea and 299,600 tonnes (40 percent) from continental waters. It is important to point out that this recovery may be related to the increment of continental production. Despite some fluctuation, the maritime production showed a stagnation tendency (Figure 1).

When analysing the accentuated decrease of 1990's total production and the relation between maritime and continental production, Dias-Neto & Dornelles (1996) presented at least two possible causes: 1) overfishing of the main fishing resources, especially the Brazilian sardine in the Southeast; and 2) the data collection methodology, or possible duplicated data collection, which resulted in an overestimate of the production. As a result, they continued, the total fish production in Brazil would be unlikely to exceed 850,000 tonnes and maritime fish production would remain under 650,000 tons. Paiva (1997) added that it was very difficult to obtain reliable statistics about Brazilian fishery due to the co-existence of two production systems (artisan and industrial), and also because the first one operates on a high number of species, with small amounts captured and ample dispersion of disembarking spots.

Until 1994, Brazilian total production was heavily influenced by the performance of maritime fishery (**Figure 2**). However, continental production has become more and more important since then, a clear result of the increment observed over the last five years of the series. This increment, in turn, resulted from the significant growth of production associated to aquaculture in continental waters, which rose from 400 tons, or about 0.5 percent of the total production in 1994, to 114,100 tonnes, or about 18.9 percent in 1999. At the same time, extractive fishery seems to have stagnated or even decreased (**Table 1**).

Paiva (op. cit.) focused on Brazilian estuarine/marine fishery from 1980 to 1994, and calculated an annual average of 600,000 tonnes, 240,000

**Figure 2 - Brazilian continental, maritime and total fishing production, from 1960 to 1999**




tonnes/year (40 percent) of which produced by artisan fishery and 360.000 tonnes/year (60 percent) by industrial fishery.

Industrial fishery is more important in the Southeast and South, which are the richest in the country (Paiva, op. cit.) and received the most tax incentives. Artisan fishery is more representative in the North and Northeast of Brazil.

It is important to point out that artisan fishery continues playing an important role in the national scenario. Considering that almost all continental extractive fishery is small-scale or artisan, it can be inferred that this type of fishery still accounts for about 60 percent of all national extractive production.

In terms of regional participation in estuarine-marine production between 1980 and 1994 (Paiva, op. cit.), artisan fishery averaged as follows: Southeast: 38.6 percent; South: 34.1 percent; North: 15.6 percent; and Northeast: 11.7 percent.

The production behaviour of marine extractive fishery can be considered "preoccupying" and deserves the attention of those responsible for national fishery management, especially when the perspective of its sustainability is considered (Dias-Neto & Dornelles, op. cit.; Paiva, op. cit.).

On the other hand, the estimated 1994-1999 continental extractive fishery production (**Table 1**), points towards a decrease. The highest production was 210,277.5 tonnes in 1996, and 185,471.5 tonnes in 1999. Of the latter, 98 percent correspond to fish and 2 percent to crustaceans. It represented 25 percent of all national fishery production in that year (IBAMA, 2000).

Regarding the evolution of total aquaculture production over the past few years, it seems that Brazil has a rather promising future, having grown from 40,000 tonnes in 1994 (Castagnolli, 1996) to about 140,600 tonnes in 1999 (**Table 1**), which corresponds to a 263 percent increase. In average, aquaculture has been growing 29.2 percent a year, i.e., 4.4 times the world's growth taxes for the same period. Thanks to these figures, Brazil has been gradually moving up in the international FAO ranking, going from the 35th place in 1991 to the 26th in 1999. However, Brazil contributes with only 0.2 percent of the world fishery production.

In 1999, the regional participation in total aquaculture production was distributed as follows: the southern region still occupied the first place, with 55.5 percent of the total, followed by the Southeast, with 16.7 percent, the Northeast with 14.4 percent, the Central West with 9.1 percent and the North with 4.4 percent. Among the southern and southeastern states, Rio Grande do Sul presented the largest production (21.6 percent), followed by Santa Catarina (18.9 percent), Paraná (14.9 percent) and São Paulo (9.5 percent). Although the southern and southeastern regions do not have favourable weather conditions for species such as carps (*Cyprinus spp.*), tilapias (*Oreochromis nilóticus* and *Tilapia rendalli*) and catfish, aquicultivation activities are very significant in those regions. The reasons for this fact are the use of appropriate technologies, the availability of subsidies, and the mobilisation of producers' associations.

It seems important to point out, however, that in the specific case of Brazilian maritime fishery, environmental issues and other human activities are not the main causes for depletion of supplies, although this can be the case in some isolated points of the coast (Marrul-Filho, 2001). The same cannot be said for the continental environment.

As mentioned before, the national extraction fishery production is stagnant and the fishery sector has been under the spell of a crisis for over a decade. More than 80 percent

**Table 1 - Production per environment and Total Production (in tonnes), and relative participation (%) of extractive fishery and of maritime and fresh water aquiculture, from 1994 to 1999.**

t x 1,000

| Year | Extractive Fishery | | | | Aquiculture | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Marine | Continental | Total | % | Sea | Fresh Water | Total | % | |
| 1994 | 494.3 | 203.2 | 697.5 | 99.5 | 3.4 | 0.4 | 3.8 | 0.5 | 701.3 |
| 1995 | 413.7 | 193.0 | 606.7 | 92.9 | 5.4 | 40.8 | 46.2 | 7.1 | 652.9 |
| 1996 | 422.2 | 210.3 | 632.5 | 91.2 | 8.5 | 52.2 | 60.7 | 8.8 | 693.2 |
| 1997 | 465.7 | 178.9 | 644.6 | 88.0 | 10.2 | 77.5 | 87.7 | 12.0 | 732.3 |
| 1998 | 432.6 | 174.2 | 606.8 | 85.4 | 15.3 | 88.6 | 103.9 | 14.6 | 710.7 |
| 1999 | 418.5 | 185.5 | 604.0 | 81.1 | 26.5 | 114.1 | 140.6 | 18.9 | 744.6 |

Source: IBAMA - 2001

of the main marine fishing resources are fully or over exploited, and some are even totally depleted or recovering from over-exploitation (Dias-Neto & Dornelles, op. cit.). The situation has worsened in the past few years, and the production of continental water resources is declining.

The picture presented above might be a result of the fact that, until the late 1980s, fishing resources were mainly considered an economic resource. Their management was based on practices that worked on the land and were more appropriate for agriculture. Only in the early 1990s did the management start to be based on environmental principles and consider the available resources as part of the aquatic ecosystem. Besides being more consistent with fishery reality, this view represented a positive change of paradigm. This change of paradigm was, in fact, very general and related to the public sector's having taken to environmental protection – already a public concern in most countries for the past 30 years. In Brazil it took a more comprehensive connotation in the late 1980s and 1990s, a fact which resulted in the already mentioned positive impacts.

Nevertheless, the sector has been facing serious difficulties over the past few years, as mentioned before. One possible explanation for this is the fact that the public, private or so-called third-sector environmental areas of the country still fail to consider or include fishery resources as environmental resources. As a result, they do not include these problems or concerns in their agendas, as if these areas' exploitation or depletion did not deserve their attention. Exceptions must be made for some "symbols" as whales, manatees and turtles, which are important but not enough, and are still associated to "endangered species". One must remember that other species have, beyond their intrinsic value as environmental resources, a great importance as the basis for generating food, job and wealth in the short, medium and long terms, especially when exploited under the perspective of sustainable use.

An additional problem is the fact that these are "invisible" resources. This makes it difficult for the layperson to understand the consequences of using them. Besides, until recently there was an unjustified expectation that this paradigm had a limitless potential.

## 7. Difficulties and Impacts

The fishing activity is performed in a complex environment and subject to a series of internal and external effects, whose correlation is not well known yet. Thus, aquatic environment and the living creatures that inhabit it suffer influences from natural climatic and oceanographic oscillations, making it difficult to forecast fishery results (Dias-Neto & Dornelles, op. cit.). Amongst the vectors of environmental impact, the most important are domestic, industrial and agricultural pollution, construction of dams and landfills, canalisation of rivers, deforestation and reef destruction, as well as many others that directly affect the aquatic environment and its natural productivity.

In the case of continental fishery, amongst the causes of production decline are deforestation, prospecting, domestic, industrial and agricultural pollution, construction of dams (hydroelectric plants) and landfills, and canalisation of rivers and streams, which modify available feeding and spawning habitats. Unfortunately, many of the instruments currently being used to mitigate these problems have proved to be sources of new damages for the maintenance of fishery supplies, as for example, restocking reservoirs with exotic fish species (Petrere, 1994).

Several factors have limited the development of the productive chain of aquaculture in Brazil, such as: the great number of cultivated species; lack of competitive production systems; lack of qualified labour force; lack of professionalism and absence of modern food, health and environmental management techniques; absence of studies aiming at genetic improvement; poor organisation of the producers for marketing their products; low effectiveness of technical support services; lack of a production financing programme; lack of quality control practices; low management capacity throughout the productive chain; lack of origin and quality certification; and lack of institutional marketing and competitiveness (Bernardino, op. cit.). In addition, the main impediments for aquacultivation are still the pollution caused by farms, the dissemination of diseases among cultivated organisms and wild ones, the dependence on world supplies of fish flours and oils (basic ingredient for fish and carnivores feed), and the conflicts related to the use of land and water. On account of this, producers have been suffering significant pressures from public opinion and have started adopting measures aimed at the sustainable development of their activity, such as the use of less pollutant feeds, reduction in the use of chemical products, preventive sanitation measures, water recycling and reduction of animal origin ingredients in their feeds. These requirements suggest different lines of research, especially those related to "clean production technologies", genetic improvement of food products and quality in general (Carvalho & Chamas, 1999).

On the other hand, people may ask why Brazil, a country that has such great biodiversity, should need to introduce exotic species in aquacultura. Undoubtedly the answer lies on our incipient knowledge of native species. Although there is an enormous amount of species that can be potentially cultivated, only few have been studied and even fewer could be considered reasonably domesticated and possibly successful, considering currently available technologies. It is not by chance that the most widely cultivated species in Brazil - marine carps, tilapias, trout, shrimp and oysters - are also widely cultivated around the world. They are also the best studied species, and therefore have clear production technology. This highlights the importance of not introducing or transporting other species. and the need to concentrate our efforts and resources to define the most appropriate Brazilian fish for fish farming. Also, the market's regional preferences and conditions should be considered, besides the species' intrinsic zoo-technical potential.

In addition, there are a number of diseases caused by the ingestion of badly prepared fish. The World Health Organisation (apud Cecarelli & Figueira, 1999) estimates that 39 million people have been infected around the world with parasites through the ingestion of freshwater fish and crustaceans, either raw or improperly cooked. These authors ponder that, although the use of animal excrement in fish farming has progressed a lot and contributes significantly to fish production world-wide, one must never forget that the these excrements contain a variety of virus pathogens,

protozoans and helminths that can be transmitted to humans through water or aquatic organisms and may become a great danger for public health.

Despite the great number of comparative and competitive advantages found in this chain related to the cultivation of bivalve clams, this sector needs actions aimed at solving some of the following problems:

- variations in production techniques and ignorance of production costs;
- lack of sanitation certification (necessary for marketing the production around the state);
- producers' low management capacity to operate the processing units;
- absence of a co-operative mentality;
- lack of an agile distribution scheme;
- visual pollution caused by the lack of standardisation of structures, hindering the tourism industry on the coast; and
- absence of studies determining the capacity of the culture areas, leading to environmental damages, illnesses, increase of culture time and mortality (Ostrensky, 2001).

On the other hand, although marine carcinocultivation is technologically viable today, it runs the risk of not being sustainable due to the fast degradation produced during the implantation and functioning of the projects. So, in order to evaluate the problems of coastal aquaculture, one must consider the nature of the multiple uses of mangrove swamps and the need to preserve them (Lisboa, 1999).

In this context, it is always worth remembering that the fast growth of marine carcinocultivation over the last years has been criticised by representative segments of society due to the destruction of mangrove areas, pollution of the water, salinisation of fresh water and other environmental impacts. These undeniable impacts are mainly the result of bad planning and bad management by some producers and governmental institutions, rather than natural consequences of this activity. As has been seen in other countries, if managed properly, marine carcinocultivation is not harmful to the environment (Queiroz & Kitamura, 2001). As Lisbon says (1999), while evaluating coastal aquacultivation problems, one must consider the nature of the multiple uses of mangrove swamps and the need to preserve them, for, although marine carcinocultivation is technologically viable today, it runs the risk of not being sustainable due to the fast degradation produced during the implantation and functioning of the projects.

Aquatic ecosystems are the most difficult to manage properly and protect from degradation. Water is a fundamental natural resource in these ecosystems, which may reach extensive areas spread over several countries. However, water may be subject to different policies: it allows various uses, and therefore takes on different degrees of importance, and shelters numerous aquatic species, many of which are not even known. The use of this resource for food production, as in the case of agricultural systems, invariably leads to alterations in the stability of ecosystems.

Actually, as a food producing culture, the environmental impacts caused by aquaculture are closely related to the management and production models adopted in that area. Aquacultivation, as other farming activities, is developed in areas that were originally part of a natural ecosystem. With the implantation of aquicolous projects and their management and raising practices, including the demarcation of their establishments, these parts of ecosystems started functioning as agroecosystems, i.e., fractions of the ecosystem that have their biogeochemical cycles intentionally modified with the objective of increasing the productivity of some organisms.

## 1. Characterisation of the disasters

Disasters are classed in terms of **evolution, intensity and origin.**

As for their evolution, disasters are classed as:

a) **Fast or acute-evolution disasters:** landslides, heavy rains, windstorms, and fires in industrial facilities and in buildings with a large number of people, earthquakes, volcanic eruptions and others.

b) **Gradual or slow-evolution disasters:** drought, erosion, loss of cultivable soil, desertification, soil salinisation and other.

c) **Disasters from a combination of partial effects:** traffic accidents, work-related accidents, increased violence, drug traffic, cholera, malaria, acquired immune deficiency syndrome.

As for the **intensity** of disasters, they are classed as:

a) ***small-scale disasters or accidents*** (Level I),
b) ***mid-scale disasters*** (Level II),
c) ***large-scale disasters*** (Level III),
d) ***major-scale disasters*** (Level IV).

In Brazil, disasters of intensity levels III and IV are legally recognised by the federal, state and municipal governments as state of public calamity and emergency. Acute and major-scale disasters are considerably rare in our country. On the other hand, disasters from a combination of partial effects and slow-evolution disasters are frequent and every year they generate greater damages and losses.

As for the causing effect **origin** or **primary cause**, disasters are classed as:

a) **natural,**
b) **human or anthropogenic,**
c) **and mixed.**

**Natural Disasters** can be related to:

a) **Spatial origin:** meteorite impact.
b) **External earth geodynamics:** wind-caused disasters, those related to external temperatures, with the increase or intense reduction of water precipitation.
c) **Internal earth geodynamics:** earthquakes, tidal waves and tsunamis, volcanic eruptions, gravitational mass movements (sliding, tumbling or falling mass) and mass transportation processes (laminar erosion, linear erosion, soil subsidence, fluvial erosion, sea erosion), and sand dune advancement.
d) **Biocenosis unbalance:** vegetable and animal plagues.

The nature of **human** or **anthropogenic** disasters can be:

a) **Technological:** spatial of technological nature, those related to means of transportation, to civil construction, fires in industrial facilities and in high user-density buildings, to hazardous products, to demographic concentrations and at risk of collapse or exhaustion of energy or of other essential resources or systems.

b) **Social:** related to urban and rural ecosystems (intentional destruction of fauna and flora, depredation, by means of uncontrolled deforestation and poor agricultural and ranching management, accumulation of mining reject material and other); related to social convulsions (unemployment, famine and malnutrition, intense and uncontrolled migrations, increased violence, poor or marginalised children and teenagers, generalised riots and disorder, drug traffic, increased criminality rates, delinquency and organised crime, terrorism, religious, ideological or racial-related persecutions), related to warlike conflicts (urban, civil and revolutionary wars, conventional wars, guerrillas, biological, chemical and nuclear wars).

**c) Biological:** dengue, yellow fever, malaria, Chagas' disease, cholera, salmonellae, shigelloses, food poisoning, measles, tuberculosis, meningitis, hepatitis B and C viruses, acquired immune deficiency syndrome and other.

**Mixed Disasters** can be related to:

**d) External earth geodynamics:** ozone layer depletion belts, intensification of the greenhouse effect, acid rain and increased air pollution, due to the temperature gradient inversion in the atmospheric layers.

**e) Internal earth geodynamics:** induced seismicity, desertification and soil salinisation.

Since most disasters can cause human, material and environmental damages, there is no sense in classing them based on the consequences. This way, the environmental disasters would encompass almost every disaster.

## 2. Human Actions and the Disasters

According to the Brazilian Doctrine of Civil Defence, *disaster* is the result of natural or man-caused adverse events on a vulnerable ecosystem, causing human, material and environmental damages and subsequent economic and social losses. Therefore, the intensity of a disaster depends on the interaction between the magnitude of the adverse event and the vulnerability of the receiving system, and it is quantified by reason of the characterised damages and losses. Epidemiological studies show that, in the last century, natural disasters produced damages far superior than those caused by war, specially in Brazil, a country with no warlike history.

The immediatist and antientropic economic development which took place in a large number of industrial districts and the disorganised city growth are two factors that strongly contributed to the environmental deterioration and aggravation of the vulnerability of human ecosystems. Because of the social segregation resulted in certain countries and social classes, the underprivileged – culturally, socially and economically – suffer the impacts of the disasters more intensely.

The economic crisis that struck the country, specially from the 70s on, helped generating highly negative reflexes on the process of social development and the communities' security against disasters. Followed by high unemployment rates, speculation, famine, malnutrition, uncontrolled migration, reduced patterns of social well-being, regional inequities, lack of urban infrastructure and insufficient fundamental services, the crisis brought about an atmosphere of uncertainty, causing human disasters related to urban violence and social conflicts, contributing significantly to an increased social debt. It also led to an increase in belts of extreme poverty in urban centres, which affected the country's general development, having repercussions such as economic stagnation, reduced tax revenues and increased cost of living.

In Brazil, there has been an increasingly higher number of disasters. Consequently, the enormous damages and losses have been reflecting on the national development, specially in the Northeast, stricken by successive droughts and floods.

Retrospectively, we can see that after many decades of effort, there were few advances achieved in reducing the vulnerability of the Brazilian society to disasters, even those with a cyclic nature. Response actions to the disasters and in terms of rebuilding demand a great sum of money, and they might consume resources that could be allocated to development programmes.

## 3. Brazil and Civil Defence Governmental Actions

in Brazil, the governmental organisation of civil defence action was created for the protection of the population at risk of bombings and armed conflicts during the World War II, when the Brazilian government joined the Anglo-Soviet Alliance. From this moment on, the agencies at the three government levels – federal, state and municipal – have gone through various changes and associations.

Some large-scale disasters were directly related to the advances of the civil defence organisation in the states.

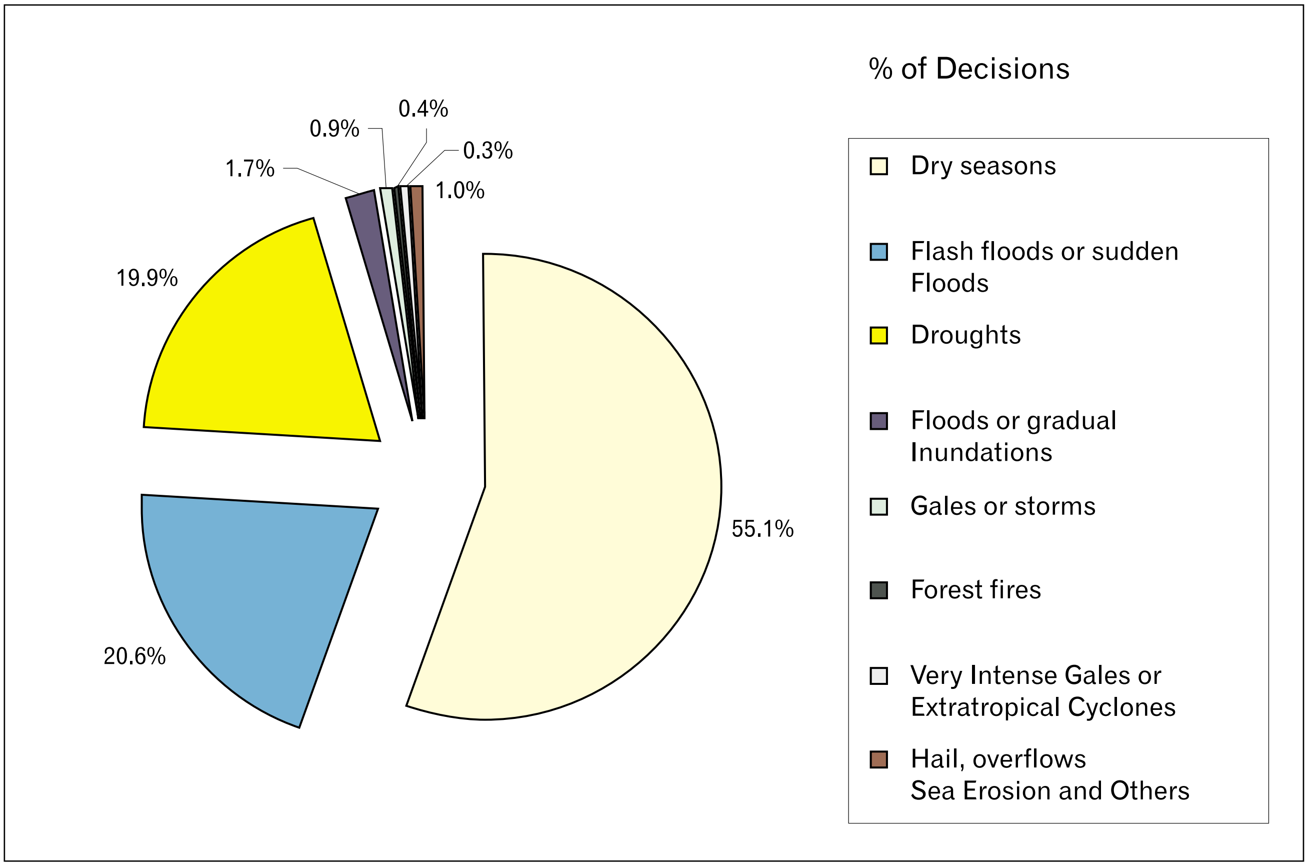
During the 1960s, the most remarkable fact was the creation of the Civil Defence in the old State of Guanabara, in consequence of the floods of 1966 in that state. By the end of the decade, the Federal Government created the **Special Group for Public Calamity Support (GEACAP – Grupo Especial de Apoio às Calamidades Públicas)**, with the aim of implementing guidelines and norms of action for a permanent defence against public calamities.

During the 1970s, the Civil Defence was created in the State of São Paulo after the infamous fires in the Joelma and Andraus buildings. The Federal Government established the **Special Secretariat for Civil Defence (SEDEC – Secretaria Especial de Defesa Civil)** within the Ministry of the Interior, aimed at co-ordinating Civil Defence actions in the entire Brazilian territory.

During the 1980s, the most important natural disasters were the great drought of 1979-1983, which affected a population of over 30 million in the Northeast, and the flood in the South Region, which affected about 80 percent of the State of Santa Catarina. The human-caused disaster that had the greatest impact was the Cesium-137 radioactive accident in Goiânia, State of Goiás, in 1987.

The National Civil Defence System (SINDEC – *Sistema Nacional de Defesa Civil*) is based on the municipal agencies, which are responsible for disaster reduction management in the municipalities and for the co-ordination of response actions to disasters, when they occur. Its structure was formalised after the Federal Constitution of 1988 was promulgated, by Decree Law no. 97,274 from 12 December 1988. From the beginning of the 1990s on, there were advances in the institutional organisation of Civil Defence structures in the states and municipalities based on the federal legislation. Thus, SINDEC was updated and re-organised by Decree Law no. 895, from 16 August 1993. It should also be noted that from 1990 to 2001 SINDEC belonged to 7 different Ministries, with differing structures and denominations. Such administrative reforms affect the continuity of any sectorial or national policy.

**Graphic 1 - Desasters - 1991 a 2001**




Source: SEDEC/MI

There is a great need for a governmental effort aimed at strengthening the municipal organisation in order for it to perform its mission of global security for the population, in addition to avoiding improvisation in disaster circumstances (**Chart 1**).

## 4. Major disasters and consequences

Disaster-related data were collected through two forms approved by the Brazilian National Council for Civil Defence – CONDEC (*Conselho Nacional de Defesa Civil*), the Disaster Preliminary Notification – NOPRED (*Notificação Preliminar de Desastres*) (APPENDIX III) and Damage Assessment – AVADAN (*Avaliação de Danos*) (APPENDIX IV). The Brazilian Information System on Disasters – SINDESB (*Sistema de Informações sobre Desastres no Brasil*) is being developed; therefore, it does not allow global consolidation of the information on disasters at national level.

As may be observed, in a ten-year period – 1991/2001, most disasters of levels III and IV are of natural origin, and are related to climatic factors.

In 2000 and 2001, the trend of major disasters was confirmed. During that period, 99.2 percent of all Recognition Decrees for Disasters of levels III and IV – emergency and state of public calamity – refer to dry seasons and sudden floods.

Thus, the following items can be mentioned as major disasters:

### 4.1. Droughts

From the meteorological point of view, drought is a long dry season, characterised by causing a sustained reduction in existing water reserves.

**Chart 1 - Current situation of the Civil Defense Municipal Organisation**

| States | Number of Municipalities | Municipalities with COMDEC | % |
|---|---|---|---|
| North Region | 449 | 67 | 14.9 |
| Amazonas | 62 | 5 | 8,. |
| Pará | 143 | 35 | 24.5 |
| Amapá | 16 | 1 | 6.3 |
| Acre | 22 | 15 | 68.2 |
| Roraima | 15 | 0 | 0 |
| Rondônia | 52 | 7 | 13.5 |
| Tocantins | 139 | 4 | 2,9 |
| Northeast Region | 1,789 | 768 | 42.9 |
| Maranhão | 217 | 4 | 1.8 |
| Piauí | 221 | 45 | 20.4 |
| Ceará | 184 | 184 | 100.0 |
| Rio Grande do Norte | 166 | 51 | 30.7 |
| Paraíba | 223 | 14 | 6.27 |
| Pernambuco | 185 | 53 | 28.6 |
| Alagoas | 101 | 1 | 1 |
| Sergipe | 75 | 0 | 0 |
| Bahia | 417 | 417 | 100,0 |
| Midwest Region | 449 | 56 | 12,5 |
| Goiás | 242 | 10 | 4,1 |
| Mato Grosso | 130 | 18 | 13,8 |
| Mato Grosso do Sul | 77 | 28 | 36,6 |
| Distrito Federal (*) | 19 (*) | 19 (*) | 100,0 (*) |
| Southeast Region | 1,668 | 591 | 35.4 |
| Minas Gerais | 853 | 206 | 24.6 |
| Espírito Santo | 78 | 26 | 33.3 |
| Rio de Janeiro | 92 | 51 | 55.4 |
| São Paulo | 645 | 308 | 47.8 |
| South Region | 1,159 | 770 | 66.4 |
| Paraná | 399 | 245 | 61.4 |
| Santa Catarina | 293 | 293 | 100.0 |
| Rio Grande do Sul | 467 | 232 | 49.67 |
| TOTAL | 5,533 | 2,253 | 40.9 |

(*) Civil Defense agencies in the 19 Administrative Regions were not considered in the estimates
Sources: Brazilian Institute of Geography – IBGE, Civil Defense State Agencies

The droughts, which happen periodically in the Brazilian Northeast Region, are related to multiple factors driven by global geodynamics in its climatic and meteorological aspects.

It is important to emphasise that the Brazilian Northeast area is the most populated semi-arid region on Earth. The droughts severely strike the Northeast and part of the Southeast Region, comprised by 11 states: east of Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia and north of the States of Minas Gerais and Espírito Santo, in an area of 1.8 million square kilometres, with a population of 60.1 million inhabitants (Brazilian Institute of Geography and Statistics – IBGE (*Instituto Brasileiro de Geografia e Estatística*)/ 1998) (**Tabel 1**)

Generally, the semi-arid zone economy is an extensive cattle-ranching and low-output agriculture complex, supported by consortiums, including cotton (tree and shrub cotton), corn, bean and cassava. This type of agriculture, based on the production system characterised by the subsistence cultivations/cotton/cattle-ranching complex, is highly vulnerable to droughts. (**Table 2**)

A change in rain distribution, or a reduction in its volume, is enough to disorganise the whole economic activity, considering that the agricultural and cattle-ranching activity is the region's productive base that other economic sectors depend on.

The subsistence agriculture, a work and support source for the large group of small rural producers with or without land, is exactly the type of agriculture that gets mostly affected by the crisis in production caused by droughts. The scarce resource reserves of low-income producers can be used only for their own subsistence, and in extremely difficult conditions.

Another impact generated by pluviometric variations is related to the effects brought by the reduction in subsistence cultivation production upon the malnutrition of small rural producers' families. Obviously, the increase in malnutrition, associated to other causes, promotes a decrease of those populations' health conditions. Thus, the social result of drought effects is the formation of true pockets of poverty and extreme poverty, mainly composed of small rural producers migrating from rural to urban areas, contributing towards imperilling even more the already precarious sanitation, health, education, transportation and housing basic services. The Northeast already has social and economic rates that are quite lower than the national average, which makes the region a priority target of public policies dedicated to overcoming its social underdevelopment status.

In the Northeast, however, the regional vulnerabilities are expressed more seriously at the geoenvironmental level. In addition to the fact that the natural resource base is extremely poor, specially in the semi-arid region, it has been harmed by human actions which, supported by the need of survival, make the ecosystem balance extremely fragile through agricultural and cattle-ranching practices that deteriorate soils and limit rain absorption capacity, which is already scarce in most of the region.

However, in the Northeast semi-arid region, the most limiting factor, for both human and animal life and the agricultural / cattle-ranching activity, is the scarcity of water resources. As a result of such scarcity and human action, which has been aggravating it, the rates relating effective water availability and its demand, the soil salinisation process and spring pollution are of great concern

By assessing the effects of the droughts occurred in the period of 1979-1983, KHAN and CAMPOS (1992) estimate that, by calculating total loss figures in the period, it gets to the impressive mark of 1.6 million tonnes of cotton; 4 million tonnes of cassava; 3 million tonnes of corn and 952,000 tonnes of beans, without taking the losses related to other products into consideration.

"the seriousness with which people are stricken by droughts depends more on the socio-economic vulnerability of the groups than on the drought regimen itself. The stricken group is normally composed of people who are not able to form economic reserves during normal years with good winters, in order to face the droughts that will inevitably occur". CAMPOS (1995)

## - The El Niño event

It has been proved that the the El Niño event – South Oscilation has a very close relation of cause and effect with the intense droughts in the Northeast semi-arid region and with the catastrophic floods occurred in the Brazilian South and Southeast regions.

When the the El Niño event is totally formed, it brings the reduction of rain over the Brazilian Northeast as a consequence, specially over the north sector – (rainy season: February to May); the increase in rainfall over the South during December, January and February; a warmer winter over part of the South and Southeast, and strong winds at high levels over the South and Southeast.

1982-1983 ´El Niño' was the strongest one this century, according to several measurements carried out. It was not forecasted nor even recognised by the scientists in its initial

**Table 1 - Northeast: area, population and municipalities affected by droughts - Period: 1979-83**

| Drought Year | No. Of municipalities (total) | No. Of Affected Municipalities | Total area (Km2) | Affected area (Km2) | Total population (Inhab.) | Affected pop. (Inhab.) |
|---|---|---|---|---|---|---|
| 1979 | 1,416 | 513 | 1,660,333 | 538,709 | 32,930,263 | 9,114,314 |
| 1980 | 1,416 | 988 | 1,660,333 | 1,399,086 | 32,930,263 | 19,487,201 |
| 1981 | 1,416 | 1,100 | 1,660,333 | 1,441,624 | 35,922,621 | 23,256,979 |
| 1982 | 1,423 | 898 | 1,660,333 | 1,391,479 | 35,922,621 | 15,483,587 |
| 1983 | 1,426 | 1,328 | 1,660,333 | 1,591,050 | 35,921,000 | 28,954,000 |

Source: Adapted from Carvalho, O - 1988 / El Niño Committee Report - Federal Senate

stages. This occurrence was marked by an exceptional rise in temperature of sea surface in Equatorial Pacific Ocean and caused major climatic changes in Brazil.

Virtually all South and Southeast regions had rainfalls that surpassed normal levels significantly from March to August 1983. In the Northeast Region, due to the irregular rain regimen, El Niño's environmental and economic impacts in that period were very severe. After three years of low rainfall, 1982-1983 El Niño caused one of the major droughts in the history of the Northeast Region (**Table 4**).

To avoid population mass migration during the droughts occurring in 1979-1983, it was necessary to create, through work fronts, around 500,000 jobs in 1979 (8.9 percent of the agricultural Economically Active Population –EAP); 720,000 in 1980 (12.9 percent of the agricultural EAP); 1.2 million in 1981 (21 percent of the agricultural EAP); 747,000 in 1982 (13.3 percent of the agricultural EAP) and 3.1 million in 1983 (around 55 percent of the agricultural EAP), according to data provided by the Regional Development Agency for the Northeast – SUDENE (*Superintendência de Desenvolvimento do Nordeste*) (**Table 5**).
The notable facts occurred due to the El Niño event in the period of 1998 to

**Table 2 - Northeast: population affected by drought and resources used by the Federal Government in emergency programmes (1958, 1970, 1979-83).**

| Years | No of Municipalities Affected | Area Affected (km2) | Population Affected | Resources spent (Constant prices) |
|---|---|---|---|---|
| 1958 | 618 | 500,000 | 10,000,000 | 422,050 |
| 1970 | 605 | 578,400 | 9,176,000 | 225,999 |
| 1979 | 513 | 538,709 | 9,114,314 | 234,768 |
| 1980 | 988 | 1,399,086 | 19,487,201 | 740,056 |
| 1981 | 1,100 | 1,441,624 | 23,526,979 | 1,018,841 |
| 1982 | 898 | 1,391,479 | 15,483,587 | 408,298 |
| 1983 | 1,328 | 1,591,050 | 28,954,000 | 1,558,592 |

Source: Adapted from Carvalho, O - 1988 / El Niño Committee Report- Federal Senate

2000 were the incidents of looting that started in March 1998, in the municipality of Conceição, State of Paraíba, where 600 hungry people took 500 kilos of food from the school lunch warehouse. Other 43 looting incidents happened until beginning of May, in the States of Ceará, Paraíba and Pernambuco – where the situation was worse.

In the South Region, due to its high demographic density and economic importance, the abnormal rise in rainfall rates causes a great impact, as the region – which is responsible for the second GDP in the country – provides 60 percent of national production of grains and 23 percent of effective cattle-ranching production.

Among the states of the Brazilian South, the State of Santa Catarina was the most seriously affected. As a consequence of rainfall concentration over the state, its hydrological network drainage situation and the distribution of urban areas, 1982-83 El Niño's impact was devastating. The state was stricken by heavy rainfall for over two months. Of the 95,000 square kilometres of Santa Catarina's territory, 75,000 were affected, the equivalent of 135 cities, and 300,000 people were unsheltered. Out of a total of 10,700 companies in the state, 6,894 were stricken by river floods and the activities of 64 percent of them were totally suspended. Small farmers were the worst harmed because only around 10 percent of planted crops were harvested.

**Tabela 3 - Drought scope 1998/2000**
**Existing municipalities x Served municipalities by the Federal Programme to combat drought effects in the Northeast Region**

| State | Existing municipalities | | | | | Served Municipalities (in the drought peak) | | | | | Served Percentage / Existing | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. Of Mun. | Area in Sq metres | Population IBGE Census | | | No. of Munic. | Area in Sq metres | Population (IBGE Census - 1996) | | | | |
| | | | Urban | Rural | Total | | | Urban | Rural | Total | Area Sq metres | Rural Population |
| MA | 217 | 333,365.6 | 2,711,557 | 2,511,008 | 5,222,565 | | | | | | 0 | 0 |
| PI | 221 | 252,378.6 | 1,556,115 | 1,117,061 | 2,673,176 | 219 | 249,823.5 | 1,434,405 | 1,078,079 | 2,512,484 | 98.99 | 96.51 |
| CE | 184 | 146,348.3 | 4,713,311 | 2,096,483 | 6,809,794 | 181 | 144,991.6 | 2,561,099 | 2,095,911 | 4,657,010 | 99.07 | 99.97 |
| RN | 166 | 53,306.8 | 1,843,486 | 715,174 | 2,558,660 | 156 | 51,680.7 | 1,053,422 | 659,594 | 1,713,016 | 96.95 | 92.23 |
| PB | 223 | 56,584.6 | 2,261,986 | 1,043,630 | 3,305,616 | 193 | 51,138.0 | 1,310,835 | 890,250 | 2,201,085 | 90.37 | 85.30 |
| PE | 184 | 98,937.8 | 5,476,915 | 1,922,216 | 7,399,131 | 127 | 87,287.2 | 1,787,311 | 1,371,421 | 3,158,732 | 88.22 | 71.35 |
| AL | 101 | 27,933.1 | 1,673,128 | 1,143,922 | 2,817,050 | 50 | 13,011.6 | 452,550 | 513,268 | 965,818 | 45.58 | 44.87 |
| SE | 75 | 22,050.3 | 1,111,579 | 455,179 | 1,566,758 | 33 | 11,521.2 | 174,985 | 194,201 | 369,186 | 52.25 | 42.66 |
| BA | 415 | 567,295.3 | 7,826,843 | 4,714,902 | 12,541,745 | 257 | 389,232.4 | 2,952,990 | 3,184,184 | 6,137,174 | 68.61 | 67.53 |
| MG(*) | 140 | 174,923.0 | 1,244,674 | 725,571 | 1,970,245 | 140 | 174,923.0 | 1,244,674 | 725,571 | 1,970,245 | 100.00 | 100.00 |
| ES(*) | 27 | 23,968.9 | 458,543 | 145,552 | 704,095 | 27 | 23,968.9 | 458,543 | 245,552 | 704,095 | 100.00 | 100.00 |
| Total | 1,953 | 1,757,092.3 | 30,878,137 | 16,690,698 | 47,568,835 | 1,383 | 1,197,578.1 | 13,430,814 | 10,958,031 | 24,388,845 | 68.16 | 65.65 |

(*)SUDENE Action Area
Source: Population - IBGE - 1996: Area - IBGE - 1997. Served Municipalities: SUDENE/CDC

**Table 4 - El Niño Effects from 1992 to 1994**

| State | Federal Resources | | | Maximum of Workers |
|---|---|---|---|---|
| | Predicted (a) | Released (b) | (b/a) % | |
| Maranhão | 4,019,541 | 3,332,137 | 82.90 | 85,000 |
| Piauí | 8,727,888 | 8,755,546 | 100.32 | 222,015 |
| Ceará | 14,505,998 | 13,704,729 | 94.48 | 369,000 |
| Rio G. Norte | 6,044,165 | 6,063,324 | 100.32 | 153,750 |
| Paraíba | 9,936,722 | 9,121,393 | 91.79 | 252,765 |
| Pernambuco | 13,160,277 | 12,419,930 | 94.37 | 334,765 |
| Alagoas | 3,561,915 | 3,599,516 | 101.06 | 90,610 |
| Sergipe | 1,609,402 | 1,428,433 | 88.76 | 34,000 |
| Bahia | 14,505,998 | 14,551,978 | 100.32 | 369,000 |
| Minas Gerais | 1,514,152 | 575,212 | 37.99 | 32,000 |
| Subtotal | 77,586,058 | 73,552,200 | 94.80 | 1,942,905 |
| Support | 64,180 | 64,180 | 100.00 | – |
| Different Dotation | 1,121,055 | – | – | 107,095 |
| Total | 78,771,293 | 73,616,380 | 93.46 | 2,050,000 |

During the drought period, El Niño was present from 1992 to the end of 1993.
Source: Regional Co-ordination of Civil Defence

### 4.2. Dry Seasons

The dry seasons are a result of rainfall reduction, the delay of rainy seasons or the lack of rains that were forecasted for a determined period. When compared to the droughts, the dry seasons are less intense and occur during shorter periods. Although this event is less intense than drought, it produces extremely important impacts on agribusiness, because it occurs relatively often in more productive and important areas than the drought areas.

The dry season, as a disaster, is related to the intense fall of surface water reserves and the consequences of such fall on river flows and agricultural / cattle-ranching productivity.

Although the dry seasons occur more frequently in tropical regions, no area of agricultural and cattle-ranching production can be considered totally immune from the event. In Brazil, dry seasons occur frequently in the Northeast, Southeast, MidWest and South regions.

## 4.3. Floods

The increase of surface discharges can be caused by a number of immediate and/or concurrent factors. In Brazil, most of times, it is caused by intense rainfall, occasioning floods of rivers, lakes, channels and dammed areas.

Due to the extension of the Brazilian territory, which is exposed to several climate-related factors associated to a water basin network with over 55,457 kilometres of rivers, the floods occur in all Brazilian regions, in different periods of the year. The following types can be highlighted: floods or gradual inundation; flash floods or sudden inundation; overflows.

Gradual inundation is characteristics of large water basins and plains rivers, such as the Amazon River, the Paraguay River, the Nile and the Mississipi-Missouri River. The event evolves in an easily predictable way, and the flood wave develops slowly from upstream to downstream, between regular intervals. The water level rise in a gradual and predictable way; it keeps in a flood situation during some time and then flows gradually. Usually, gradual inundation is cyclic and notably seasonal.

A typical example of periodicity occurs in the annual inundations in the Amazon river basin. During almost one hundred years of observation and records, it was characterised that the flood crest occurs in mid-June in most years in the city of Manaus.

Gradual inundations are intensified by medium and long term meteorological variables, and are little subject to influence by weather daily variations; they are more related to long periods of continuous rain than to intense and concentrated rain. The event is characterised by its coverage and large extension.

**Table 5 - Productive Work Front Programme**

| State | Municipalities Served | Area in Sq metres | Rural Population Served | Benefitted Workers | Population Directly Benefitted(*) |
|---|---|---|---|---|---|
| MA | 42 | 110,729 | 840,783 | 85,000 | 425,000 |
| PI | 144 | 201,971 | 1,153,580 | 222,015 | 1,110,075 |
| CE | 181 | 146,481 | 2,203,814 | 369,000 | 1,845,000 |
| RN | 136 | 49,435 | 596,423 | 153,750 | 768,750 |
| PB | 159 | 52,020 | 1,071,533 | 252,785 | 1,263,825 |
| PE | 123 | 87,039 | 1,491,396 | 334,765 | 1,673,825 |
| AL | 42 | 13,274 | 440,579 | 90,610 | 453,050 |
| SE | 32 | 11,445 | 219,113 | 34,000 | 170,000 |
| BA | 246 | 370,841 | 3,078,962 | 369,000 | 1,845,000 |
| MG | 50 | 120,701 | 602,587 | 32,000 | 160,000 |
| NE | 1,155 | 1,163,936 | 11,697,170 | 1,942,905 | 9,714,525 |

(*) Number of Workers Served x 5
Source: Regional Co-ordination of Civil Defence - CORDEC/NE - SUDENE

The sudden inundations are triggered by intense and concentrated rainfall, over rough terrain regions, and are characterised by causing sudden and violent elevations of discharges, which flow rapidly and intensely, leading to overflow. This phenomenon is usually a surprise due to its violence and low predictability, which requires a complex monitoring.

The overflows are frequent in badly planned cities or when they grow explosively, making it difficult to carry out rainwater drainage works. The overflows in cities usually cause more material and human damage then flash floods, due to the large areas affected, normally during long periods, as there is not an appropriate drainage system in most urban areas, mainly those cut by rivers and streams.

**Table 6 - Harvest Loss in the South Region 1982-83.**

| State | Loss (tonnes) |
|---|---|
| Rio Grande do Sul | 1,693,777 |
| Santa Catarina | 1,626,298 |
| Paraná | 1,568,700 |
| South Region | 4,888,775 |

El Niño Committee Report - Federal Senate
**Source**: Federal University of Rio Grande do Sul

It is common to have a combination of both phenomena – flash flood and overflow – in urban rough areas, as happens in Rio de Janeiro (State of Rio de Janeiro), Belo Horizonte (State of Minas Gerais) and in cities built up in the mountains. In coastal cities, developed at low heights, such as Recife (State of Pernambuco) and the cities in Baixada Fluminense (region in the State of Rio de Janeiro), the coincidence with high tides aggravates the problem.

In 2000 alone, around 1.7 million people were affected by floods, corresponding to one percent of the Brazilian population, with records of 89 deceased and 16,045 unsheltered people, US$11.9 million in federal resources spent on assistance activities, in addition to the amount from state and municipal resources. (SEDEC/MI).

## 4.4. Slides

Slides are phenomena caused by the sliding of solid materials, such as soil, rocks, vegetation and/or construction materials down dropping grounds, referred to as slopes, declivities or cliffs.

Although in other countries slides can be caused by other factors, such as tremors or snow melting by volcanoes, in Brazil those mass gravitation moves are related to water infiltration and slope soil infiltration. For that reason, slides are notably seasonal in Brazil and are closely related to periods of intense and concentrated rainfall.

In Brazil, the chaotic occupation of urban slopes is the main cause of slides, which result in important human damage, including casualties, in addition to material and environmental damages, and serious social and economic losses. The slides occurring in occupied slope areas normally happen in cut slopes, landfills and natural slopes aggravated by human action.

The geographical distribution of slope slides in Brazil has been affecting mostly the States of Rio de Janeiro, São Paulo, Espírito Santo, Minas Gerais, Bahia and Pernambuco.

Among the slides occurred in Brazil, with a large number of casualties and great material losses, the ones which happened in the State of Rio de Janeiro, in the mountain cities of Petrópolis, Teresópolis and Friburgo are highlighted, when there was intense rainfall in the region for a long period. It is important to mention the slides occurred in Santos (State of São Paulo) and the slides in the surrounding areas of Salvador (State of Bahia) and Recife (State of Pernambuco), due to urban settlement in vulnerable areas. Given the large number of casualties caused by the slides, the following occurrences are highlighted:

- Caraguatatuba/São Paulo – March/1967 – 200 deceased;
- Contagem/Minas Gerais, Barraginha Slum – February/1971 – 64 deceased;
- (*)Petrópolis/Rio de Janeiro – February/1988 – 171 deceased;
- (*)Rio de Janeiro/Rio de Janeiro – February/1988 – over 30 deceased;
- Salvador/Bahia – June/1989 – around 100 deceased;
- Salvador/Bahia – June/1995 – 55 deceased;
- Recife/Pernambuco – April/1996 – 66 deceased.

(*) Munasinghe et al 1991

## 4.5. Forest Fires

Forest fires usually occur more frequently and intensely during dry seasons, and they are closely related to the reduction in environmental humidity.

Daily monitoring by satellites has shown that most heat points represent "burns". The burns occur in deforested areas, therefore they burn degraded or non-degraded pastures, secondary forests and plantations. The burns are a result of intentional fire, associated to cutting and burning forests for agricultural planting and/or pasture formation (Hecth 1985, Serrão et al 1979), and they do not mean uncontrolled forest fires.

In Brazil, the occurrence of burns includes all national territory, as it is a normal procedure in traditional agriculture, whereas forest fires occur specially in the MidWest and North regions. (**Figures 1 and 2**).

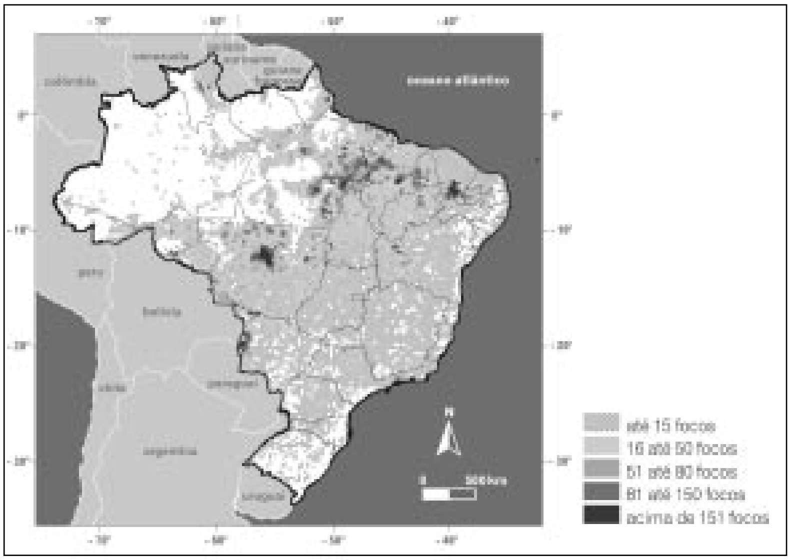
The most important forest fire occurred in March 1998 in the State of Roraima, in a 13,000 square kilometre area, which is equivalent to around 5.8 percent of the state, striking 14 municipalities, burning savannahs, forests and sub-forests (IBAMA). Only the Federal Government spent around US$2.5 million on emergency actions in that region.

### 4.6. Gales and Tornadoes

Gales are phenomena caused by notable disturbances in atmospheric normal status. They are characterised by a violent air-mass displacement, from a high-pressure area to a low-pressure area. They are also referred as very hard winds, corresponding to 10 on Beaufort Scale, the speeds of which vary between 88 and 102 km/h.

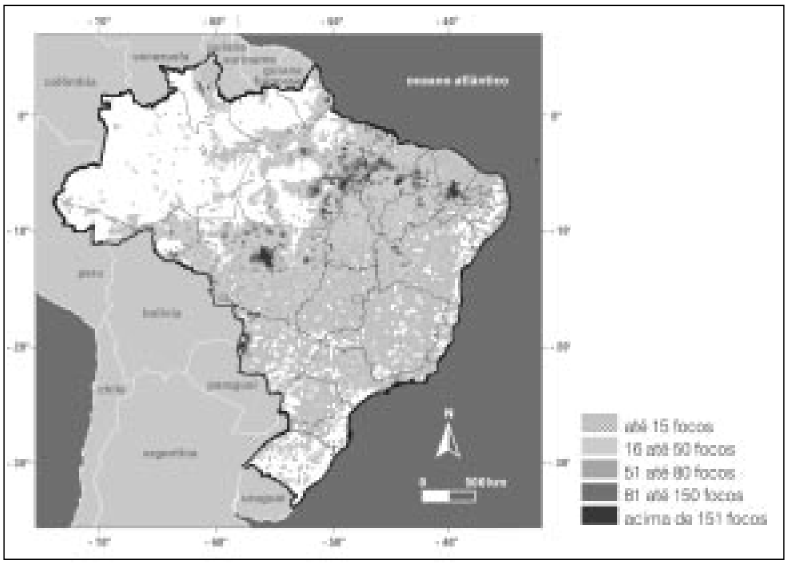
In Brazil, gales occur most frequently in the states of the South Region. Normally, the impact of gales on the environment includes: collapse of trees, with damages to constructions and plantations; collapse of wiring assemblies, causing interruptions in power supply; damages to badly constructed or badly located buildings; displacement of roof tiles; traumas caused by drowning, slides and the impact of objects transported by the wind.

**Figure 1 - Concentration of heat spots - 2000**




Source: IBGE, IBAMA - PROARCO

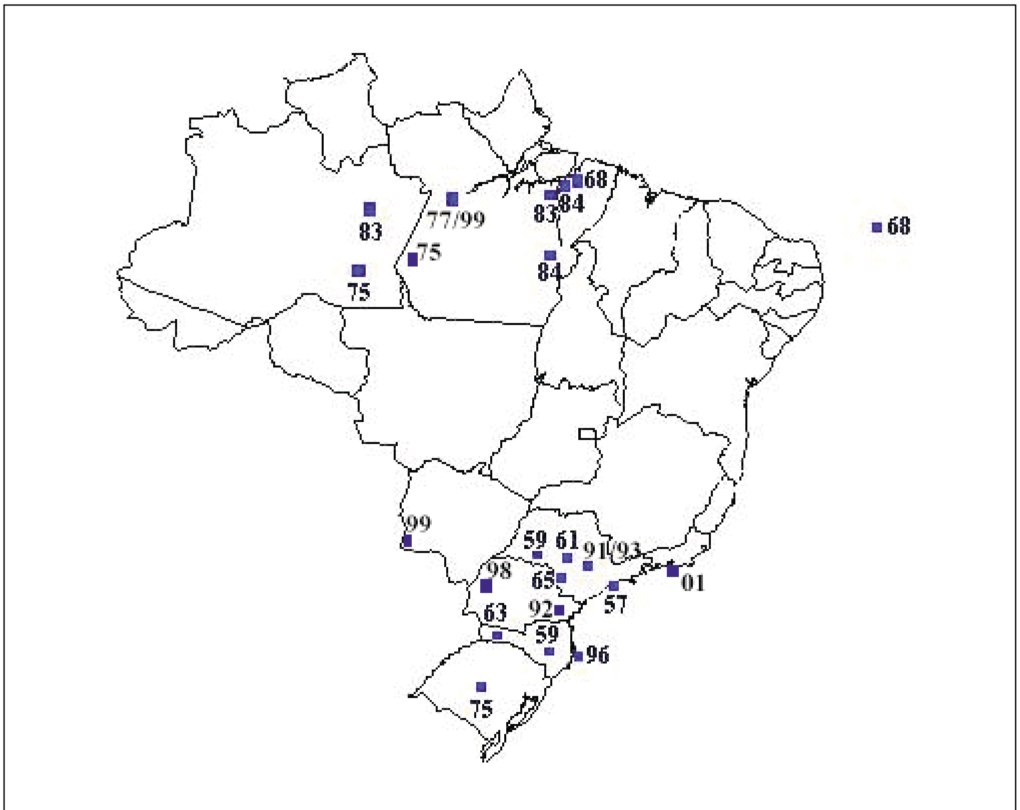
**Figure 2 - Concentration of heat spots - 2001**




Source: IBGE, IBAMA - PROARCO

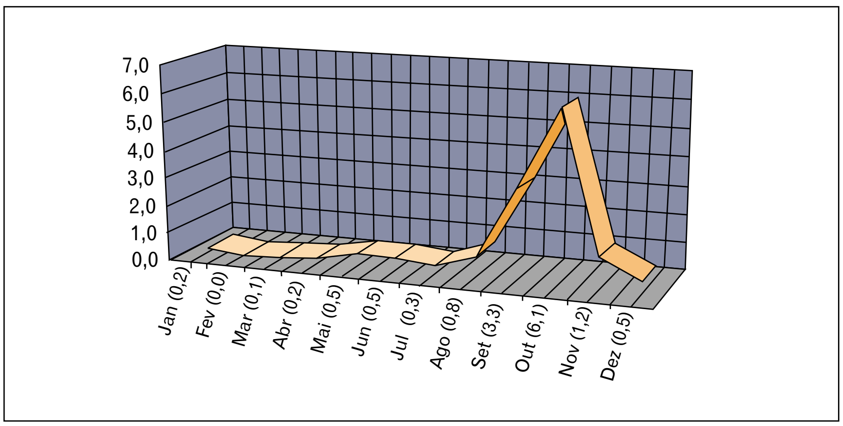
The tornadoes are phenomena with a high power of concentrated destruction, that is, damages occur along the way it ran only. For this reason, it is considered the most violent atmospheric disturbance phenomenon. This event is denominated waterspout when it occurs on water surface only, for example, on the sea or a lake. (**Figure 3**)

**Figure 3 - Tornado/waterspout spots**




The accompanying number refers to the year the prenomenon occurred
Source: Dimitrie Nechet/UFPA

**Figure 4 - Average monthly hail falls in Paraná State.**




Source: State Co-ordination of Civil Defence. Period: Jan/1980 - Dec/1999

There are several scales to measure the intensity of a tornado, but the most internationally accepted scale is the Fujita Scale, elaborated in 1957 by T. Theodore Fujita, from the University of Chicago. This scale is based on the destruction rate caused on the structures, the size, diameter or speed of the tornado. It is not about measuring it, but assessing the damage caused. The scale has six degrees (from 0 to 5), that are preceded by the letter "F" in its author's honour.

In Brazil, the tornadoes are of levels F0 and F1, which correspond to the speeds of 60-100 km/h and 100-180 km/h, respectively.

The tornadoes occur in all continents. In Brazil, they are rare and occur mainly in the South and Southeast regions, specially in the states of São Paulo, Paraná and Santa Catarina. There are also tornado records in the North Region. The following occurrences are highlighted, according to the tornado's impact:

- State of Santa Catarina State – 1959 – 34 deceased;
- Tamandaré/Paraná – May/1992, 6 deceased and 33 injured, F0.
- Itu/São Paulo – September/1991
- (*) São Paulo/São Paulo – April/ 1991
- Jacareacanga/Pará –1975, F0
- Ponta Porã/Mato Grosso do Sul – October/1999, 1 deceased e 13 injured.

(*) Brazilian Meteorology Magazine, by Silva Dias, M.A. and Grammelsbacher, E.A. Rev. Bras. Met. 6, 513-522

### 4.7. Hail

In Brazil, the regions that are mostly stricken by hail are: South, Southeast and south of MidWest Region, specially in plateau areas, and the States of Santa Catarina, Paraná and Rio Grande do Sul.

Hail causes great losses in agriculture, being usually accompanied by disastrous storms. In Brazil, tobacco cultivation and the cultivation of temperate climate fruits, such as apples, pears, peaches and kiwi are the most vulnerable to hail.

Among the material damage caused by hail, the most important ones correspond to the destruction of roofs, specially when built with asbestos or clay tiles.

## 4.8. Earthquakes, tremors

The Brazilian territory is located in the interior of South-American Tectonic Plate, away from its east and west boundaries, represented by the Meso-Atlantic Chain and the subduction zone of the Andean belt, South-America Pacific coast, respectively.

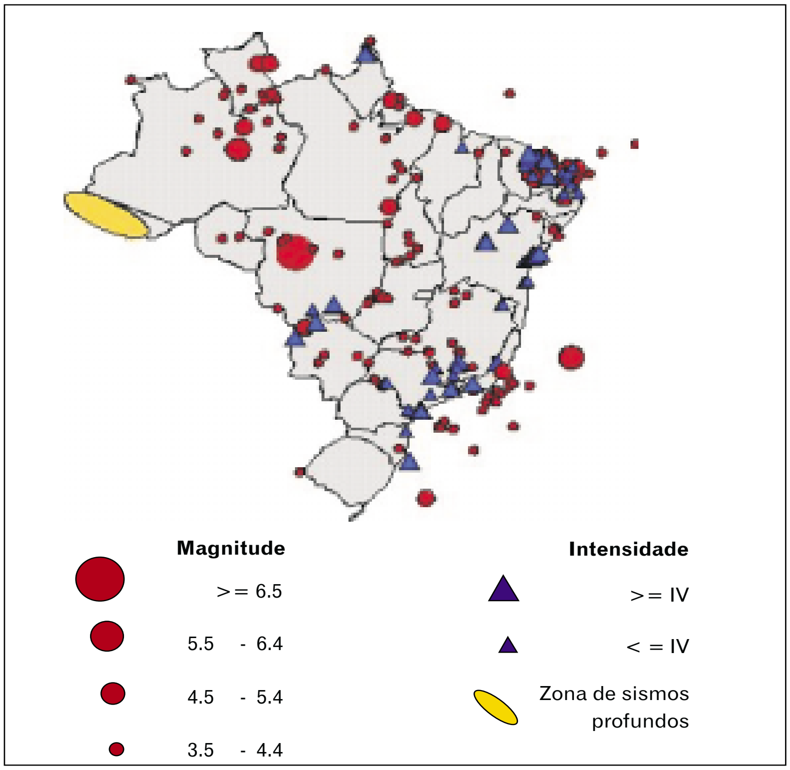
The seismic activity is more intense on plate boundaries and lower in its interior. For that reason, such activity is notably smaller in Brazil than in the Andean countries. However, seismic records show that, despite of the fact that the Brazilian territory is located in an intraplate region, several tremors have been recorded, which were higher than 5.0 degrees in the Richter Scale. (**Figure 5**)

The Brazilian tremors usually have superficial hypocentres (30 km), except in the State of Acre, where the tremors caused by Nazca plate oblique dive activity present an extremely deep hypocentre (around 500 km) and even the strongest tremors produce their effects on the surface of the terrain and are felt as far as many kilometres from the epicentre.

The Northeast is one of the most active regions. In it, tremors occur most frequently in the States of Rio Grande do Norte, Ceará and Pernambuco. Normally, the tremors in this region are very superficial and lower than 4.5 degrees. In the area that corresponds to the boundary between Peru and the State of Acre, earthquakes occur at great depths.

The greatest earthquake recorded in Brazil, with mb=6.6 degrees in the Richter Scale, occurred on 31 January 1955, in Roncador, State of Mato Grosso. In March 1955, another earthquake happened, measuring 6.3 degrees, in the Atlantic Ocean, 300 km far from the coast of Espírito Santo State, and in 1983, an mb=6.3 earthquake was recorded in the State of Amazonas. Almost ten earthquakes have already been recorded, varying between 5.0 and 5.5 degrees in different Brazilian regions.

**Figure 5 - Seismicity in Brazil**




Epicentral data, indicated in circles, are relatively more recent and have been obtained through seismographic equipment.
Source: University of Brasilia's Seismic Observatory.

Dozens of historical reports on earthquakes felt in different points in Brazil show that tremors can cause material damage, disturbance to population and even produce uncontrolled panic in people. In João Câmara (State of Rio Grande do Norte), the main tremor, measuring mb=5.1, occurred on 31 November 1986, followed by hundreds of repetitions, four of them measuring 4.0 or higher in the Richter Scale, damaging 4,000 houses, 500 of them were rebuilt using federal resources.

This map contains data on earthquakes, with a magnitude of 3.0 or higher, occurred in Brazil since the colonisation period until 1996. The oldest information, which is indicated by triangles, is called historical information and was obtained after a long and careful research work using libraries, books, diaries and newspapers (J. Berrocal et al 1984).

### 4.9. Disasters Related to Dangerous Substances

A dangerous substance refers to a product that represents risks to life, the environment and individual or public property. The United Nations adopted a classification that groups such substances in nine risk classes:

- **Class 1 -** Explosives
- **Class 2 -** Gases
- **Class 3 -** Inflammable Liquids
- **Class 4 -** Inflammable Solids; substances subject to spontaneous combustion; substances that, when in contact with water, emit inflammable gases
- **Class 5 -** Oxidising Substances; Organic Peroxides
- **Class 6 -** Toxic Substances; Infective Substances
- **Class 7 -** Radioactive Materials
- **Class 8 -** Corrosive Substances
- **Class 9 -** Several Dangerous Substances and Items

Brasil has the 7th largest chemical industry in the world. The number of industries that produce and consume dangerous substances, in relation to the country's territorial extension, considerably increases accident probability.

In order to study the accidents with dangerous substances, it is necessary to investigate the various places where accidents often occur: road, railway, maritime, river and lake means of transportation; fixed facilities, such as: ports or terminals, warehouses, producing industries, consuming industries, oil refineries and petrochemical centres. In other facilities, the following items must also be considered: ducts, deposits of residues, leftover or rejected items, as well as the stages of dangerous substance processing, consumption, use or handling.

The large number of records of accidents with dangerous substances is caused, in most cases, by the lack of observation of safety, construction and maintenance rules. Thus, the following accidents are highlighted: (**Charts 2 and 3**)

a) **Warehouse: SODIUM PENTA-CHLOROPHENOL** – Rio de Janeiro/ State of Rio de Janeiro. A cargo of sodium penta-chlorophenol arrived in Brazil in packages either out of normal patterns or not identified. The product transfer was made by several men dressed with shorts only, with no individual protection equipment, on a day when the temperature was measured at 40º Centigrade. The product's "dust" was inhaled and the men's sweated skin absorbed the substance, causing the death of three workers by intoxication.

b) **Railway Transportation: GASOLINE and ALCOHOL** – Municipality of Ipojuca, State of Bahia – The derailment of a train which was transporting gasoline and alcohol caused a row of people who tried to loot the products for trading. A large fire triggered by a spark took over the whole train and the whole area with the spilled fuels, causing the death of over 100 people.

c) **Duct: GASOLINE** – Socó Village, Municipality of Cubatão, State of São Paulo. Petrobras buried a duct network for fuel transportation, over which the population of Socó Village built a slum. With the spill from one of the ducts, the spilled fuel caused a huge fire that killed 500 people.

d) **Commercial Building: GLP GAS** – Osasco Shopping Centre, Municipality of Osasco, State of São Paulo. A spill was found in the underground fixed facilities, designed to transport GLP gas to different places in the building. The confined gas was pressurised and exploded in the lower part of the building, causing a partial destruction of the shopping centre; over 40 people died and a large number of people were injured.

Among the dangerous substances used as pesticides, insecticides and herbicides, from the best commercially known products in the country, the following items are highlighted:

a) **All organochlorined products, such as DDT:** they were massively used in the past and now are forbidden; however, there are still abandoned warehouses all over the country, specially in the State of Rio de Janeiro.

b) **Aldrin-2751:** Organophosphorous insecticide, which is excellent to tackle ants.

c) **2,4D-2765 phenoxide-based herbicide:** It is highly carcinogenic and was used in the area of Tucuruí Hydroelectric Plant, in the State of Pará.

d) **Antu- Alphanaphthyl thiourea- 1651:** Rat poison.

Other disasters with dangerous products are related to fireworks factories (using explosives as raw material), that operate illegally without any safety equipment or procedures, and are not inspected by the public power.

## Accidents with Oil Spills

The petrochemical sector is one of the most important chemical industries in Brazil. At the moment, it has four Petrochemical Centres: Camaçari, State of Bahia, Cubatão, State of São Paulo, Duque de Caxias, State of Rio de Janeiro, Triunfo, State of Rio Grande do Sul. The refineries are located in: Manaus and Urucu, in the State of Amazonas; Mataripe, in the State of Bahia; Duque de Caxias, in the State of Rio de Janeiro; Betim, in the State of Minas Gerais; Araucária, in the State of Paraná; Cubatão, São José dos Campos and Capuava, in the State of São Paulo; Rio Grande, Canoas and Manguinhos, in the State of Rio Grande do Sul.

The storage, transportation and utilisation of oil have caused accidents in different places and spill conditions. The Charts below show the main accidents caused by oil spills in 1999 and 2000.

**Figure 2 -Oil spill accidents, 1999**

| Pipeline Pipeline Breaks | Place | Responsibles for the accident/ | Ecosystems Affected | Spilled Oil Volume (l.) |
|---|---|---|---|---|
| 30.07.1999 | Mata de São João - Pipeline Of the station, Camboatá, -BA | PETROBRAS | Water Resources | **50,000 |
| 01.08.1999 | Pipeline of the thermoelectric plant Franca Amaral da CERJ - RJ | CERJ | Itabapoana River | 700 |
| 09.08.1999 | Pipeline of REMAN Refinery – AM | PETROBRAS | Igarapé Corutu, R.Negro | 3,000 |
| **Terminal** | | | | |
| 16.04.1999 | Madre de Deus Terminal – BA | PETROBRAS | Beaches and mangrove | 500 |
| 29.12.1999 | Porto de Itaqui Terminal – MA | PETROBRÁS | Marine | 1,500 |
| **Well** | | | | |
| 18.07.1998 | Well 7 -C-116, Candeias - BA | PETROBRAS | Mangrove | 30,000 |
| **Ship** | **Amazon Basin** | **Name of the ship** | | **Liter** |
| 1999 | Belmont Rio Madeira - RO | Oziel Mustafa | Fluvial | *49,000 |
| 1999 | Rio Madeira - RO | Comercial Alecrim | Fluvial | *19,447 |
| 1999 | Rio Madeira - RO | S.A. Leite Navegação | Fluvial | *15,000 |
| 1999 | Rio Madeira - AM | Navezon Linhas Internas | Fluvial | *36,000 |
| 1999 | Rio Madeira - AM | Navegação da Amazônia | Fluvial | *82,694 |
| 1999 | Igarapé do Cururu - AM | Refinaria REMAM | Fluvial | 3,000 |
| 1999 | Porto de Itaqui - MA | Terminal PETROBRÁS | Fluvial | 1,500 |
| **Ship** | **Other places** | | | **Tons** |
| Jan 99 | Vitoria – ES | Sara Valetta | - | 1,500 |
| Jan 99 | Angra dos Reis – RJ | Doce Kjord | - | 10 |
| Apr 99 | Paracuru – CE | Mariprima | - | - |
| May 99 | São Paulo – SP | Vicuna | - | 4 |
| May 99 | São Paulo –SP | Confidence | - | 2 |
| Jun 99 | São Paulo -SP | Kapitan Ivanchuvk | - | 2 |
| Ago 99 | Baia da Guanabara – RJ | Navio Petrobras | - | 2 |
| Ago 99 | Rio de Janeiro – RJ | Poti-Pronave | - | 4 |
| Nov 99 | Porto de Tubarão - ES | Brazilia | - | 0.5 |

Observation: N/T tanker; N/M - merchant ship
Sources: * Port and Coast Authority - Brazilian Navy, ** IBAMA/BA

## 5. Regional Scenario of Main Disasters

The national scenario of disasters can be reflected by the events of the past two years – 2000-2001 – in the five politico-geographical macro-regions: North, Northeast, MidWest, Southeast and South. The fact that all regions have an inherent pattern of disasters deserves consideration. The main natural disasters are associated to weather phenomena.

The Brazilian territory has a wide weather diversification due to several factors, such as its geographical configuration, maritime or continental conditions, altitude, land size, both relative to the latitude (5°16'20''N a 33°44'32''S) and to the longitude (73°59'32''E a 34°47'30''W), landscape and the dynamics of air-masses. The latter is a key factor as it exerts direct influence on temperature and rainfalls. The air masses that have a more direct impact on Brazil are: Equatorial (Continental and Atlantic), Tropical (Atlantic and Continental) and Polar Atlantic, which account for the weather variations in the individual regions.

**Chart 3 - Oil spill accidents in 2000**

| Ship | Place | Name of the ship | | Spilled Volume tonnes |
|---|---|---|---|---|
| Fev 2000 | Barcarena – Pará River – PA | Texaco Balsa Miss Rondônia "Naufragio | - | 1.8 |
| Aug 2000 | Guanabara Bay – RJ | Cantagalo | - | - |
| Aug 2000 | Angra dos Reis – RJ | Cantagalo | - | 4 |
| Aug 2000 | Paracuru – CE | Mariprima | - | 0.1 |
| Jul/2000 | Amazonas River Mouth – AM | Western Inlet | - | 0.1 |
| Aug 2000 | Guanabara Bay – RJ | Transroll | - | - |
| Aug 2000 | Ilha da Paz – SC | Caprice | - | 0.3 |
| Jul 2000 | Guanabara Bay – RJ | Pioneiro | - | - |
| Oct 2000 | Guanabara Bay – RJ | Pirapita | - | - |
| Nov 2000 | Almirante Barroso Sea terminal – São Sebastião – SP | Verginia Ii | - | 86 |
| **Well /buoy** | **Place** | **Responsible ones for the accident/Causes** | **Ecosystems Affected** | **Spilled Volume Litre** |
| 08.03.2000 | Xaréu well, Par acuru – CE | PETROBRAS | Sea | 100 |
| 04.11.2000 | Buoy No. 2 ,Tramandaí – RS | PETROBRAS | Sea fauna, flora | 18,000 |
| **Terminal** | | | | |
| 03.28.2000 | Cabedelo Port Terminal – PB | PETROBRÁS | Sea | - |
| 05.05.2000 | CVRD Terminal – MA | CVRD | Mangrove | 30,000 |
| 05.31.2000 | Itaqui Port Terminal – MA | PETROBRÁS/SPEAR Ship | Port area | 80 |
| 09.18.2000 | Railway disembarkation platform terminal of Petrobrás – Tubarão – ES | PETROBRÁS Valve Failure | - | 20,000 |
| 05.06.2000 | Itaqui Port Terminal – MA | CVRD | Port Area | 25,000 |
| 10.27.2000 | Paranaguá Terminal of Petrobrás – PR | PETROBRÁS Joint/ Duct Failure | Sea | 450 |
| **Duct** | | | | |
| 01.18.2000 | REDUC Refinery Duct – RJ | PETROBRÁS | APA Guapimirim Mangrove | 1,300,000 |
| 07.16.2000 | REPAR Refinery Duct – RJ | PETROBRÁS | Iguaçu River | 4,000,000 |
| 07.30.2000 | Paracambi Duct – SP/RJ | PETROBRÁS | Water Table | 1,000 - MTBE methyl terciary--butyl ether |

Source: IBAMA / MMA

## NORTH REGION

The North covers nearly the entire Amazon, which is the largest hot and humid forest in the world. It covers almost half of the Brazilian territory and is entirely crossed by the Equator line. The predominance of low-altitude lands (0-20m) makes it easier to outline the region's weather profile. There are four atmospheric circulation systems in the region: the NE and E wind system of subtropical anticyclone in the South Atlantic and Azores associated to stable weather; the W wind system of continental Equatorial Mass (Eqm) (mEc), the N wind system of Inter-tropical Convergence (ITC); the S wind system of Polar Anticyclone. The three latter systems cause instabilities and precipitation. (INMET)

During the coldest months (June and August), due to the Polar Anticyclone movement towards the continent and the resulting polar front, the temperature typically drops. This is a particularly important phenomenon for the region – the so-called "friagem" (cold spell) –, when minimum daily temperatures can be as low as 8°C in the southwestern part of the region.

The rainy season takes place during the summer-autumn period, except for the state of Roraima and north of the state of Amazonas, where the maximum precipitation levels occur in winter and the minimum levels in summer (according to the Northern Hemisphere regime).

The dry season lasts from one to three months on the most part of the region (except for the Central Western area and around Belem City, where there is no dry season at all) in addition to the eastern part of Roraima, where the dry season lasts for four or five months (INMET).

**Table 7 - North Region - 2000**

| States Affected in 2000 Flood | Municipalities Affected | Dead | Injured | Affected / Unsheltered |
|---|---|---|---|---|
| Acre | 1 | – | – | 1,.304 |
| Amapá | 1 | 1 | 111 | 6,.384 |
| Roraima | 1 | – | – | 180 |
| Rondônia | 3 | – | – | 165 |
| Amazonas | 1 | – | 3 | 4,748 |
| **Total** | **6** | **1** | **114** | **12,781** |

Source: State Co-ordination of Civil Defence - CEDEC (only data informed to SEDEC/MI)

This region typically has high-intensity, gradual and cyclical floods, and also the absence of such floods that cause imbalance in the ichthyofauna, thus affecting reproduction of the fish living in the largest drainage basin in the world.

The so-called "terras caídas" (fallen lands) is a natural phenomenon that can become a disaster, but the "pororoca" (an event where sea and river meet) can and should be used for tourism purposes as it forms waves that can ride 90 km when great rivers with a gorgeous tropical forest along them come together.

Forest fires are natural disasters concentrated in transitional forest areas and savannahs situated on the south and far north of the North Region, i.e. on the boundaries of the Amazon Forest.

As the burns take place in deforested areas, they affect degraded and non-degraded pastures, secondary forests and crops. Burns derive from intentional fires and are associated to forest slash and burn for agricultural and pasturing purposes.

Among human-caused disasters that seriously damage the region, the use of mercury deserves special notice as it intoxicates the ichthyofauna and the riparian population. Malaria, cholera and bouts of yellow fever are often reported.

**YEAR 2000** – The most serious disasters were floods in the region. From April to June, the Municipality of Laranjal do Jari (Amapa State) was greatly affected: 70 percent of the City Hall was flooded during four months and 40 percent of the rural area was damaged. (**Tables 7 and 8**).

**YEAR 2001** – No major disaster was reported in 2001 in the Region. Ji-Parana City (Rondonia State) was affected by a flood in March and Belem City (Para State) had a forest fire in December.

**Table 8 - North Region - 2001**

| States Affected in 2001 | | Municipalities Affected | Dead | Injured | Affected/ Unsheltered |
|---|---|---|---|---|---|
| Pará | Forest Fire | 01 | – | – | – |
| Rondônia | Flood | 01 | – | – | – |
| Total | | 02 | – | – | – |

Source: State Co-ordination of Civil Defence - CEDEC (only data informed to SEDEC/MI)

## NORTHEAST REGION

The Northeast Region's landscape and its plains and coastal tablelands generally below 500m and inner surfaces above 800m (Borborema Plateau) and sometimes above 1,200m (Diamantina Plateau), together with different circulation systems, makes it difficult to describe the region's weather in terms of precipitation levels.

There are four circulation systems that exert an influence over the region:

a) **System of South Disturbed Currents (Sistema de Correntes Perturbadas de Sul):** this is the most frequent during the autumn-winter seasons, when the fronts reach the seacoast in Pernambuco (at Recife City). During the spring-summer seasons, the fronts rarely reach the region and, when this occurs at all, they only come as far as the south of Bahia State.

b) **System of North Disturbed Currents:** Represented by ITC, this system plays a key role during summer and particularly in autumn, when it arrives at its southern-most position and reaches south latitudes of 9° and 10°.

c) **System of East Disturbed Currents:** These provoke fairly abundant rains, fading towards west and seldom reaching the slopes of Borborema and Diamantina. They appear most often during winter.

c) **System of West Disturbed Currents:** These are brought by Tropical Squall (TS) lines and they frequently reach the States of Bahia and Piaui.

Precipitation levels in this region are extremely complex both in terms of its short-lived occurrence (three months, but it can be shorter or non-existent) and of its annual total, which may vary from 300 to 2,000mm. These levels occur along the eastern coast and on the Rio Grande do Norte's Plateau hillside as far as Bahia, the maximum level is reached during the autumn-winter seasons and the minimum level during the spring-summer seasons. It is typical of climates of Mediterranean regions.

Uneven rains are the main weather features in the region. The percentage level during the rainiest three consecutive months shows that on the coastline the figure is below 50 percent. In the northern area this varies between 50 and 70 percent and in "sertão" (dry hinterland), the rainy season sometimes lasts only two months (INMET).

This region is characterised by long periods of drought and dry spells with historical records dating back to the 16th century. During such periods, major social and economic losses are inflicted, especially because the lower classes have increased malnourishment problems.

Sudden floods and landslides have also been common since the colonial period. These disasters are increasing in seriousness on a yearly basis due to the growing vulnerability caused by human action and the disorderly use of the territory.

Among human-caused disasters, it is worth mentioning a fire provoked by a spill of fuel from a derailed train in Ipojuca (State of Bahia) in 1993, where 100 people died, mostly children.

A lack of proper environmental awareness is at the source of the continued disgraceful plantation procedures, such as clearing and burning, which have greatly contributed to further worsen desertification in the semi-arid area of the Northeast Region.

Major economic losses have been reported in the region because of crop-infesting pests, such as the boll weevil in cotton crops, which caused 2 million lay-offs and nearly annihilated this sort of plantation. Another major pest is the so-called “vassoura de bruxa”, (witch’s broom) which plagued cocoa crops, particularly in Bahia State.

**YEAR 2000** – From July, heavy precipitation affected the States of Rio Grande do Norte, Paraiba, Pernambuco and Alagoas, where approximately 264,600 in 105 municipalities suffered their impacts. The dry season also affected the Northeast Region, and water-tank trucks assisted 94 municipalities: Sergipe State (10); Rio Grande do Norte (42); Piaui (31) and Paraiba (11). (**Table 9**).

**YEAR 2001** – The Northeast was extensively affected by the dry spell that was visited on more than 1,000 municipalities during almost the whole of 2001. As a result, aid programmes were developed by the Ministry of National Integration, such as “Bolsa Renda” (Income Scholarship), “Bolsa Renda/ Alimentos” (Income/Food Scholarship) and “Carro-Pipa” (Water-Tank Truck) (**Table 10**).

Floods occurred in Ceara the State of (Fortaleza City had six casualties during the rains); in October they occurred in the state of Bahia State (Catu City); in June in the State of Pernambuco (Vicencia City); and in April in the State of Maranhao (Santa Luzia do Parua City).

**Table 9 - Northeast Region - 2000**

| States Affected in 2000 By flood | Municipalities Affected | Dead | Injured | Affected/ Unsheltered |
|---|---|---|---|---|
| Rio Grande do Norte | 29 | 02 | – | 28,000 |
| Pernambuco | 44 | 22 | – | 107,,304 |
| Alagoas | 27 | 21 | – | 128,,336 |
| Paraíba | 05 | 0 | – | 960 |
| Total | 105 | 45 | – | 264,600 |

Source: State Co-ordination of Civil Defence - CEDEC (only data informed to SEDEC/MI)

**Table 10 - Northeast Region - 2001**

| States Affected in 2001 | Affected Municipalities | Deaths | Injured | Affected people / Homeless |
|---|---|---|---|---|
| Alagoas | | | | |
| Dry season | 71 | – | – | 28,000 |
| Bahia | | | | |
| Dry season | 257 | – | – | 107,304 |
| Floods | 01 | | | |
| Ceará | | | | |
| dry season | 136 | – | – | – |
| Floods | 08 | 6 | 89 | 95,069 |
| Paraíba | | | | |
| dry season | 198 | – | – | 5,069 |
| Pernambuco | | | | |
| dry season | 127 | | | 50,395 |
| Floods | 01 | – | – | 183 |
| sea erosion | 02 | – | | – |
| Piauí | | | | |
| dry season | 114 | | – | – |
| Maranhão | | | | |
| Floods | 01 | | – | 15 |
| sea erosion | 01 | | – | – |
| Rio Grande do Norte | | | | |
| dry season | 147 | | – | 25,711 |
| Sergipe | | | | |
| dry season | 21 | | – | – |
| Total | 1,085 | 6 | 89 | 503,084 |

Source: State Coordinations of Civil Defence - CEDEC (only those notified to SEDEC/MI)

Coastal erosion (sea encroachment) also took place in the State of Pernambuco, in the municipalities of Paulista and Jaboatao dos Guararapes in August and May respectively, and in the state of Maranhão´s municipality of Humberto de Campos in August.

The Income Scholarship Programme benefited over one million families – each family was granted R$60.00 per month, from August to December. In November and December, the Income/Food Scholarship Programme was established. This replaced the food baskets doled out by PRODEA (Food Distribution Programme) in the area affected by the drought; approximately 800 thousand families received R$15.00 per month. The table below shows figures associated to these Programmes (**Table 11**).

**Table 11 - Emergency Actions by the Federal Government - 2001 Drought R$1.00**

| SEGMENTS | Recipient Municipalities | Recipient Famillies | Recipient Population | Fund Expenditures |
|---|---|---|---|---|
| Income scholarship | 1,211 | 1,018,654 | 5,000,000 | |
| Income/Food scholarship | 737 | 800,000 | 4,000,000 | 383,000,000 |
| Water-tank trucks | 1,040 | ---------- | 4,000,000 | 57,500,000 |
| TOTAL | -------- | 1,818,654 | -------- | 440,500,000 |

Source: State Coordinations of Civil Defence - CEDEC (only those notified to SEDEC/MI)

## MIDWEST REGION

The MidWest Region's temperature is extremely diversified due to its landscape, latitudinal extension and atmospheric dynamics. This does not hold true for precipitation levels, which is more homogeneous.

The region's precipitation levels are predominantly due to the atmospheric circulation system. The annual average precipitation level ranges from 2000 to 3000 mm to the north of the State of Mato Grosso and decreases towards E and S, where this average revolves around 1500 mm in East of the State of Goias and 1250 mm in Mato Grosso's "Pantanal" (Wetlands). Despite this unevenness, the region has high rain rates (INMET).

This region is the largest area vulnerable to forest fires in Brazil. The long dry spells have been more serious than droughts as they cause losses to the region's agriculture and 50 million head of cattle, when the green mass of pastures falls down to 20%.

**Table 12 - MidWest Region - 2001**

| States Affected in 2001 | Affected Municipalities | Deaths | Injured | Affected/ Homeless |
|---|---|---|---|---|
| Goiás | | | | |
| Gales | 01 | – | – | 93 |
| Floods | 01 | – | – | – |
| Mato Grosso | | | | |
| Floods | 29 | 11 | – | 8,850 |
| Linear erosion | 01 | – | – | – |
| dry season | 02 | – | – | |
| Mato Grosso do Sul | | | | |
| Gales | 01 | – | – | 50 |
| Floods | 02 | – | – | – |
| Forest fires | 01 | – | – | – |
| dry season | 01 | – | – | – |
| Total | 40 | 11 | – | 8,993 |

Source: State Coordinations of Civil Defence - CEDEC (only those notified to SEDEC/MI)

Specially because the population's lack of proper awareness, one of the most serious radiological disasters in the world occurred in the region. On September 13, 1987, a contamination of Caesium-137 took place in Goiania City. Four people died and another 129 suffered from internal and external contamination. Decontamination of affected areas generated 13.4 tons of contaminated waste, which has been properly isolated.

Another major regional disaster is associated to mining activities, when mercury wastes are carried by rivers to the Pantanal.

**YEAR 2000** – The most relevant disaster in the Central West were floods and windstorms, especially in the State of Mato Grosso, where 11 municipalities and 25 thousand people were affected by floods. In addition, 50 thousand people in one municipality suffered the effects of a windstorm.

**YEAR 2001** – Again, MidWest was visited on by floods and windstorms. The State of Mato Grosso deserves special notice – in Cuiaba City the floods killed 10 people. Disasters were more frequent from April to June, except for Navirai City; in the State of Mato Grosso do Sul, where windstorms materialised in August (/ **Table 12**).

Other disasters also occurred: dry spell from August to October in some municipalities of Mato Grosso (Guimaraes Plateau and Jangada City) and Mato Grosso do Sul (Bonito City) and in September a forest fire destroyed the Municipality of Bodoquena, in Mato Grosso do Sul.

## SOUTHEAST REGION

The Southeast Region's Climate Profile is quite diversified in terms of temperature. The region's main traits are its latitudinal position crossed by the Tropic of Capricorn, the extremely uneven landscape and the influence of systems of *Disturbed Currents*.

It is a transitional region from the hot climate in low latitudes to the mesothermal climate of middle latitudes, but its more tilted towards tropical climates than to temperate climates. Precipitation levels are no less important than the temperature. There are two main rainy zones: one that lies along the coast and the Serra do Mar and another that covers the west of the State of Minas Gerais and the City Rio de Janeiro. The annual precipitation level in those areas is above 1,500 mm. In Serra da Matiqueira these figures stand above 1,750 mm and in Itatiaia's high valleys they are 2,398 mm. Many areas in the States of Minas Gerais and São Paulo report frosts after the occurrence of the Polar Front.

The maximum rain level in the region normally occurs in December or January and the minimum level occurs in July. Out of the total precipitation, 30-50 percent occurs in only three months. The dry season lasts from one to six months, usually concentrated during winter (INMET).

As the Southeast comprises the most industrialised states, where the major industrial complexes and petrochemical hubs are located, it accounts for the largest number of human-caused technological disasters. It is worth mentioning the spill of hazardous products and combustible oil in the region and in the south of the State of Bahia, with major environmental damages, explosions and fires.

**Table 13 - Southeast Region - 2000**

| States Affected in 2000 Flood/Landslide | Municipalities Affected | Dead | Injured | Affected / Unsheltered |
|---|---|---|---|---|
| São Paulo | 40 | 43 | 123 | 6,605 |
| Rio de Janeiro | 17 | 13 | 10 | 6,244 |
| Minas Gerais | 198 | 35 | – | 150,000 |
| Total | 255 | 91 | 133 | 162,849 |

Source: State Co-ordination of Civil Defence - CEDEC (only data informed to SEDEC/MI)

The Vila Soco fire, in Cubatao City (State of São Paulo) is an illustration of the population's lack of awareness, mainly due to the lack of information on personal and collective risks with urban settlement in risky areas: in hillsides, near high tension lines, near petrochemical complexes, garbage dumping areas, sanitary landfills, floodable areas, among others.

The most significant natural disasters in this region are floods; landslides in the Serra do Mar area, which stretches from the State of Rio de Janeiro to the State São Paulo. Droughts are concentrated in the north of Minas Gerais State and in Jequetinhonha Valley, north of the State of Espirito Santo and they cause major economic losses.

**YEAR 2000** – This year, floods and landslides were the main natural disasters. The States of São Paulo, Rio de Janeiro and Minas Gerais were affected, where 162,849 people lost their homes. Major events in Southeast were the dry spell in the north of Minas Gerais, which provoked damages in approximately 200 municipalities, and the floods in Rio de Janeiro City that killed over 40 people in December (**Table 13**).
**YEAR 2001** – In the States of Rio de

Janeiro (Marica City) and Espirito Santo (Conceiçao da Barra City) the Sea Encroachment phenomenon took place; Windstorms in the States of Minas Gerais (cities of Abre Campos and Lavras in November and December) and Espirito Santo (cities of Mucurici and Ponto Belo in March); and the floods in the State of São Paulo (Praia Grande in January) (**Table 14**).

**Table 14 - Southeast Region-2001**

| States Affected in 2001 | Municipalities Affected | Dead | Injured | Affected / Unsheltered |
|---|---|---|---|---|
| Espírito Santo | | | | |
| flood | 79 | – | 03 | 346 |
| dry season | 03 | – | – | – |
| Marine erosion | 01 | – | – | 303 |
| Gale | 02 | – | 18 | 80 |
| Minas Gerais | | | | |
| dry season | 200 | – | – | 6,000 (Franciscópolis) |
| flood | 04 | – | 24 | 12,006 |
| Gale | 02 | – | 03 | 2,531 |
| Rio de Janeiro | | | | |
| flood | 07 | 45 | 191 | 26,181 |
| dry season | 01 | – | – | |
| marine erosion | 01 | – | 2 | 180 |
| São Paulo | | | | |
| flood | 01 | – | – | 370 |
| Total | 301 | 45 | 241 | 47,997 |

Source: State Co-ordination of Civil Defence - CEDEC (only data informed to SEDEC/MI)

## SOUTH REGION

The South Region, in addition to its landscape and geographical position (below the Tropic of Capricorn) being almost entirely in the temperate zone, the atmospheric circulation systems exert an influence on the climate, especially on precipitation levels. The South bears two distinctive features. First, its homogeneous rain level and stagnant regime and second, its climatic uniformity, i.e., the near-absolute prevalence of the temperate mesothermal climate.

The annual average precipitation level varies between 1,250 and 2,000 mm, except for the coast of Parana State and the western part of the State of Santa Catarina, where levels are above 2,000 mm, and north of Parana and the short coastal strip of Santa Catarina, with levels below 1,250 mm. The maximum precipitation level

occurs in winter, and the minimum level takes place in summer for virtually the entire region, except for a portion of Parana, where the maximum level occurs in summer and the minimum level occurs in autumn; and Parana's and Santa Catarina's coast, with maximum levels in summer and minimum levels in winter. The region does not have a clearly defined dry season, except for the northwest area of Parana (INMET).

This region is particularly affected by sudden floods, dry spells, frosts, hail rains, windstorms and, to a lesser degree, tornadoes. Disasters with hazardous materials are noteworthy because of the active traffic between southern states and neighbouring countries – Uruguay, Argentina and Paraguay.

**YEAR 2000** – All states in the South have been affected by natural disasters, especially by dry spells, hail rains, windstorms and floods.

**YEAR 2001** – The South was particularly affected by floods and dry spells during the last quarter. Floods occurred in more than 130 municipalities in the State of Rio Grande do Sul from February to April and from September to November; 49 municipalities in Santa Catarina were affected from January to June and in November and December, with special notice for March, month during which the greatest number of municipalities was affected; and 3 municipalities in Parana in November (**Table 15**).

In June, the State of Santa Catarina witnessed the sea encroachment phenomenon in 6 municipalities (Barra Velha, Bombinhas, Navegantes, Balneario de Camboriu, Balneario Barra do Sul and Itapoa) and in 01 municipality in the State of Parana (Matinhos).

**Table 15 - South Region - 2001**

| States Affected in 2001 | Municipalities Affected | Dead | Injured | Affected/ Unsheltered |
|---|---|---|---|---|
| Paraná | | | | |
| marine erosion | 01 | – | – | – |
| flood | 03 | – | – | – |
| Santa Catarina | | | | |
| flood | 49 | 01 | 55 | 34,109 |
| Gale | 03 | – | – | 16,340 |
| marine erosion | 06 | – | – | |
| Rio Grande do Sul | | | | |
| flood | 138 | – | 20 | 18,715 |
| hail | 03 | – | 7 | 10,924 |
| dry season | 02 | – | – | – |
| Total | 205 | 01 | 82 | 80,088 |

**Figure 6 - Summary of disasters in Brazil**


*Forest fires, including burns as a procedure to clear land for cropping purposes.
Source: SEDEC/MI

Still in Santa Catarina, the municipalities of Grao-Para, Santa Terezinha (January) and Laguna (April) suffered the effects of windstorms and, in Rio Grande do Sul, the municipalities of Ijui, Camaqua and Cotipora were affected by hail rains.

In January dry spells were reported in the municipalities of Braga and Coronel Bicaço (Rio Grande do Sul). This disaster remained in early 2002; more intensely in the States of Santa Catarina and Rio Grande do Sul.

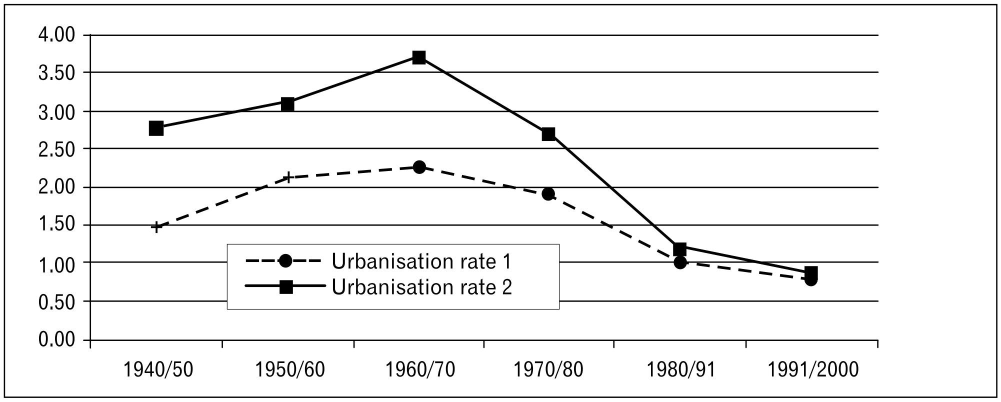
## 1.1Urban Context

### 1.1. Urbanisation Process

The Brazilian urban network is currently comprised of regional systems with cities located primarily along the coastal line and in the Southeast. Until 1920, Brazil had 74 cities with a population above 20,000 inhabitants, which accounted for 14.93% of the total population and, 47.71% of the urban population; 58.3% of these cities were in the Southeast – in the States of São Paulo, Rio de Janeiro and Minas Gerais (IBGE 2002).

The South and Southeast were the first to develop greater links among their cities, thus speeding up the territorial division of the work they originated from and causing urbanisation rates to increase dramatically. As a result of this evolutionary process, by the year 2000 there were 1,485 cities with over 20,000 inhabitants and 80% of the total Brazilian population.

**Graph 1 - Urbanisation rates - Brazil - 1940/2000**




Note: The Urbanisation rate 1 uses the IBGE definition of urban and rural population, while the Urbanisation rate 2 uses the definition of urban population as those individuals who live in cities with less than 20,000 inhabitants. The urbanisation rate is defined by the following expression: (((1 + ru)/(1 + rt)) - 1) * 100. This formula was elaborated by CARVALHO, J.A. (Brito et al 2001)
Source: Brito et al - 2001

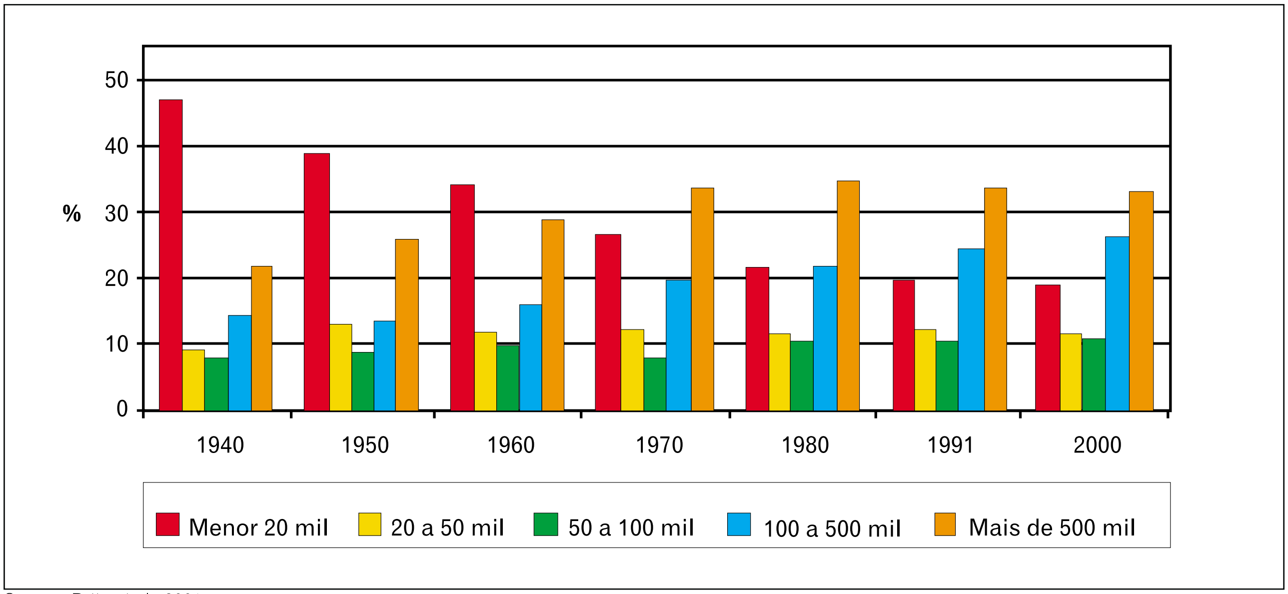
Up until 1980, this cycle of urban expansion drove the flow of people towards big cities. At that time, 57% of the population lived in cities with more than 100 thousand inhabitants – 35% in cities with over 500 thousand inhabitants. This cycle derived from structural changes in society and from the significant growth in the industrial-urban economy that proved to be quite uneven in spatial and social terms until the late 1970s.

The economic development model adopted in the country caused efforts and investments to be concentrated in the main urban centres, particularly in Rio de Janeiro and São Paulo, which brought about an intense process of domestic migration. The zenith of urban expansion was reached in the early 1980s, when a reduction in birth rates in large cities took place together with a decrease in rural-urban migration.

**Graph 1** shows the consequences of a dramatic fall in the growth rate of urban population, which started to occur in the 1970's. Data suggest that the zenith of urban expansion was reached in the early 1980's, when the reduction of birth rates in urban areas was intensified and the rural-urban migration declined substantially (Brito et al 2001).

After 1980, this expansionary cycle changed its direction, with decentralisation of urban growth in terms of population and degree of urbanisation. Urban decentralisation, though relative, is demonstrated through a more intense growth of cities with a population ranging from 100 thousand to 500 thousand inhabitants, approximately of 19% of the total population (**Graph 2**).

**Graph 2 - Urban population distribution - Brazil - 1940/2000**




Source: Brito et al - 2001

### 1.2. Configuration of the Current Urban Network

The Brazilian urban network now falls into two systems: a system with polarising cities and an axis-oriented system. Metropolitan areas are still strong hubs of economic activities. Public investments to be applied in development axes, however, help shape the country's territory as they favour dynamic spaces. This occurs to the detriment of those areas with poor economic dynamics or ones in stagnation.

The country currently has 5,561 municipalities scattered throughout a territory of 8,514,215.3 km2, in five large regions (North, Northeast, MidWest, South and Southeast) (IBGE 2002). Today, the urban network shows that the overall configuration of the national territory remains unchanged, except for urban development in the Amazon and for the way States are divided. The occupied sectors in the economic areas have also been intensified in the *Cerrado* and part of the Amazon (**Map 1**).

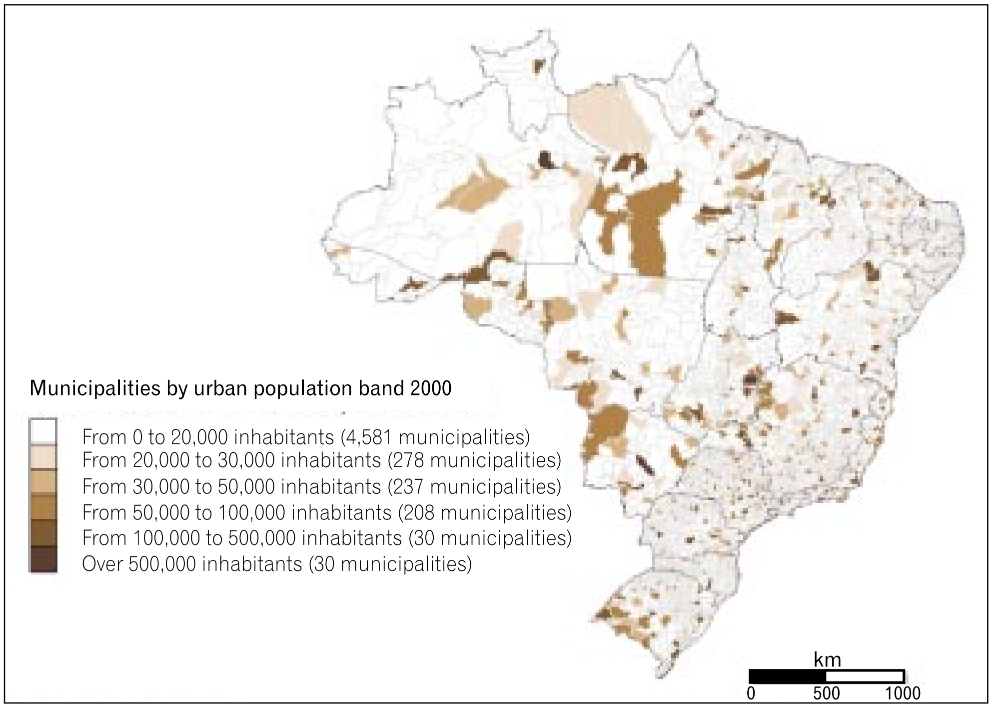
### 1.3. Metropolitan Regions

For four centuries, the construction of the Brazilian urban network followed the slow pace of exploration of a vast territory, always in low-density conditions. The dynamic development of the Brazilian urban network was due not only to the growth of the Brazilian population, but also to its mobility.

Domestic migrations were intensified by the country's industrialisation process and drove the rural population to the cities. It was massively concentrated in the urban peripheries of Rio de Janeiro and São Paulo and, to a lesser degree, in other cities that were considered regional hubs. Such clusters were responsible for the development of nine metropolitan regions in the country[1] in order to better focus on the management of urban, social and environmental problems in those areas. The original spatial configuration of Metropolitan Regions has been undergoing changes over the past few decades, thus increasing the number of areas considered as metropolitan regions and of municipalities that comprise such areas.

[1] Complementary Law no. 14, of 06/08/1973, establishes the Metropolitan Regions of São Paulo, Belo Horizonte, Porto Alegre, Recife, Salvador, Curitiba, Belém and Fortaleza; Complementary Law no. 20, of 07/10/1974, establishes the Metropolitan Region of Rio de Janeiro.

Map 1 - Municipalities by urban population band - Brazil - 2000




Source: IBGE population census - 2000

When the urbanisation process reached its zenith in 1970, nearly half of the urban population dwelled in municipalities situated around metropolitan centres, and approximately 34% lived those centres. The data contained in **Table 1** show that the percentage of the Brazilian population living in the 12 main metropolitan agglomerations of the country increased during the period 1970-2000, though the growth rate in these areas declined in the same period, according to **Table 2**. Nowadays, 33.28% of the population lives in those agglomerations.

From 1970 to 2000, the population living in metropolitan agglomerations increased 122%, while the Brazilian population grew 82% during the same period. An individualised analysis of the centre and peripheries in urban agglomerations shows a decreased

**Growth rates in metropolitan agglomerations - Brazil 1970/2000**

**Table 1 - Total population according to metropolitan agglomerations - Brazil - 1970/2000**

| Metropolitan Agglomerations | Total population | | | |
|---|---|---|---|---|
| | 1970 | 1980 | 1991 | 2000 |
| Belém | 669,768 | 1,021,486 | 1,401,305 | 1,794,981 |
| Fortaleza | 1,070.114 | 1,627,042 | 2,339,538 | 2,901,040 |
| Recife | 1,755.083 | 2,347,005 | 2,874,555 | 3,272,322 |
| Salvador | 1,135,818 | 1,752,839 | 2,474,385 | 2,988,610 |
| Belo Horizonte | 1,619,792 | 2,570,281 | 3,385,386 | 4,161,028 |
| Rio de Janeiro | 6,879,183 | 8,758,420 | 9,796,649 | 10,847,106 |
| São Paulo | 8,113,873 | 12,552,203 | 15,395,780 | 17,768,135 |
| Campinas | 644,490 | 1,221,104 | 1,778,821 | 2,215,027 |
| Curitiba | 809,305 | 1,427,782 | 1,984,349 | 2,634,410 |
| Porto Alegre | 1,590,798 | 2,307,588 | 3,029,073 | 3,495,119 |
| Goiânia | 424,588 | 807,626 | 1,204,585 | 1,606,955 |
| Brasília | 625,916 | 1,357,171 | 1,980,432 | 2,746,747 |
| Total Agglomerate | 25,338,728 | 37,750,547 | 47,644,858 | 56,431,480 |
| Pop. Brazil | 93,139,037 | 119,002,706 | 146,825,475 | 169,544,443 |
| Agglomerates/Brazil | 27.21 | 31.72 | 32.45 | 33.28 |
| Urban Pop. | 52,084,984 | 80,436,409 | 110.990,990 | 137,679,439 |
| Agglomerates/Urban | 48.65 | 46.93 | 42.93 | 40.99 |

Source: Brito et al - 2001

growth rate and a slow down of this decline in the 1990's. The urban peripheries went on growing more rapidly than the centre at a relatively high rate – 3% per year (Brito, 2001).

**Table 3** contains data indicating the reduction in growth rates in large metropolitan agglomerations, and also the relative decline in its share of the total urban population.

Although small municipalities – those with an urban population below 20 thousand inhabitants – account for approximately 75% of Brazil's total, they house only 19% of the country's total population, which means that around 80% of the population dwells in only 25% of the municipalities scattered in the Brazilian territory. Again, this is an indication of the extreme concentration found in the country (IBGE 2000). (**Map 2**).

With regard to urban centres, the periphery grew steadily and corroborated a trend towards the development and consolidation of 49 urban agglomerations that bring together 379 municipalities and represent approximately 47% of the country's total population, to a total of 74.3 million inhabitants (IPEA/UNICAMP/IBGE 1999).

**Table 2 - Growth rates of metropolitan agglomerations - Brazil - 1970/2000**

| Metropolitan Agglomerations | GROWTH RATE (%) | | |
|---|---|---|---|
| | 1970/1980 | 1980/1991 | 1991/2000 |
| Belém | 4.31 | 2.92 | 2.82 |
| Fortaleza | 2.28 | 3.36 | 2.44 |
| Recife | 2.95 | 1.86 | 1.46 |
| Salvador | 4.43 | 3.18 | 2.14 |
| Belo Horizonte | 4.73 | 2.54 | 2.34 |
| Rio de Janeiro | 2.44 | 1.02 | 1.15 |
| São Paulo | 4.46 | 1.87 | 1.62 |
| Campinas | 6.6 | 3.48 | 2.49 |
| Curitiba | 5.84 | 3.04 | 3.23 |
| Porto Alegre | 3.79 | 2.5 | 1.62 |
| Goiânia | 6.64 | 3.7 | 3.29 |
| Brasília | 8.05 | 3.5 | 3.74 |
| Total Agglomerate | **4.07** | **2.14** | **1.92** |

Source: Brito et al - 2001

**Table 3 - Annual growth rate of the centre and periphery of metropolitan agglomerations - Brazil - 1970/2000**

| Metropolitan Agglomerations | GROWTH RATE (%) | | | | | |
|---|---|---|---|---|---|---|
| | 1970/1980 | | 1980/1991 | | 1991/2000 | |
| | Centre | Periphery | Centre | Periphery | Centre | Periphery |
| Belém | 3.95 | 9.26 | 2.65 | 5.36 | 0.31 | 14.29 |
| Fortaleza | 4.3 | 4.18 | 2.78 | 5.42 | 2.15 | 3.3 |
| Recife | 1.27 | 5.11 | 0.69 | 2.96 | 1.03 | 1.81 |
| Salvador | 4.08 | 6.91 | 2.98 | 4.31 | 1.84 | 3.61 |
| Belo Horizonte | 3.73 | 7.45 | 1.15 | 5.11 | 1.11 | 3.97 |
| Rio de Janeiro | 1.82 | 3.39 | 0.67 | 1.49 | 0.73 | 1.66 |
| São Paulo | 3.67 | 6.37 | 1.16 | 3.22 | 0.85 | 2.81 |
| Campinas | 5.86 | 7.56 | 2.24 | 4.79 | 1.5 | 3.33 |
| Curitiba | 5.34 | 7.24 | 2.29 | 4.72 | 2.13 | 5.15 |
| Porto Alegre | 2.43 | 5.3 | 1.06 | 3.71 | 0.83 | 2.15 |
| Goiânia | 6.54 | 7.48 | 2.31 | 10.94 | 1.9 | 7.01 |
| Brasília | 8.15 | 7.38 | 2.84 | 7 | 7.77 | 7.17 |
| Total Agglomerate | **3.49** | **5.32** | **1.5** | 3.28 | **1.21** | **2.99** |

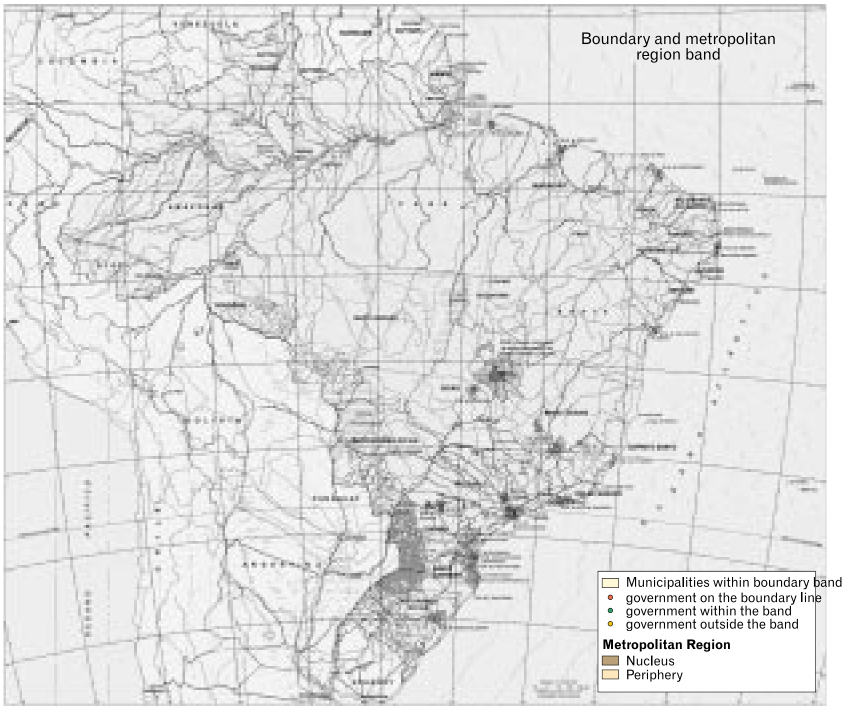
Source: Brito et al - 2001

## 1.4. Social Inequalities

The metropolitan agglomerations and regions report the highest rates of informal occupation, followed by lacking infrastructures and basic services. These weaknesses are partly due to the rapid process of urbanisation, which was not proportionally matched by the development of public policies for housing, sanitation, education, and healthcare. This is also partly due to the huge social inequality that characterised the development model adopted by the country.

Other factors can be considered, such as the lack of accrued scale economies or the reduced competitiveness in Brazilian urban agglomerations relative to urban centres in other countries. In short, a lengthy list of causes can be associated to the current precarious environment that characterises the Brazilian metropolitan areas.

**Map 2 - Institutionalised spaces / Boundary and metropolitan region band**




Source: IBGE - National Atlas of Brazil - 2000

Although indicators regarding access to housing in Brazil have experienced relative improvement, the percentage of improper homes located in substandard settlements (slums and similar areas), risky areas or environmentally protected areas are still large. Brazil continues to lack housing facilities, especially for the poor segments of the population. In 1998, there were 1.3 million permanent private homes located in substandard settlements, out of which 79.8% were situated in the ten main metropolitan regions of the country (Federal Government, Ministry of Planning and Administration 2002).

## 1.5. Recent Trends

Except for the peculiarities of the North and Southeast Regions, the main recent trends in the Brazilian urban system are as follows:

- Homogenisation of regional urban networks, with a growing share of major cities and medium-sized cities;
- Growth rates for medium-sized and large cities above the national average and also for cities with 50-100 thousand inhabitants situated outside metropolitan regions;
- Larger population growth in agglomerations located in metropolitan areas yet to be institutionalised, such as Goiânia, Brasília and Campinas;
- Negative migration rates in small cities, in virtually all-Brazilian regions;
- Increase in the relative share of non-metropolitan cities with more than 50 thousand and less than 800 thousand inhabitants in the Brazilian population total. This share jumped from 24.4 percent in 1970 to 29 percent in 1996.

## 2. Population

An analysis of the Brazilian population's expansion over the course of the 20th century shows an extremely dynamic pattern of growth with distinctive features in time and space. The population did not grow at a linear rate and in successive periods the vegetative growth rates increased on a yearly basis, which was the case during the first half of the century.

There were later relatively stable periods and the growth rate declined. This state of affairs is paralleled to the economic and social development process itself in Brazil, where the population experienced a more than tenfold growth.

The modalities of spatial organisation have also changed. In this century, a significant change in the location of the Brazilian population takes place: the most part of the population, who lived in rural areas, flows rapidly to the cities and becomes essentially urban towards the end of the century. Indeed, during the period 1940-2000, the Brazilian population undergoes a fourfold growth, while the urban population grew eleven-fold during the same period. (**Table 4**)

## 2.1. Growth Dynamics

With regard to the dynamics of demographic growth, its components change dramatically, i.e., infant mortality (**Graph 3 and Table 5**), life expectancy and birth rates (**Graph 4 and Table 6**) are modified, as well as their mutual relations. Hence, even as mortality and life expectancy at birth rates have improved over the course of the past 50 years, the Brazilian population's birth rates reported a greater reduction and the average annual growth rates started to decline in the 1960's.

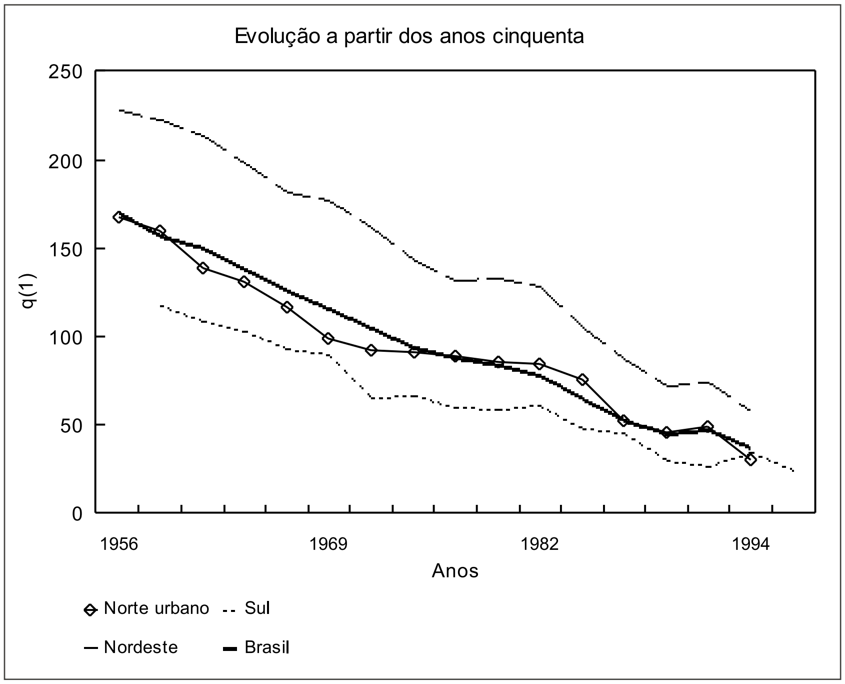
An analysis of demographic growth patterns shows that Brazil is in an advanced stage of demographic transition, leaving behind an old standard of high birth and mortality

**Table 4 - Evolution of the Brazilian population - 1940/2000**

| Years | Total | Urban | Urbanisation rate |
|---|---|---|---|
| 1940 | 41,236,315 | 12,880,182 | 31.23% |
| 1950 | 51,944,397 | 18,782,891 | 36.15% |
| 1960 | 70,070,457 | 31,303,034 | 44.67% |
| 1970 | 93,139,037 | 52,084,984 | 55.92% |
| 1980 | 119,002,706 | 80,436,409 | 67.59% |
| 1991 | 146,825,475 | 110,990,990 | 75.59% |
| 2000 | 169,544,443 | 137,697,439 | 81.21% |

Source: Tabulation made fromCensuses Historical Data - IBGE

**Graph 3 - Children mortality rates in Brazilian regions**




Source: Brito et al 2001

**Table 5 - Probability of death before one year old (per 1,000 live births) - Brazil and regions -1960/1990**

| REGION | 1960 | 1970 | 1980 | 1990 | Reduction 1960/90 (%) |
|---|---|---|---|---|---|
| North* | 159.6 | 94.2 | 75.3 | 45.9 | 71.2 |
| Northeast | 223.4 | 177.1 | 144.0 | 72.6 | 67.5 |
| Southeast | 134.1 | 88.4 | 66.0 | 32.2 | 75.0 |
| South | 109.1 | 61.1 | 61.6 | 27.3 | 75.0 |
| Midwest | 128.9 | 91.1 | 71.1 | 28.9 | 79.2 |
| Brazil | 157.3 | 116.2 | 94.3 | 45.6 | 71.1 |

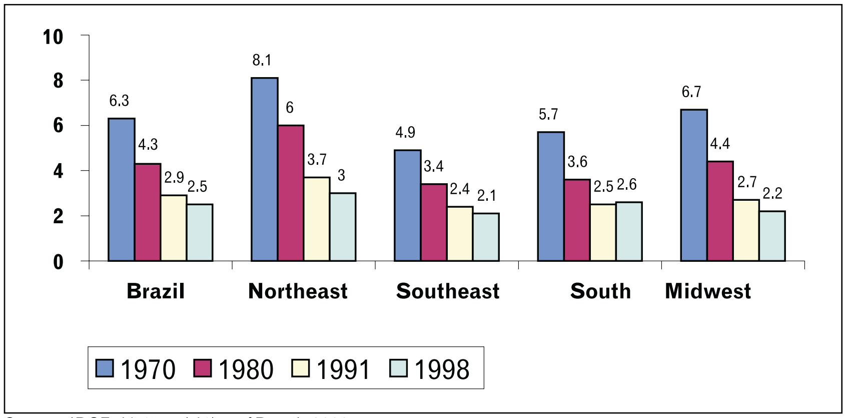
* The data refer to the urban population.
Source: Brito et al - 2001

**Table 6 - Life expectancy at birth - Brazil and regions - 1940/1990**

| REGION | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 |
|---|---|---|---|---|---|---|
| North* | 40.69 | 44.59 | 53.36 | 54.63 | 61.31 | 65.97 |
| Northeast | 36.68 | 38.94 | 40.98 | 45.54 | 56.90 | 59.59 |
| Southeast | 43.53 | 48.95 | 57.18 | 57.30 | 64.54 | 71.02 |
| South | 49.19 | 52.82 | 60.32 | 60.03 | 63.47 | 71.47 |
| Midwest | 47.92 | 51.11 | 56.65 | 58.93 | 63.47 | 70.99 |
| Brazil | 41.53 | 45.51 | 51.64 | 53.46 | 61.76 | 66.01 |

* The data refer to the urban population.
Source: Brito et al - 2001

**Graph 4 - Total fertility rates by large regions - 1970/1998**




Source: IBGE - National Atlas of Brazil - 2000

rates and moving into the current pattern of low birth and mortality rates (**Graph 5**). The transitional phase, with relatively lower mortality rates – though still with high birth rates – accounts for the demographic boom occurred in the period 1950-1980 (where high average annual growth rates varied between 2.99 to 2.48 a year). (**Table 7**).

## 2.2. Settlement Standards

Just as important as the quantitative improvement of the population are the way their dwelling places changed and the conditioning factors of such changes. To a certain extent, the country's accelerated industrialisation process accounts for the changes, i.e., it not only pulls people to urban areas, but it also leads to behavioural changes, which is an indication of lower birth rates in the intermediate term. An analysis of demographic data shows that these processes occur during the industrialisation process: until 1940, 31.2 percent of the population lived in urban areas, 55.9 percent in 1970 and 81.2 percent in 2000.

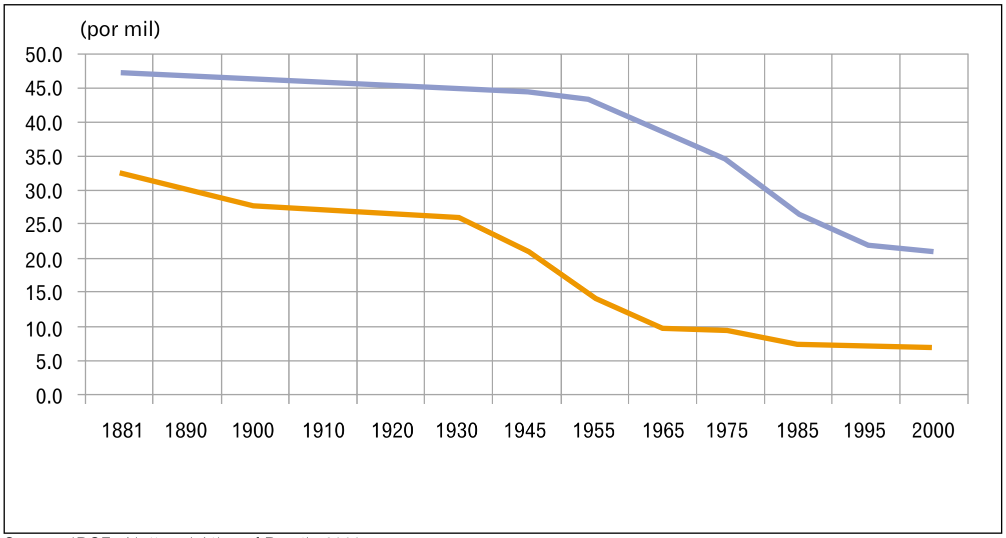
A large portion of the urban demographic growth was due to rural exodus. This migratory process becomes more intensive during the period of the so-called "developmentalism" in the Brazilian economy (1950s-1960s). During the following decades, however, in the period 1960-1980, the flows from rural to urban areas reached its zenith, representing 53 percent of the urban population's growth.

From that time on, demographic concentrations in intermediate- and large-sized urban agglomerations are intensified. Those municipalities with more than 100 thousand and less than 200 thousand inhabitants reported a nine-fold growth in population during the period 1940-1980. Those municipalities with a population ranging from 200 thousand to 500 thousand inhabitants jumped from eleven in 1960 to 76 in 2000, which is nearly a seven-time difference. There were only two cities with over half a million inhabitants in 1940; 14 cities in 1980; and 31 cities in 2000.

Cities with more than one million inhabitants – only two in 1960, Sao Paulo and Rio de Janeiro –, became five in 1970; 10 in 1980; and finally 13 in 2000. These figures become more meaningful if compared to data on Brazil in 1872, a time when the total population of the ten largest cities was below one million inhabitants – only 815 thousand inhabitants.

These figures unveil a new reality of macro urbanisation and metropolisation. However, when demographic figures regarding either direct agglomerations or those in the immediate outskirts of these large cities are taken into account, the demographic concentration picture is substantially magnified.

**Graph 5 - Evolution of birth and mortality rates in Brazil - 1881/2000**




Source: IBGE - National Atlas of Brazil - 2000

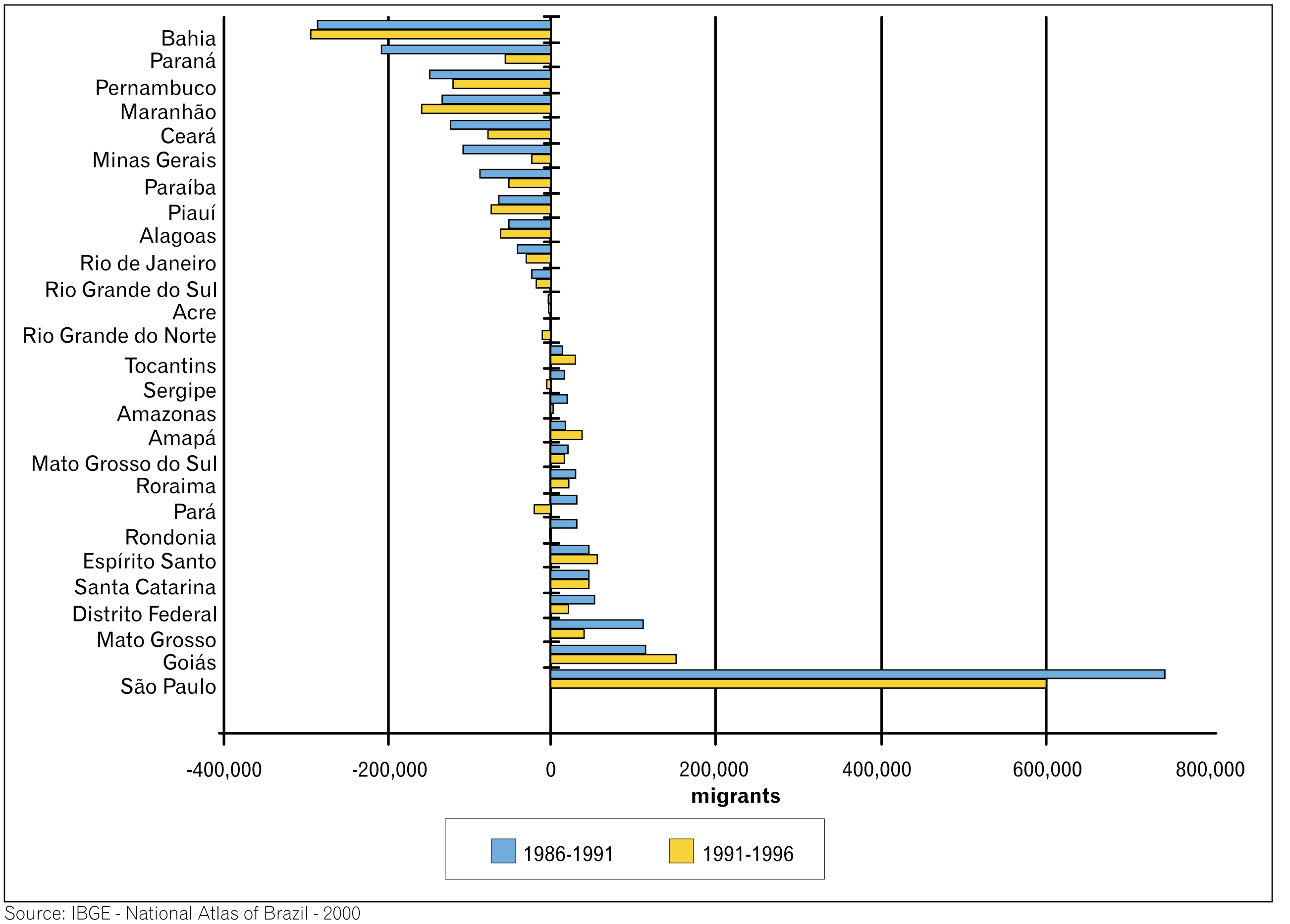
**Table 7 - Average geometric rate of annual growth Brazil and Regions - 1940/1996**

| REGIONS | Average geometric rate of annual growth (%) | | | | | |
|---|---|---|---|---|---|---|
| | 1940/1950 | 1950/1960 | 1960/1970 | 1970/1980 | 1980/1991 | 1991/1996 |
| Brazil | 2.39 | 2.99 | 2.89 | 2.48 | 1.93 | 1.38 |
| North | 2.29 | 3.34 | 3.47 | 5.02 | 3.85 | 2.44 |
| Northeast | 2.27 | 2.08 | 2.4 | 2.16 | 1.83 | 1.06 |
| Southeast | 2.14 | 3.06 | 2.67 | 2.64 | 1.77 | 1.35 |
| South | 3.25 | 4.07 | 3.45 | 1.44 | 1.38 | 1.24 |
| Midwest | 3.41 | 5.36 | 5.6 | 4.05 | 3.01 | 2.22 |

Sources: IBGE National Atlas of Brazil - 2000

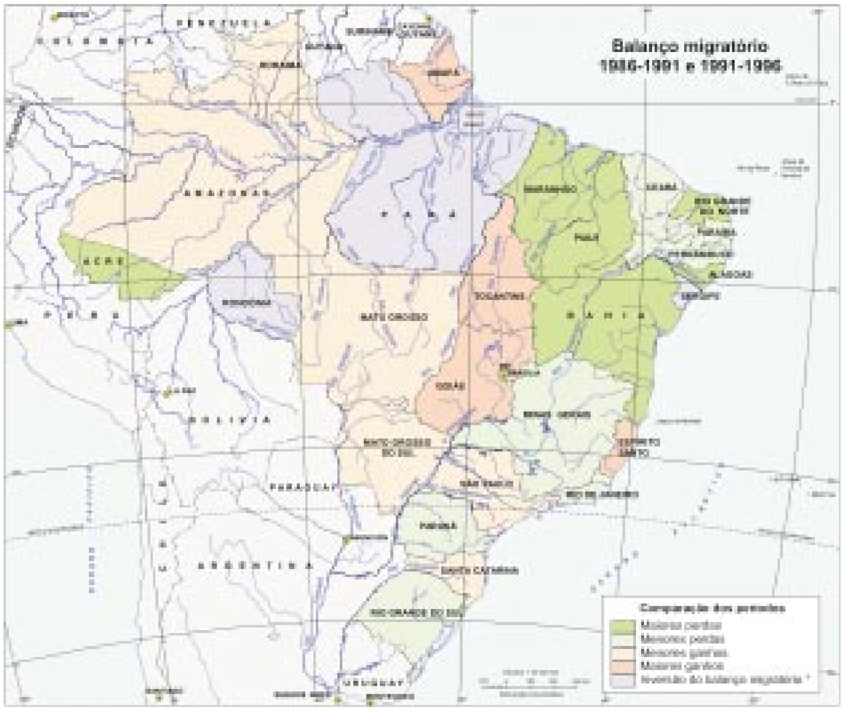
During the 1990's, migration dynamics in Brazil undergo changes as two complementary trends of the current spatial distribution of population are strengthened. On the one hand, the Southeast Region remains as a centralising area and keeps pulling migrants both towards its metropolitan area and to its dynamic, moderate-sized cities. On the other hand, the new migration trends towards rural areas refer to the people who move towards dynamic agricultural hubs, such as the States of Goias, Mato Grosso, Rondonia and Tocantins (situated in the soybean expansion zone). Even though the migratory flows are geared towards agricultural areas, the output of this process will concentrate in the urban peripheries of these regions. (**Graph 6 and Map 3**).

**Graph 6 - Migrant population loss and gain - 1986/1996**




Source: IBGE - National Atlas of Brazil - 2000

**Map 3 - Migration balance 1986 - 1991 / 1991-1996**




Sources: National Atlas of Brazil - IBGE - 2000

**Table 8 - Average annual growth rates of GDP, agriculture and industry, according to decade (in %).**

| Decade | GDP | Agriculture | Industry |
|---|---|---|---|
| 1900/10 | 4.2 | 3 | 5.5 |
| 1910/20 | 4.2 | 3.8 | 6.2 |
| 1920/30 | 4.5 | 3.9 | 3.8 |
| 1930/40 | 4.4 | 2.4 | 7.5 |
| 1940/50 | 5.9 | 3.1 | 9 |
| 1950/60 | 7.4 | 4.4 | 9.1 |
| 1960/70 | 6.2 | 4.4 | 6.9 |
| 1970/80 | 8.6 | 4.7 | 9 |
| 1980/90 | 1.6 | 2.4 | 0.2 |
| 1990/96 | 2.8 | 4.1 | 2 |
| 1900/80 | 5.7 | 3.7 | 7.1 |
| 1900/96 | 5 | 3.6 | 6 |

Source: Bonneli & Gonçalves - 1998

## 3. Industry and Urbanisation

### 3.1. Initial Stage

The strong connection between urbanisation and industrialisation is a characteristic of processes of territorial, demographic and economic dynamics in the Brazilian history.

Within a 30-year period, the country shifted from an agrarian economy to a highly urbanised and industrialised one, with figures showing this transition. During the 1970s – the most dynamic period – Brazil grew at an average annual rate of 8.6 percent, the industrial production grew at an average annual rate of 9.0 percent and the urban population as a share of the total population jumped from 44 percent to over 55 percent. (**Table 8**).

This process brought about various effects over the natural environment – as a result of impacts on ecosystems during implementation of infrastructure and exploration of Natural Resources for industrialisation – and over cities – as a result of strong migratory flows and of the new dynamics associated to the establishment of economic activities in the area. Natural differences were gradually replaced by socio-spatial differences as the Southeast and South Regions started to play a key role in the country's industry. Up until the early 1980's, industrialisation reached all regions in the country. During the period 1980-1995 changes in the country's economic, social and physical spaces were consolidated.

**Map 4 - Location of industrial companies - 1996**


Sources: IBGE - National Atlas of Brasil - 2000

Inter-regional connections become stronger in the face of intense flows of people and goods generated by the link between urbanisation and industrialisation and by emergence of domestic tourism, which tapped the country's rich natural and cultural heritage to fix its position among the new activities facilitated by this process (Santos 2000).

With regard to the interaction between the urbanisation-industrialisation association and ecosystems, effects on the physical space and natural resources unveiled a set of significant impacts. Its influence failed to be more profound and far-reaching due to slowed economic growth during the 1980.

## 3.2. Changes in the Production Structure

In the first years of the 1980's, the Brazilian industrial development underwent extensive adjustments, which began together with the external debt crisis. The Brazilian industrial sector took a series of hits from the periods of recession, stagnation and hyperinflation that affected the Brazilian economy.

This period witnessed a reduction in the relative size of traditional industries, which was offset by the advancement of dynamic segments, such as the electrical and transport supplies sectors. Both phenomena helped the Brazilian industrial structure come closer to that of major developed economies, which displayed a certain balance among three large groups of industrial goods: traditional economies: (i) those established in the old days, generally producing non-durable consumer goods; (ii) those that produced modern intermediary goods (metallurgical, chemical and plastic goods, construction supplies, paper and rubber) and (iii) those that produced capital goods and the majority of the durable consumer goods (the so-called "metal-mechanical complex") (Bonelli 1999).

From the second half of the 1990's, the new worldwide economic dynamics led to the urban-industrial picture currently in place in Brazil, where the new conditions brought about by globalisation, together with the heritage from previous times, reflected on the spatial distribution and on the interaction among markets. (**Map 4**).

Such transformations in the Brazilian production structure were triggered by the worldwide internationalisation of production, went on with the country's economic opening and were finally consolidated with the currency stability and the recent change in exchange rate policies. There were three key developments to the internationalisation of the Brazilian economy: privatisation of publicly-held enterprises operating in the sectors of infrastructure and raw materials; acquisition of large- and medium-sized domestic enterprises by foreign groups interested in the Brazilian market; and finally increased investments by global corporations that had local plants (Dupas 2001).

**Table 9 - Structure of the Brazilian industrial production in selected years (in % of the current production value)**

| Products and Groups | 1920 | 1940 | 1950 | 1960 | 1970 | 1975 | 1980 | 1985 | 1990 |
|---|---|---|---|---|---|---|---|---|---|
| Tradicional | 89.67 | 79065 | 74.05 | 56.19 | 48.09 | 34.07 | 35.15 | 35.64 | 39.06 |
| Wood | 4.04 | 2.41 | 3.39 | 2.64 | 2.29 | 2.21 | 2.05 | 1.19 | 1.01 |
| Furniture | 1.27 | 1.38 | 1.66 | 1.84 | 1.78 | 1.55 | 1.19 | 1.16 | 0.99 |
| Leather and animal skin | 2.35 | 1.95 | 1.52 | 1.08 | 0.66 | 0.49 | 0.49 | 0.60 | 0.53 |
| Pharmaceutics | 0.76 | 1.44 | 1.93 | 1.95 | 2.14 | 1.53 | 1.11 | 1.15 | 1.18 |
| Cosmetics | 2.52 | 1.77 | 1.73 | 1.52 | 1.39 | 1.02 | 0.82 | 0.84 | 0.79 |
| Textile | 25.20 | 20.61 | 18.69 | 12.54 | 9.29 | 1.85 | 6.50 | 5.77 | 5.23 |
| Clothing | 7.70 | 6.20 | 4.34 | 3.41 | 3.38 | 3.48 | 3.50 | 4.34 | 4.09 |
| Food | 37.35 | 36.17 | 32.02 | 24.15 | 20.21 | 16.36 | 14.05 | 15.81 | 18.81 |
| Beverages | 4.40 | 2.24 | 3.13 | 2.37 | 1.88 | 1.28 | 1.07 | 1.06 | 1.15 |
| Tobacco | 3.34 | 1.53 | 1.38 | 1.12 | 0.96 | 0.79 | 0.55 | 0.60 | 0.61 |
| Publishing | ... | 3.15 | 2.83 | 2.28 | 2.52 | 2.20 | 1.63 | 1.32 | 2.39 |
| Various | 0.74 | 0.80 | 1.43 | 1.29 | 1.59 | 1.31 | 1.49 | 1.80 | 2.28 |
| Dynamics - A | 9.06 | 16.13 | 21.09 | 30.19 | 33.32 | 43.78 | 43.96 | 44.28 | 43.10 |
| Non-metallic minerals | 2.55 | 3.52 | 4.51 | 4.52 | 4.17 | 4.06 | 4.25 | 3.02 | 2.92 |
| Metallurgy | 3.18 | 5.41 | 7.60 | 10.53 | 12.47 | 13.46 | 13.9 | 13.99 | 13.12 |
| Paper and cardboard | 1.19 | 2.11 | 1.99 | 2.97 | 2.44 | 2.37 | 2.72 | 2.81 | 2.82 |
| Rubber | 0.12 | 0.50 | 1.61 | 2.53 | 1.70 | 1.62 | 1.52 | 1.66 | 1.67 |
| Chemicals | 2.02 | 4.59 | 5.18 | 8.96 | 10.89 | 15.5 | 19.52 | 20.88 | 20.92 |
| Plastic | ... | ... | 0.20 | 0.68 | 1.65 | 6.77 | 2.05 | 1.92 | 1.65 |
| Dynamics - B | 1.27 | 4.24 | 5.31 | 13.62 | 18.61 | 22.15 | 20.89 | 20.08 | 17.82 |
| Mechanics | 0.07 | 0.91 | 1.60 | 2.85 | 5.70 | 8.02 | 7.69 | 6.85 | 5.99 |
| Electrical Material | ... | 0.79 | 1.40 | 3.98 | 4.71 | 5.06 | 5.26 | 5.80 | 5.38 |
| Transportation Material | 1.20 | 2.54 | 2.31 | 6.79 | 8.20 | 9.07 | 7.94 | 7.73 | 6.45 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source: Bonelli - 1998

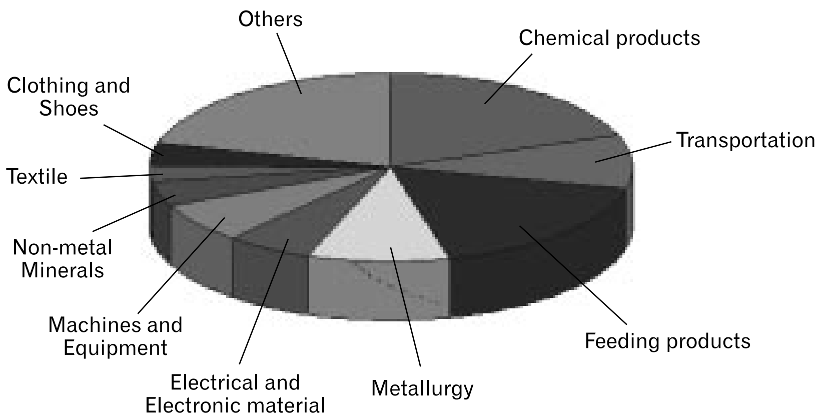
Following the path of international capitalist economies, Brazilian companies alternate short recession periods with short periods of growth (**Table 9**): the industrial production declined about 2 percent during the 1980's, whereas the GDP grew a mere 16.8 percent – on average, this was equivalent to 1.56 percent per year. The pattern of economic growth in the 1990's is characterised by two different periods. In the period 1990-1993, the recession faced by the Brazilian economy determined an average growth rate of only 1.2 percent per year, while the industry reported a rate of 0.3 percent. Between 1993 and 1997, the GDP rose more favourably: the growth rate stood slightly above 4.4 percent per year on average, while the industrial rate was 3.8 percent (IBGE 2000).

### 3.3. Economic Activities within the New Industrialisation Framework

The industrial sector's profile has also experienced changes by introducing new operations in the urban economy and in the exportation segment (**Graph 7**). The subcontracting sector's performance has been extraordinary by further developing production operations and expanding the supply to match the demand created by globalisation. Its growing importance in the urban economy is a hallmark of external economic opening, when the outsourcing and subcontracting surge reshaped the traditional production structure. The subcontracting sector's growth in that stage was important and its rate as a share of the GDP was 59.7 percent (IBGE 2000).

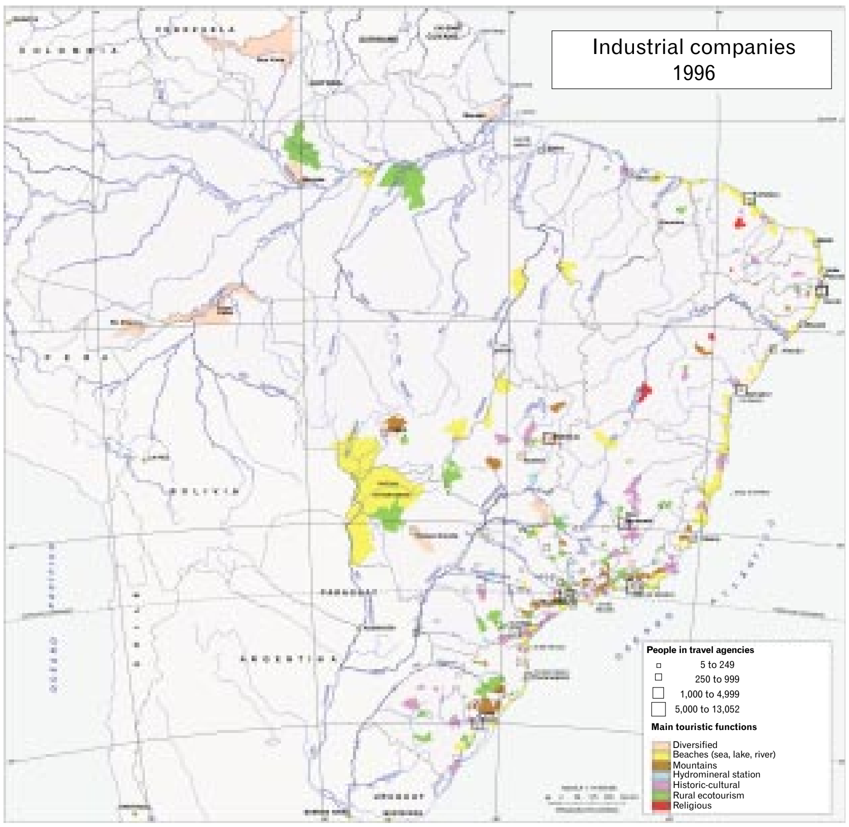
At intra-sectoral level, in 1994 the financial institutions' share starts to undergo a streamlining process and share of other services expands, specially those related to infrastructure, such as telecom services. After growing approximately 2.5 times in the 1980's, this segment grew over 120 percent during the first six years of the 1990's.

**Graph 7 - Industrial transformation - 1998**




Source: CNI - National Industry Confederation - 2002

**Map 5 - Expansion of tourism / Typology of touristic municipalities**




Sources: IBGE - National Atlas of Brazil- 2000

Some industries, such as tourism and entertainment, stood out dramatically in the larger picture and in this new stage they intensified flows and exchanges at the domestic level, whose foundations had been established during the modernising period of the economy. Tourism in particular experiences a major growth in terms of options it offers and in terms of the territorial expansion, which is also responsible for leveraging the entertainment industry. (**Map 5**).

An increased concentration of sales of industrialised goods is also indicative of changes in the Brazilian economy and urbanisation: in 1986, the 15 most important sectors accounted for 61 percent of sales and, in 1996, they represented 75 percent (IBGE 2000).

The rise of the auto industry is associated both to the urban expansion and exportation operations, thus occupying the first position in the period. The urban expansion also contributed to the good performance of sales in the publishing sector, which accounted for 2.77 percent of all sales in the segment in 1996. Other indicators of the expansion of the urban consumer market demonstrate the favourable performances of such sectors as the industrialised food, beverages, electronic supplies and telecom (IBGE 2000).

These data stress the close relationship between urbanisation and industrialisation and they also provide inputs to the analysis of the pressure they exert on the environment. This is dealt with in section 4.1 of this chapter.

### 3.4. Industrialisation and Spatial Reorganisation

The transformations in the international production structure have caused the rationale for the spatial distribution of industries and their complementary operations to be significantly redesigned. The new spatial order established at global level causes major metropolitan areas and their traditional industrial activities to become meaningless and substitutes them with a variety of services that serve both the domestic and foreign plants.

At the international level, the location trend imposed globally is the concentration of enterprises in the subcontracting sector in metropolitan areas and the dispersion of plants throughout moderate-sized cities or regions.

**Box 1 - Recent strategies for industrial location**

**A reduction of industrial production activities and an expansion of the service segment in Brazilian metropolises are consequences of trends in the globalisation of the economy. As Geiger (2000) described, companies, particularly transnational companies, have been relocating their plants from metropolises to moderate- and small-sized cities in the wake of trends in developed countries. An illustration of this new territorial organisation of industrial activities is the agglomeration of auto industries in the cities of Resende and Porto Real, in the State of Rio de Janeiro; and the cities of Betim and Juiz de Fora, in the State of Minas Gerais.**

**The Rio de Janeiro-São Paulo axis reinforces the connection between two service hubs through industrial activities in moderate- and small-sized municipalities situated inbetween the Rio and São Paulo. These undertakings, however, have their administrative and managerial headquarters and their service benchmarks in the metropolis.**

Although statistical data have failed to encompass these recent changes in industrial locations as of now, specific studies show that the two largest cities in Brazil, Sao Paulo and Rio de Janeiro, had their share of the GDP reduced from 38.6 percent to 31.7 percent during the 1975-1996 period (IBGE 2000).

Metropolitan Areas start to play a new role in this state of affairs by attracting to their outskirts the establishment of transnational plants or service companies, which either causes their value to appreciate or their shape to be altered in order to meet the new requirements.

In Brazil, transnational companies have been transferring their plants from domestic metropolitan areas to moderate- and small-sized cities. Large cities, particularly state capitals, have taken up a national-level role in addition to their regional hegemony, while they concentrate on educational and political decision-making functions.

From 1980 to 1985, while Brazil grew at an annual rate of only 1.27 percent, the most part of the 13 metropolitan cities and 16 regional cities expanded at much higher rates: 9 capitals in the “regional centres” category grew at rates higher than 3.0 percent per year and, in the case of “sub-regional centres”, 13 of them reported a growth rate above the national average for the part 20 years (IBGE 2001).

At local level, new uses to the territory have developed and, in order to be competitive at global level, cities required massive investments in telecommunication informatics infrastructure by reason of the demand for the establishment of large corporate conglomerates.

### 3.5. Industry and the Environment: a New Interface

As the economy goes global, natural resources – a primary source of export revenues for peripheral countries – undergo a growing deterioration of their exchange power due to accelerated technological absorption of industrialised services and goods.

Unlike the post-war industrialisation, which consumed a substantial portion of natural resources – raw materials, commodities and power sources – the new pattern of growth is characterised by a strong demand for information and knowledge; there is a relative reduction in the consumption of natural resources and in the emission of polluting effluents. Though the industrialisation model employed at that time in Brazil included technological standards that were admittedly advanced for the domestic framework, it was not matched by environmental protection policies geared towards sustainable development principles and the accommodation of conflicting interests.

The rapid adoption of the international industrial framework in Brazil internalised production patterns (chemicals, petrochemicals, metals and mechanics, transport supplies, timber, paper and pulp and non-metallic minerals) with a strong impact on the environment. Focusing on the peculiarities of individual ecosystems, this impact depends in turn on factors such as the industrial structure's nature in connection with the natural environment, on the intensity and spatial concentration of industrial goods and segments and on the technological standard of production. (**Map 6**).

The new potentialities offered by computing and bioengineering now have essentially altered the concept of appropriation of Natural Resources. Degradation and processing of genetic codes have given new life to Biological Reserves, which have become invaluable sources of genetic knowledge.

The replacement of the old style of concentration in industrial plants in districts situated either in the periphery of hub cities or in metropolitan areas also creates a new relationship between production and environment. The changes in spatial distribution and specialisation of production activities shaped by globalisation of the economy exert an influence at both local and regional level, thus provoking other types of impact on the environment and bring the need for a new response in terms of an environmental policy.

## 4. analysis of urban environmental quality

The recent changes and trends in the Brazilian municipal networks indicate a series of common urban environmental problems, which make pressure on the natural resource base. The issues related to land access, soil use and occupation, environmental sanitation, urban transportation and development of economic activities are highlighted among the issues affecting the sustainable development of Brazilian cities.

The urban expansion process in the last four decades is a result from an intense rural-to-urban population shift and disparities in income between regions, and determined the disorganised occupation of the urban soil, making pressure on the governments for the implementation of services and infrastructure. This process, which co-occurred with the progressive decline in public finances, failed to meet many of the society's demands, contributing towards the aggravation of the scenario in metropolitan areas and in other large cities.

**Map 6 - Urbanisation of the territory/ urban agglomerations - 1996**

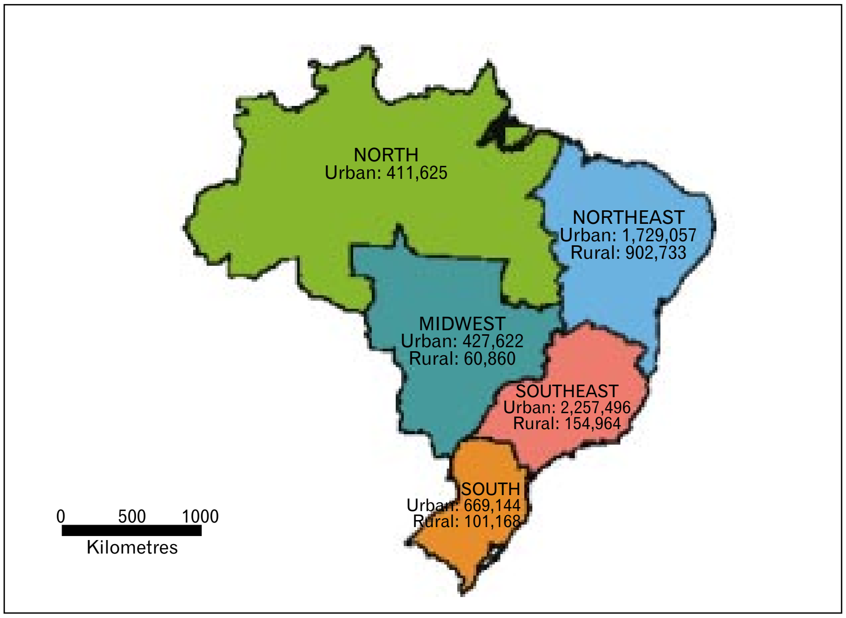
Sources: National Atlas of Brazil - IBGE - 2000

### 4.1. Land Access and Housing Deficit

The number of people living in slums overcame the 5 million mark in 1991. The slums have been extending in all areas, even those where there is a sharp decline in the population growth rates as a whole. The slums grow particularly in the Northeast (from 15.24 percent to 25.75 percent) and North regions (from 3.15 percent to 9.52 percent). In some cities, virtually half of the constructed area is irregular and/or informal, including issues from the construction's lack of safety to the ways vulnerable areas are occupied. The land irregularity represents an obstacle to credit access and to official housing programs. Although the invasion of public areas – mainly along rivers, streams and hillsides – is a serious issue specially in metropolitan areas and large urban agglomerations, it is also noted in medium-sized cities (Brazilian Ministry of Environment – MMA, 2000 A).

The difficulties of access to the urban land and the unfair income distribution result in a housing deficit in Brazil totalling 6,656,526 units in 2000 – around 29.3 percent or 1,951,677 units in metropolitan regions, 2.54 million in the other urban areas and 1.645 million units in rural areas. The deficit rose during the same period to 665,000 units, 200,000 of which in metropolitan areas, 450,000 in the other urban areas and 15,000 in rural areas. It is estimated that the housing deficit corresponds to 11.5 percent of the stocks of permanent houses of metropolitan regions, 13 percent in the other urban areas and 21.4 percent in rural areas. The Northeast region accounts for the greatest housing demand and it is estimated that the region needs 2,631,790 units. The Southeast region comes second, with the need for 2,412,460 units. Both regions represent 75.8 percent of the Brazilian housing deficit. The difference is that in the first region a significant part of the problem needs to be solved in rural areas (João Pinheiro Foundation 2001). (**Map 7**).

**Map 7 - Estimates related to the housing deficit per household situation According to Brazilian Regions - Brazil - 2000**




Source: Basic Data: Ibrazilian Institute of Geography and Statistics (IBGE), Preliminary Synopsis of the Demographic Census - 2000; National Household Sample Survey (PNAD) - 1999 (microdata)
Design: João Pinheiro Foundation (FJP), Statistics and Information Centre (CEI)

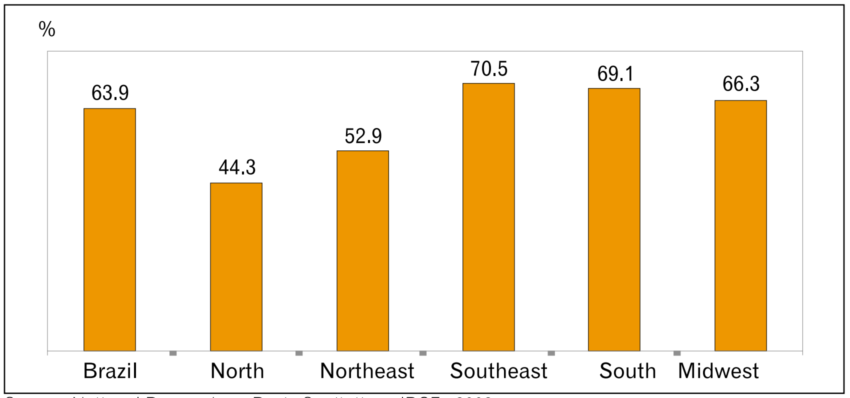
The lack of infrastructure, which was estimated at 4,652,611 houses throughout Brazil in 1991, was reduced to 3,046,334 in 2000. Such reduction indicates a slight improvement, in a general way, of the conditions of basic services, leading to less pressure on the environment (contamination of water and soil bodies, and occurrence of diseases due to the lack or inefficiency of infrastructure services).

### 4.2. Environmental Sanitation

In Brazil, 63.9 percent of the houses have water supply (**Graph 9 and Map 8**). The population not served, or served in poor conditions, is located in peripheral and slummed areas in the cities. The Southeast Region has the best situation, with 70.5 percent of the houses being served by the general water supply system. The North has the worst situation in terms of served houses – less than half of the houses have a water supply. As a supply alternative for the houses that are not served by the general water supply system, there are wells or springs, with and without internal pipes. The water supply from wells or springs, however, poses greater risks of water contamination, mainly in areas without sewage system, where the population uses pits that allow infiltration into the soil. Among metropolitan regions, Fortaleza (State of Ceará) presents the lowest percentage of houses with water supply from a general system – 77.1 percent.

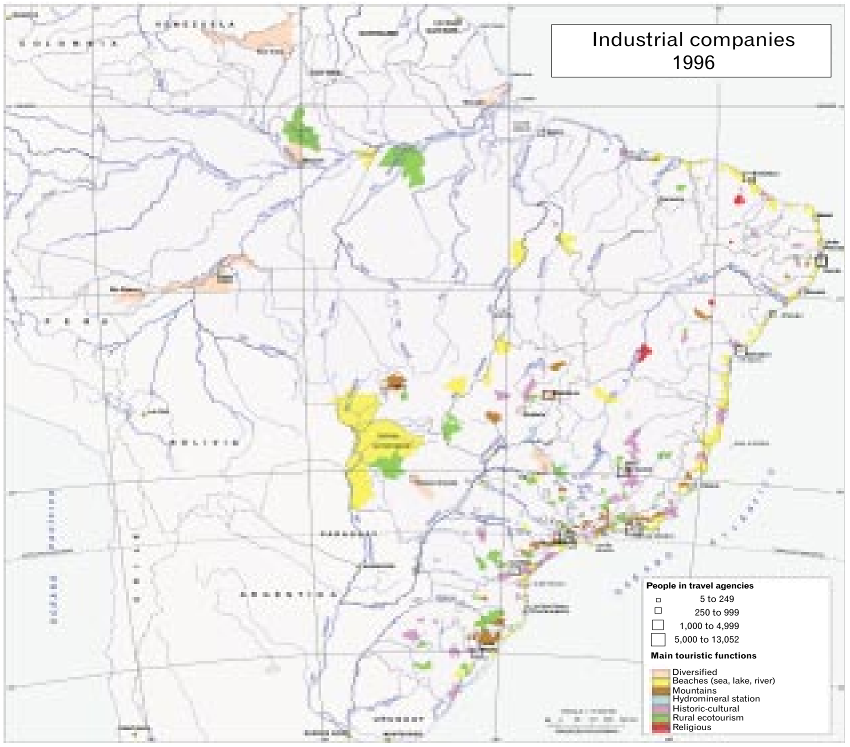
With regard to sewage (**Map 9**), it is indicated that only 31 percent of the Brazilian population is served, and only 8 percent of that sewage is properly treated. The sewage situation is one of the greatest challenges to governmental public policies, considering its implications on the population and the environment. It is important to notice that the investments made in order to reach 91.1 percent of the houses with water supply implied, on the other hand, in the same quantity of sewage effluent. In 1999, 52.5 percent of urban houses used the sewage general system; 23.1 percent used septic pits; 12.1 percent primitive pits; and 6.1 percent used ditches or directed their sewage straight to water bodies (rivers, seas, lakes, etc.). The Southeast Region has the highest percentage of urban houses connected to the general system (78.8 percent), and the North Region has the lowest (8.2 percent). In metropolitan regions, the service levels do not follow the relations found in the North and Southeast regions (Brazilian Institute of Geography and Statistics – IBGE 2001).

**Graph 9 - Houses served by general network, according to large regions - Brazil - 2000**




Source: National Research on Basic Sanitation - IBGE - 2002

**Map 5 - Expansion of tourism / Typology of touristic municipalities**




Sources: IBGE - National Atlas of Brazil- 2000

The service pattern through the general system changes in the Metropolitan Region of Porto Alegre (State of Rio Grande do Sul), which has the lowest percentage of houses connected to the general system (4.9 percent), well under the Metropolitan Region of Belém (7.7 percent). However, the information on Porto Alegre does not necessarily represent a negative situation, because is reflects a policy of incentive to the dissemination of the use of septic pits, considering that the sewage directed to collection networks without any treatment is potentially more hazardous to the environment, which is proved by the health indicators and the quality of life in the Porto Alegre Metropolitan Region, that are well above the Brazilian average (IBGE 2001).

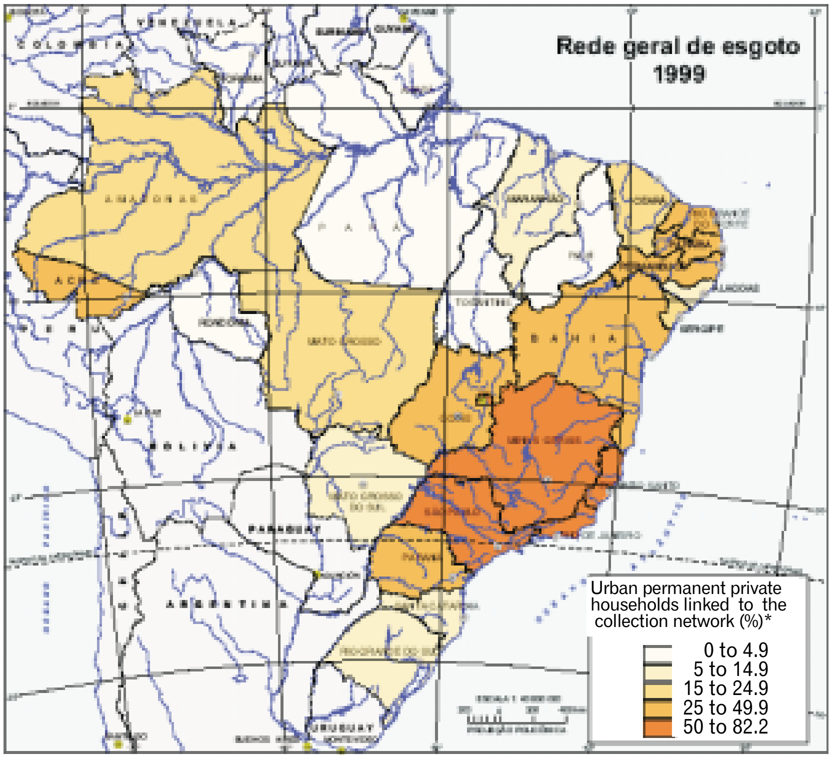
The domestic sewage is the source of the three most serious problems of water pollution in Brazil: faecal coliforms, organic pollution (BOD) and phosphorus. Despite of the fact that the coliform and BOD production is, roughly speaking, constant per person, the house production of phosphorus is significantly different between the rural and urban areas, because of the intensive use of phosphorous detergents in the latest.

The faecal coliforms and other pathogens in the sewage are the main source of mortality and morbidity, specially of children. To reduce the primary threaten to human health, the most important action, therefore, is sewage collection and transportation away from residential areas, either through sewage systems or through periodic removal in the maintenance of septic pits (IBGE 2001).

With regard to drainage, most Brazilian municipalities have a kind of urban drainage service (78.6 percent), regardless of their network extension and the efficiency of the systems as a whole. The results from the National Sanitation Research Program – PNSB (*Pesquisa Nacional de Saneamento Básico*) 2000 – indicate that the drainage network distribution is more favourable to the most developed areas. In the South region, 94.4 percent of the municipalities have an urban drainage network, whereas in the North region the percentage is only 49.4 percent. PNSB 2000 **Graph 10** illustrates those data on drainage services per region, disclosing the regional disparities in this subject.

The permanent waterways are the receiving bodies mostly used by the municipalities as a drainage system (75.7 percent). **Graph 11** confirms the statement for all regions in the country, also proving that alternative systems – such as storage reservoirs – are a quantitatively elementary initiative, being used in only 7.5 percent of Brazilian municipalities (PNSB 2000).

**Map 9 - Urbanisation and Environment General Sewage Network 1999**




Sources: National Atlas of Brazil - IBGE - 2000

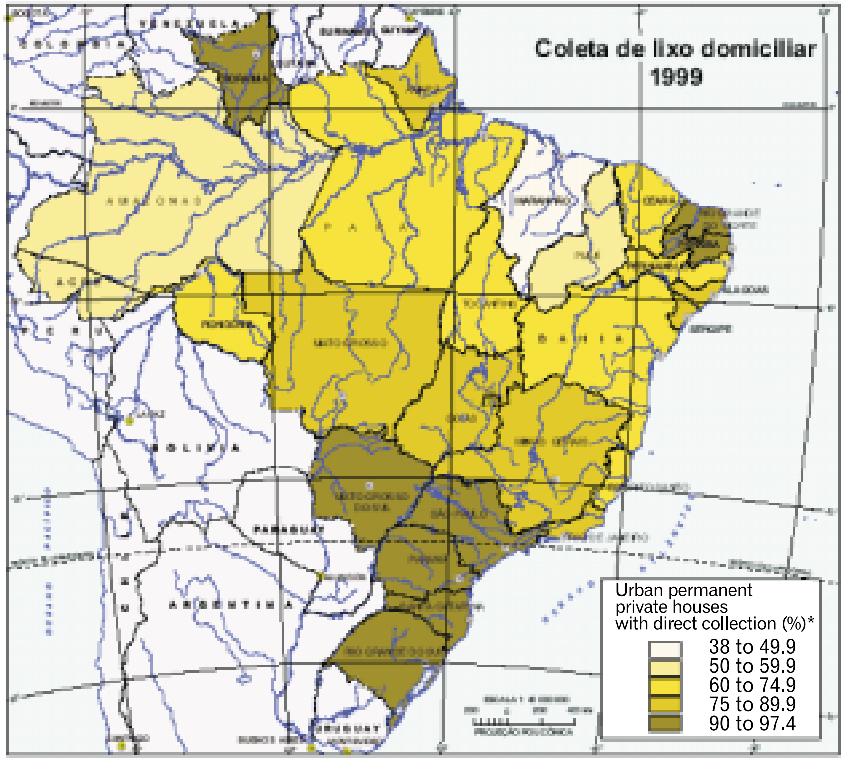
With regard to solid residues, it is estimated that the house garbage collection in Brazil is over 100,000 tonnes per day (**Map 10**). Around 90.7 percent of Brazilian urban houses have garbage collection services, although many of them operate in an irregular and incomplete way. The urban characteristics of spatial agglomeration and the garbage composition by perishable residues recommend direct collection, because it lessens the risks of contamination and the bad smell from the houses. The North Region has the lowest percentage of urban house garbage collection service (85 percent), and the South Region has the highest rate in the country (96.8 percent) (**Table 10**). Among metropolitan regions, Porto Alegre (State of Rio Grande do Sul) presents the largest coverage of garbage collection, serving 96.7 percent of the houses, and Recife (State of Pernambuco) has the smallest coverage – 76.9 percent. Of total collected solid residues, it is

**Table 10 - Households per sanitation condition and electricity (%) - Brazil - 1999**

| Brazil and Regions | Piped water and general Distribution network | Sewage and Septic Tank(1) | Collected Waste(1) | Electricity(1) |
|---|---|---|---|---|
| Brazil | 63.9 | 52.8 | 79.9 | 94.8 |
| North | 44.3 | 14.8 | 81.4 | 97.8 |
| Northeast | 52.9 | 22.6 | 59.7 | 85.8 |
| Southeast | 70.5 | 79.6 | 90.1 | 98.6 |
| South | 69.1 | 44.6 | 83.3 | 98 |
| Midwest | 66.3 | 34.7 | 82.1 | 95 |

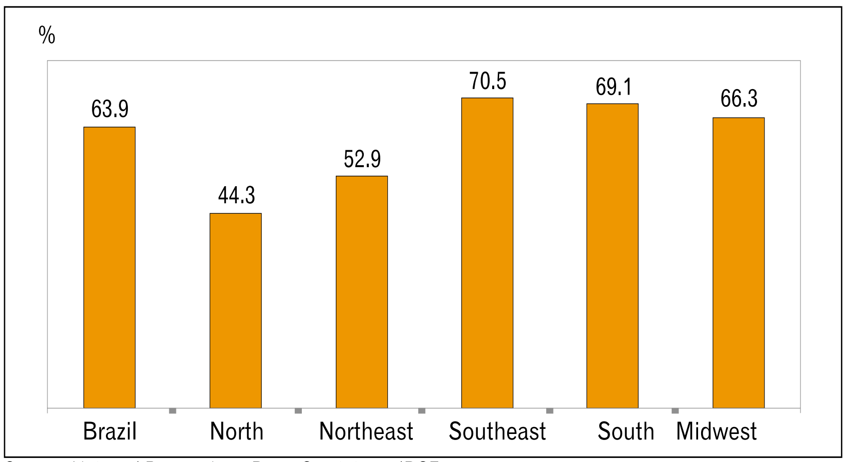
(1) Excluding the North region rural population.
Source: National Household Sample Survey 1999 - IBGE - 2000 and National Basic Sanitation Survey - IBGE - 2002

**Map 10 - Urbanisation and the environment house garbage collection - 1999**




Sources: National Atlas of Brazil - IBGE - 2000

**Graph 9 - Houses served by general network, according to large regions - Brazil - 2000**




Source: National Research on Basic Sanitation - IBGE - 2002

estimated that only 28 percent have an appropriate destination. The other 72 percent are disposed of in garbage dumps in the open air or thrown in valleys and rivers (IBGE 2001).

Among the environmental sanitation factors that make pressure on urban environment, there is also the insufficient attention to urban drainage issues, which are accountable for periodic floods. In most cities, the planning actions are not able to prevent the effects of rainfalls, either by carrying out palliative blockage works in rivers with the usual flood flow, in an attempt to stop them from flooding the lowlands within their area, or by wrongly prevent the maintenance of the areas for natural blockage and slow percolation of rainfall into the water table. The number of parks, green areas and linear parks in the bottom of valleys is insufficient, and they should have been associated to the preservation of lowlands with the adequate use for such purpose.

### 4.3. Urban Transportation

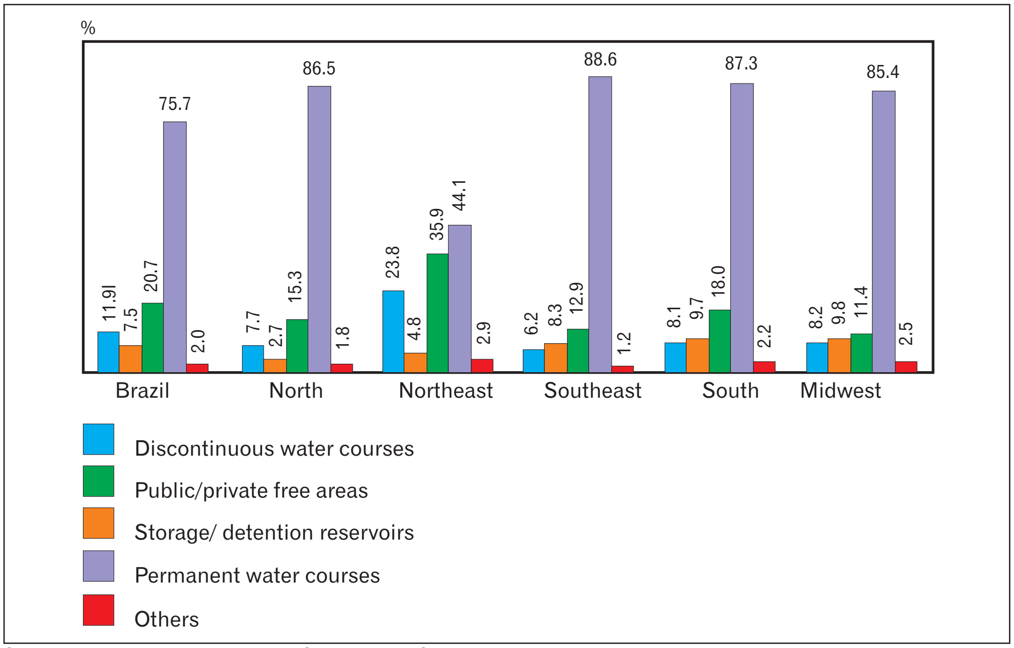
The chaotic scenario of urban transportation, specially in the metropolitan areas, is evidence of constant fall of the population mobility rate and growth of the motorization rate, individual transportation prevailing over collective transportation. In turn, the distribution of motorised modes indicates the great importance of buses as mass transportation, considering the suspension or insufficiency of investments in railways or subways.

In the Brazilian metropolitan regions, the mobility rate can barely reach 60 percent of world average. The home-work-home travel time has increased significantly. The inhabitants/ vehicles proportion in São Paulo, for example, rose from 6 x 1 to 2 x 1 in a twenty-year period (1977-1997). The average speed of buses lowered from 22 to 15 kilometres per hour in ten years. The motorization rate in Brazil rose from 72 inhabitants/ vehicle in 1960 to just over five in 1998, and it is expected to get at 4.3 in 2005. The daily average number of trips per inhabitant tends to rise from 1.5 in 1995 to 1.7 in 2005 (MMA, 2000 A).

The means of transportation are acknowledged as one of the main sources of air pollution in the urban environment, and it can reach hazardous proportions to public health when the dispersion of the gases produced and particulate materials is harmed by the lack of wind. In accordance with studies sponsored by the World Bank, 20 percent of the pollutants in the atmosphere in Rio de Janeiro Metropolitan Region is caused by the means of transportation[2].

The soil impermeability and also the improper occupation of the depths of valleys are largely responsible for the periodic problem – on each rainy season, in relation to floods, traffic jams and blocks, as well as threats to populations living in risk areas. The piping and embankment works carried out in rivers up to the moment only aggravate the problem because they take more water, and faster, to those courses, acting as a flood area transfer (MMA 2000).

**Graph 11 - Drainage network discharge points, by type, according to large regions - Brazil - 2000**




Source: National Research on Basic Sanitation - IBGE - 2002

**Box 2 - Public transportation model**

**The mayor of Curitiba describes his city as "an urban model both to developed and developing countries". Its urban transportation system encourages residential and business developments, in harmony with the urban and zoning plans of the city. In 1973, the Curitiba Research and Urban Planning Institute - IPPUC - developed special buses designed to mass transportation. These were later adapted and expanded in order to face up to the increasing needs of the population of the 80's and 90's. The system currently takes two million people a day. The transportation net provides four integrated transportation alternatives within 12 municipalities of the metropolitan region. The massive use of the public transportation system in Curitiba has reduced the number of cars in the streets, decreasing the levels of air pollution, smog incidence, and the risks of respiratory diseases. Curitiba has also become the first city in Brazil to use a less polluting kind of fuel, decreasing emissions of atmospheric particles in more than 43%.**

Source: Taniguchi, 2001

[1] See "*Política de transportes de passageiros para a Região Metropolitana do Rio de Janeiro – 2000*"

### 4.4 Economic Development

In addition to pressures on the environment caused by the lack of sanitation, transportation and housing, another important source of pressure is the pollution caused by the development of economic activities, particularly those of industrial origin. The (i) emissions of organic material, nutrients and heavy metals into rivers, bays and beaches; (ii) the emissions of particulate materials and gases into the atmosphere; (iii) the inadequate management of solid residues, mainly the dangerous ones and (iv) the power production and consumption pollute and contaminate surface water and groundwater, the air and the soil, harming the urban environmental quality. Such harm affects the population's health and is a negative interference in the economic activities performance itself, as they:

- raise recovery costs of basic resources such as water and soil;
- limit the attraction and use of natural assets for tourism and entertainment;
- cause the imbalance of aquatic populations, particularly in coastal regions, reducing fishery exploitation, as well as the alternative represented by aquacultivation.

However, although these problems are present in major urban areas in Brazil, they have different intensities in each place.

Among economic activities at intra-urban level, mineral extraction is highlighted, specially clay carving, stones and sand extraction. Such activities cause environment degradation by altering topography, removing vegetal cover and causing soil erosion and sanding-up of the drainage system. Despite the extent of the problems caused, there are no information systematically gathered that allows the quantification and measurement of the scope of such impacts.

The productive activities also generate an intense move in the transportation of toxic cargoes affecting the urban environment directly or indirectly. For example, in 1996, out of a total of 1.2 thousand million tonnes of transported cargo in Brazil, only 1.5 percent used river navigation. These trips, made via sea, road or railway, are sources of pressure, particularly on water resources, because of their potential risk of accidents in several circumstances. However, their quantification is not a systematic task carried out by the official administration yet (MMA 2000 A).

### 11.4.5 Pollutant Dumping into Water Resources

Chart 1 presents a summary of the main pollutants and some relevant information on them. From the cost point of view, sewage BOD and phosphorus control is the most expensive, followed by heavy metals and industry BOD.

### 11.4.6 Emission of Pollutants into the Atmosphere

In Brazil, the most serious atmosphere pollution problem noted in large cities is the emission of particulate materials, caused mainly by motorised vehicles (with diesel and gasoline engines) and industries.

The characteristics of the activities and primary sources of pollution are also important to establish the control strategies to be adopted. In general, fixed sources are easier to regulate than the disperse ones. In urban areas the

**Chart 1 - Critical Pollutants - Water**

| Pollutant | Main Damages | Physical Environment | Source | Source Characteristics | Source Location |
|---|---|---|---|---|---|
| Faecal Coliforms | Health | Water | Domestic | Disperse | Urban |
| BOD | Ecosystems | Water | Industrial (by sector)<br>Domestic | Precise (Small, Large)<br>Disperse | Urban<br>Urban |
| Phosphorus | Ecosystems | Water | Domestic (By Location)<br>Agriculture (By type of cultivation) | Disperse<br>Disperse | Urban<br>Rural |

activities are more concentrated and this reduces monitoring and inspection costs.

The most harmful particulate materials are the ones equal or smaller than 2.5 m g/m3. However, the available information allows for the estimate of emissions of particulate materials that are equal or larger then 10 m g/m3. Studies carried out by the World Bank present the 15 most problematic municipalities in terms of particulate material emission, as shown in Table 11.

The limited information prevents the measurement of how serious the atmosphere pollution registered in large centres is, particularly in the South and Southeast regions of the country. In these cases, the emissions of nitrogen oxides, hydrocarbons, carbon monoxides and aldehydes

**Figure 2 - Critical contaminants - air**

| Contaminant | Main damages | Means | Source | Source's features | Source's Localisation |
|---|---|---|---|---|---|
| PM10 | Health, aesthetic and material | Air | Industry (by sector)<br>Transportation (by fuel) | Point (small, big)<br>Mobile | Urban<br>Urban |

Source: World Bankl - 1998

**Table 11 - Brazilian municipalities with highest rates of particulate material emission**

| Municipality (State) | Pop. (x 1000) | Total MP10 (Tonnes) | Ind. MP10 (Tonnes) | Transp. % of the total | Small Industries % of the total | Large Industries % of the total |
|---|---|---|---|---|---|---|
| São Paulo (SP) | 9,646 | 41,204 | 17,123 | 58 | 1 | 41 |
| Rio de Janeiro (RJ) | 5,481 | 16,684 | 6,957 | 58 | 1 | 41 |
| Belo Horizonte (MG) | 2,020 | 10,140 | 5,206 | 49 | 1 | 50 |
| Curitiba (PR) | 1,315 | 9,759 | 3,706 | 62 | 2 | 36 |
| Porto Alegre (RS) | 1,236 | 6,107 | 1,413 | 77 | 2 | 21 |
| Salvador (BA) | 2,075 | 6,104 | 1,308 | 79 | 2 | 19 |
| Brasília (DF) | 1,601 | 6,089 | 2,461 | 60 | 1 | 39 |
| Volta Redonda (RJ) | 220 | 5,833 | 5,443 | 6 | 1 | 93 |
| Manaus (AM) | 1,012 | 5,480 | 1,800 | 67 | 1 | 32 |
| Campo Grande | 526 | 4,603 | 639 | 86 | 1 | 13 |
| Recife (PE) | 1,298 | 4,542 | 2,494 | 45 | 3 | 52 |
| Itapeva (SP) | 82 | 4,515 | 4,403 | 2 | 1 | 97 |
| Cubatão (SP) | 91 | 4,406 | 4,168 | 6 | 4 | 90 |
| Sete Lagoas (MG) | 144 | 4,316 | 3,982 | 8 | 1 | 91 |
| Guarulhos (SP) | 788 | 4,228 | 2,208 | 48 | 2 | 50 |

Source: World Bank - 1998

affect the surface ozone and are mainly originated from vehicles – figures registered between 49 percent in Belo Horizonte (State of Minas Gerais) and 62 percent in Curitiba (State of Paraná) (World Bank 1998).

With regard to the cities with less than 250,000 inhabitants, in none of them the emissions from vehicles represent over eight percent of particulate materials. It means the participation of industry and transportation in the emission of particulate materials is different between large and small urban centres.

As it is the case of particulate materials, the emissions of industrial effluents containing heavy metals are highly concentrated in a few municipalities. Also in this case, the 25 selected cities are located mainly in the South and Southeast regions.

The industries in the mechanical sector are the main source of emissions of effluents containing heavy metals, and the regional agglomeration of the 25 most polluting cities mirrors the industrial concentration in this case, specially in the States of São Paulo and Minas Gerais.

In addition to the fact that industries and transportation are the activities that mostly emit pollutants into the atmosphere, some non-fossil fuels also contribute towards the pressure on air quality. In spite of the fact that alternative-type fuel burning produces a lower level of atmosphere pollution, it also indirectly promotes emissions of particulate material. That happens due to sugar cane burning, which is a practice that was not totally eradicated, and the accidental pollution of water courses with '*vinhoto*' (a highly-polluting waste liquid originated from sugar cane processing). On the other hand, one of the positive aspects of this indirect influence of alternative fuel, in this case the alcohol, is the important contribution towards the reduction of CO2 emissions into the atmosphere through carbon absorption during sugar cane growth stages.

**Table 12 - Municipalities with the highest discharges of heavy metals in water**

| Municipality | Metal (Tonnes) | Pop. (x 1000) | Area | Percentage Small Industries | Percentage Medium Industries | Percentage Large Industries | Total Ranking of Metals |
|---|---|---|---|---|---|---|---|
| São Paulo (SP) | 61.1 | 9,646 | 1,514 | 7 | 37 | 57 | 1st |
| Volta Redonda (RJ) | 29.6 | 220 | 168 | 0 | 2 | 98 | 2nd |
| Rio de Janeiro (RJ) | 26.2 | 5,480 | 318 | 5 | 26 | 69 | 3rd |
| Cubatão (SP) | 24.1 | 91 | 140 | 0 | 2 | 98 | 4th |
| Ipatinga (MG) | 20.2 | 180 | 163 | 0 | 2 | 98 | 5th |
| Camaçari (BA) | 19.7 | 113 | 742 | 1 | 11 | 88 | 6th |
| Belo Horizonte (MG) | 17.1 | 2,020 | 331 | 3 | 20 | 77 | 7th |
| GuaRulhos (SP) | 15.7 | 787 | 313 | 2 | 31 | 67 | 8th |
| Joinville (SC) | 15.7 | 347 | 1,056 | 1 | 8 | 91 | 9th |
| Timóteo (MG) | 11.3 | 58 | 154 | 0 | 3 | 97 | 10th |
| Santo André (SP) | 9.3 | 616 | 167 | 2 | 11 | 87 | 11th |
| Contagem (MG) | 8.5 | 449 | 191 | 3 | 22 | 75 | 12th |
| Serra (ES) | 8.5 | 222 | 270 | 1 | 2 | 97 | 13th |
| Diadema (SP) | 8.4 | 305 | 29 | 4 | 38 | 58 | 14th |
| Ouro Branco (MG) | 8.0 | 4 | 275 | 0 | 2 | 98 | 15th |
| São Bernardo do Campo (SP) | 7.9 | 566 | 428 | 3 | 17 | 80 | 16th |
| Porto Alegre (RS) | 7.6 | 1,263 | 520 | 6 | 28 | 66 | 17th |
| Divinópolis (MG) | 7.6 | 151 | 726 | 2 | 20 | 78 | 18th |
| São Caetano do Sul (SP) | 7.6 | 149 | 13 | 2 | 16 | 82 | 19th |
| Barra Mansa (RJ) | 7.2 | 172 | 860 | 2 | 1 | 97 | 20th |
| Sete Lagoas (MG) | 7.1 | 144 | 534 | 0 | 7 | 93 | 21st |
| Mauá (SP) | 6.2 | 294 | 77 | 1 | 13 | 86 | 22nd |
| Piracicaba (SP) | 6.1 | 283 | 1,497 | 3 | 23 | 74 | 23rd |
| Triunfo (RS) | 5.8 | 17 | 825 | 0 | 5 | 95 | 24th |
| Candido Mota (SP) | 5.7 | 102 | 746 | 0 | 5 | 95 | 25th |

Source: World Bank - 1998

Another biomass power source adopted in Brazil is the charcoal. The steel metallurgy sector is maintained based on that source. From the CO2 emission point of view, this industry causes an expressive impact, because it replaces the use of coke as a reducer, which has an emission of 0.513 tC/t pig iron. If, on one hand, the charcoal steel metallurgy reduces pollutant emissions, on the other it has been indicated as an important factor of deforestation, child labour and even slave labour in the Southeast (States of Minas Gerais and São Paulo), Midwest and North (Carajás region) regions (MMA 2000 A).

### 11.4.7 Pollutants Derived from Solid Residues from Industrial Activity

Although there is a lack of data on the activities of industry-generation residues countrywide, in the State of São Paulo only, São Paulo's Environmental Sanitation Agency – CETESB (*Companhia de Tecnologia de Saneamento Ambiental*) – state agency responsible for environment control – lists 110,000 polluting sources in the state, and the industrial residue movement is estimated at 26 million tonnes per year, over 535,000 of them are dangerous. Presently, the Brazilian Ministry of Environment is developing the proposal of a national inventory, aiming to map the activity and seek data standardisation. Companies that provide treatment, recovery and disposal of special residues joined forces in 1998 to promote the development of the sector and assure that their associates' procedures (treatment plants, sanitary landfills, industrial landfills, incinerators and co-processing plants), in relation to residue handling, properly meet the standards required by the environmental legislation and by inspection agencies. For an idea of the profile of those companies, 423,700 tonnes are disposed of in landfills; 24,000 tonnes are incinerated; 1,500 tonnes are treated and 145,000 tonnes are co-processed (*Revista Brasileira de Saneamento e Meio Ambiente* – Brazilian Magazine on Sanitation and Environment 2001).

### 11.4.8 Energy Consumption

Energy consumption pattern can also have an influence on air quality. The use of hydroelectric energy and biomass contributes to a relatively low level of greenhouse gas emissions in Brazil. However, this is also due to average energy consumption levels, which are considered low in Brazil, specially if compared with developed economies, such as the United States or European countries. Brazil consumes the equivalent of 1 TOE (tonne of oil equivalent) / inhabitant / year, while the Unites States has a consumption of 8 TOE / inhabitant / year, and European consumption is 3.4 TOE / inhabitant / year. The challenge here is to increase energy consumption so as to ensure a satisfactory social and economic outcome, but to do it in an efficient manner, minimising economic and environmental losses brought about by this process (La Rovere, 2001).

According to World Resources 1994/95, Brazil is responsible for the emission of 215.6 million annual metric tonnes of carbon dioxide from industrial sources – about 2.5 percent of this category's world total – and 970 million annual tonnes of $CO_2$ originated from changes in the use of land – 26 percent of the sector's total (Brazilian Ministry of the Environment - MMA, 2000 B).

The metropolitan regions and other urban areas in Brazil, the main environmental problems, with variable degrees, refer to:

- Surface and underground water pollution, due to lack of basic sanitation – specially sanitary wastewater collection and treatment, and inadequate collection and final disposal of solid waste;
- Floods and hillside landslides due to insufficient drainage and low-income communities and slums located in areas of environmental risk;
- Air pollution caused by vehicles, industries, among others (specially in São Paulo and, to a lesser extent, in Rio de Janeiro and Belo Horizonte);
- Sound pollution in the cities' central areas and in high-density neighbourhoods.

Human action on the ecosystems results in degradation and it compromises water, air and soil quality. Organic pollution is directly proportional to the size of the population, while industrial pollution depends on the distribution, location and scale of the activity in industrial sectors with a heavy Biochemical Oxygen Demand (BOD).

Therefore, the problems derived from the organic pollution of the water are consequently more evident in the country's metropolitan regions and higher-density cities, where household contribution predominates over industrial. Table

13 shows this situation, once the participation of households is over 85 percent in all cases and over 95 percent in 17 of the 25 listed cities.

For the aquatic ecosystem, the most serious threats come from the organic pollution of the water, measured by the Biochemical Oxygen Demand (BOD) from industrial and household effluents, and from phosphorus dissolved in household effluents. Organic pollution of the water in Brazil will only be controlled with the implementation of adequate wastewater treatment systems in Brazilian cities.

The concern with the presence of phosphorus in the effluents released into aquatic ecosystems is reasonable, since excessive loads are the main cause of eutrophisation. In the urban environment, domestic sewage discharges are the largest source of this type of pollution. Table 14 provides information on the geographical and sectorial distribution of estimates related to phosphorus loads in the country.

The largest discharges of phosphorus can be found in the major urban centres – São Paulo, Rio de Janeiro, Salvador, Brasília, Fortaleza, Curitiba, Nova Iguaçu and Porto Alegre. The potential phosphorus problems caused by the use of agricultural fertilisers can in turn be found specially in production areas in the South region of Brazil.

### 11.4.9 Quality of the Urban Water

in the country's major urban and industrial areas or surrounding areas, the rivers, basins and beaches are severely polluted due to wastewater discharges, industrial effluents and percolated liquids resulting from the bad disposal of solid waste, presenting a large quantity of solids, organic material and faecal coliforms.

The creeks and streams flowing through urban areas are generally used for open wastewater and solid waste discharge. These waterways are unfit for any type of

**Table 13 - Brazilian municipalities with the highest concentrations of BOD**

| Municipality | Domestic Ranking | Ranking Industry | BOD Domestic (x 1000 tonnes) | BOD Industry (x 1000 tonnes) | BOD Total (x 1000 tonnes) | Domestic Percentage |
|---|---|---|---|---|---|---|
| São Paulo (SP) | 1st | 1st | 217.810 | 19.875 | 237,685 | 92 |
| Rio de Janeiro (RJ) | 2nd | 2nd | 124,962 | 8,309 | 133,270 | 94 |
| Salvador (BA) | 3rd | 76th | 47,300 | 735 | 48,035 | 98 |
| Belo Horizonte (MG) | 4th | 7th | 45,997 | 2,021 | 48,018 | 96 |
| Fortaleza (CE) | 5th | 18th | 40,325 | 1,540 | 14,865 | 96 |
| Brasília (DF) | 6th | 155th | 35,730 | 360 | 36,089 | 99 |
| Curitiba (PR) | 7th | 49th | 29,983 | 957 | 30,940 | 97 |
| Recife (PE) | 8th | 35th | 29,600 | 1,129 | 30,728 | 96 |
| Nova Iguaçu (RJ) | 9th | 132nd | 29,557 | 403 | 29,961 | 99 |
| Porto Alegre (RS) | 10th | 25th | 28,661 | 1,328 | 29,989 | 96 |
| Belém (PA) | 11th | 3118th | 24,780 | 0 | 24,780 | 100 |
| Manaus (AM) | 12th | 118th | 23,017 | 490 | 23,508 | 98 |
| Goiânia (GO) | 13th | 53rd | 20,947 | 923 | 21,870 | 96 |
| Campinas (SP) | 14th | 31st | 19,119 | 1,187 | 19,477 | 94 |
| Guarulhos (SP) | 15th | 14th | 17,873 | 1,604 | 19,477 | 92 |
| São Gonçalo | 16th | 64th | 17,780 | 817 | 18,597 | 96 |
| Tocantins (MG) | 17th | 1,269th | 17,431 | 11 | 17,442 | 100 |
| Duque de Caxias (RJ) | 18th | 56th | 15,193 | 891 | 16,083 | 94 |
| Santo André (SP) | 19th | 6th | 14,067 | 2,041 | 16,108 | 87 |
| Maceió (AL) | 20th | 8th | 13,926 | 1,898 | 15,825 | 88 |
| Natal (RN) | 21st | 396th | 13,837 | 99 | 13,936 | 99 |
| Teresina (PI) | 22nd | 265th | 13,278 | 180 | 13,458 | 99 |
| Osasco (SP) | 23rd | 148th | 12,956 | 375 | 13,331 | 97 |
| São Bernardo do Campo (SP) | 24th | 19th | 12,821 | 1,538 | 14,359 | 89 |

Source: World Bank - 1998

recreational activity. In addition to that, their appearance is not appealing and they usually have an unpleasant smell. It is a problem common to almost every major city.

The larger rivers and basins that receive urban effluents have a greater dilution capacity and usually do not present an unpleasant smell. However, they have high concentrations of pollutants that make them unfit for bathing, reduce fishery production and damage valuable ecosystems, such as mangrove marshes. The Paraíba do Sul River, which crosses three states (São Paulo, Rio de Janeiro and Minas Gerais), the Capiberibe River, in Recife (State of Pernambuco), and the Guaíba River, in Porto Alegre (State of Rio Grande do Sul) are some examples of this situation. Except in places with high concentrations of heavy metals and industrial toxic pollutants, the water can be treated for residential supply at a modest cost.

The nutrients of wastewater and residual water from agricultural areas penetrate lakes, reservoirs and basins, might lead to the production of toxic algae that threaten the supply of potable water. Guanabara Bay, in Rio de Janeiro, is an exemplary case of a seabed deeply affected by the phenomenon.

As for the industries, there are many options for reducing emissions by means of pollution prevention and minimisation of residues at a cost considerably lower than treating wastewater of industrial effluents. Although these lower-cost measures should be encouraged, they will be insufficient to solve problems related to water pollution, since industrial emissions are responsible for only 15 percent of the total organic load in most cities (World Bank, 1998).

The necessary levels of effluent treatment should be established according to the pollutants, the polluters, and specific places. Heavy metal and toxic pollutants limit drastically the use of the water and they generally cause long-term or irreversible damages. The pollutants that constantly exceed the acceptable limits include phenol, mercury, oil and grease. Strict control should take place at the source, specially for industrial sources, in order to achieve goals of desirable water quality.

The open sewerage in urban areas causes a loss of amenities and can induce disease vectors. In these cases, the construction of interceptors or the conversion of these channels into covered sewage channels are actions aimed at improving environmental quality. Many oceanic beaches in Brazil represent an important economic asset, due to their high touristic value and potential. Nevertheless, they are threatened by pollution, which requires an improved local collection and disposal system. In some cases, this includes building oceanic sewage interceptors.

The quality parameters of the urban waters, presented in Table 13 are state indicators of the environment in some selected Brazilian localities.

### 11.4.10 Air Quality

The regions with the most acute air pollution problems are the country's metropolitan areas – notably São Paulo, Rio de Janeiro, Belo Horizonte, Salvador, Recife, Porto Alegre and Curitiba.

Automotive vehicles are responsible for the highest rates of pollutant emissions in the cities, specially in areas with frequent thermal inversions. These emissions are more important than is suggested by emission inventories, as they are closer to the surface and consist of finer particulates than typical industrial emissions.

**Table 14 - Air quality in selected cities**

| Season averages during various periods of time | PM 10 ($g/m^3$) | SO ($g/m^3$) |
|---|---|---|
| WHO directives and environmental standard for the Annual average | 50 | 40 |
| Metropolitan area of São Paulo (SP) | 70 | 20 |
| Cubatão (SP) | 90 | 15 |
| Rio de Janeiro (RJ)(Basin III) | 88 | 38 |
| Belo Horizonte (MG) | 37 | n.a. |
| Contagem (MG) | 48 | 25 |
| Betim (MG) | 40 | 13 |
| Porto Alegre (RS) | 54 | 23 |
| Volta Redonda (RJ) | 66 | n.a. |

Source: World Bank - 1998

The parameters presented for some Brazilian cities below are indicators of the state of the environment in terms of air quality.

Energy is at the origin of the main environmental impacts faced by modern society. Burning fossil material, which is largely used as fuel, causes a large part of these impacts. The main problems derived at the local level are air pollution in major cities, and at the global level, climatic changes caused by the greenhouse effect.

The combustion of fossil substances causes the emission of airborne pollutants, the most important being sulphur oxides, nitrogen oxides, carbon oxide and carbon dioxide. These emissions vary in quantity according to the fuel used, its composition and the measures adopted to reduce them.

The quality of urban air is determined by a complex system of stationary (industries, garbage burning, boilers etc.) and mobile sources (automotive vehicles). The interaction between pollution sources and the atmosphere will define the air quality level, which in turn determines the occurrence of negative effects of air pollution on man, animals, materials and plants (Ministry of the Environment, 2000 B).

As for the greenhouse effect, the gases that can bring about this phenomenon are mainly water vapour, carbon dioxide ($CO_2$), ozone ($O_3$), methane ($CH_4$) and nitrous oxide ($N_2O$). Human activities are intensifying the concentration of these gases in the atmosphere, thus increasing their capacity to absorb energy and, consequently, raising the planet's temperature.

Human emissions of carbon dioxide – the gas that contributes the most towards intensifying the greenhouse effect – are mainly caused by burning coal, oil and natural gas, as well as by destroying forests and other natural carbon pools and sinks (which absorb carbon dioxide from the atmosphere). Global warming caused by increased mean temperatures is one of the probable consequences of increased concentration of greenhouse gas in the atmosphere, which can also cause new climate patterns with repercussions in the wind, rain and general ocean circulation regimes.

### 11.4.11 Soil Quality

The degradation of areas due to inadequate disposal of domestic and industrial-originated solid waste in open-air cesspools happens throughout the country and compromises a large number of areas.

The natural resources, which most suffer negative effects by this inadequate disposal of solid waste, are the soils, the waters (both surface and underground) and the air. These effects result largely from inadequate location and operation of garbage dumps. The soil is directly affected by waste dumped in clandestine and open areas, causing the visual degradation of the landscape and the contamination by pathogenic microorganisms, heavy metals, salts and chlorate hydrocarbons contained in leach ate, the liquid resulting from decomposed garbage.

There are many contaminated areas in the country, places where the soil and water is compromised by the existence of harmful substances. The contamination in such places derives from current or past industrial/ commercial activities, in which leakage or spills of hazardous substances may have occurred, as well as inadequate disposal of industrial residues in the soil, garbage dumps gas station leakage or spills, accidents and others.

The inventories of areas contaminated by industrial residues, specially hazardous ones, are insufficient and available only for a few regions. In São Paulo, the state agency for environmental control, in co-operation with the German Agency for Technical Co-operation (GTZ), has been developing methodologies to manage contaminated areas since 1993. These methodologies comprise the identification, register, inspection and re-measuring of these areas.

### 11.5 Impact Indicators

Today, Brazilian cities suffer a series of environmental problems, which affect human health, reduce the quality of life, increase production costs and cause damage to ecosystems in the long run.

As in any urban and industrial society, the consumption pattern increases the pressure over environmental assets and services. Deforestation is frequently used to express the growth/environment relationship in developing countries. However, the effects of urban pollution tend to be more relevant for industrialised economies, in which a significant part of the population lives in densely occupied areas.

Environmental assets and services' consumption trends are associated with different income levels of the urban population and entail different levels of degradation. The environmental costs incurred by society due to urban degradation are more acutely felt by the poor, who have less means to defend themselves against pollution (Seroa da Motta, 2002).

#### 11.5.1 Health Damages

The direct effect of surface waters pollution on health are intestinal diseases, skin and kidney-related diseases, due to water consumption and bathing in polluted areas. Intestinal diseases are caused by the presence of pathogens in drinking water and in the home environment, and they are responsible for high child mortality rates.

A study developed by the by the National School of Public Health (ENSP-FIOCRUZ - *Escola Nacional de Saúde Pública*), evaluated the bathing quality of Sepetiba Bay, in the Metropolitan Region of Rio de Janeiro, and it showed that 27 percent of Muriqui's children, 23 percent of Ibicuí's children and 50 percent of Itacuruçá Island children had contracted hepatitis. The study showed that the incidence was higher in the regions where environmental sanitation was most precarious.

Health costs associated with water pollution in Brazil can be estimated through models, which correlate child mortality incidence rates, and variables related to the availability of basic sanitation services in poor urban households (public supply of treated water, sewage collection systems and sewage treatment systems during 1980-1990). Studies

carried out by the Brazilian Institute of Applied Economic Research (IPEA) estimated the number of children who would probably be saved if basic sanitation services were increased in 1 percent of the population of families receiving less than five minimum wages (Seroa da Motta, 2002).

Increasing the public supply of water in 1 percent for the population that is not served yet would reduce by 2.5 percent the number of child mortality cases associated with waterborne diseases (intestinal infections, cholera, typhoid fever, poliomyelitis, amoebic dysentery, schistosomiasis and shigellosis). For the increase of 1percent in sewage collection and treatment, the equivalent reductions would be of 1.6 percent (298 lives) and 2.1percent (395 lives), respectively. When these three services are jointly offered to that population, the reduction levels would reach 6.1percent (1139 lives) (Seroa da Motta, 2002).

*In Brazil, it is estimated that diseases derived from lack of sanitation are responsible for about 65 percent of the total admissions in public and affiliated hospitals*[3] *in the country. It is also estimated that every 4 Reals invested in sanitation means an economy of 10 Reals in hospital admissions (MMA, 2000 A).*

Other studies show that waterborne diseases are responsible for 65 percent of paediatric admissions and 80 percent of paediatric consultations in the public health system.

In Brazil, about seven million people are infected by schistosomiasis, 600,000 contract malaria annually and there is an outbreak of leptospirosis whenever there are floods. Diseases that were under control, such as dengue, leishmaniasis and cholera, have resurged. Diarrhoea still contributes strongly for the high child mortality rates registered in the country (Ministry of the Environment, 2000 A).

On the other hand, air pollutants, such as particulates, ozone and sulfur dioxide, cause respiratory diseases and even premature death. The effects on health can be translated into personal suffering, productivity reduction and high costs of medical treatment.

In São Paulo, studies[4] carried out for the 1980-1989 period show that a variation of 10 ug/m3 in the concentration of particulate material entails a mean variation of 1.24 percent in the rate of mortality caused by respiratory diseases. Thus, if the concentration level in the figures observed in São Paulo was reduced to 44 percent, it would equal the primary pattern of 50ug/m3 and it could avoid the death of 6.4 percent of the patients who died of respiratory diseases in that region in 1991 (Seroa da Motta 2002).

### 11.5.2 Production and Material Costs

The toxic pollution of water increases the cost of water treatment for human use. Water pollution is also responsible for the reduction in fish production, which entails losses for the fishery sector. The large number of recent accidents involving oil leakage, such as in Rio de Janeiro, specially in the Guanabara Bay region, and in the State of Paraná, related to the transportation of oil and fuel, have been causing great losses for these activities.

More than 11 million people live in cities with no access to water by channel systems. On the other hand, water waste in the public systems can amount to up to 45 percent of the volume offered to the population, which represents an annual loss of 2.08 thousand million per m3, in a total of about 4.68 thousand million m3 of water produced during this time. Even if reaching the goal of 25 percent of losses, which is considered acceptable, the annual loss would still amount to 1.02 thousand million Reals (MMA, 2000 B).

In turn, the air pollution in urban areas damages the buildings, which entails increased costs related to conserving, maintaining and cleaning the city buildings.

The automotive vehicles produce more atmospheric pollution than any other individual human activity. The major Brazilian metropolises face huge daily traffic jams. In the city of São Paulo, the extension of these traffic jams mounts up to 200 km during afternoon rush hours. It is estimated that these traffic jams cause a consumption of two to three extra litres of fuel per day in a city like São Paulo, corresponding to an average waste of 11percent (about

[3] The study mentioned refers to health costs associated with air pollution in the municipality of São Paulo, in correlation to them and mortality rates caused by respiratory diseases with meteorological parameters (humidity and temperature), pollution concentration data (particulates and SO2) and socioeconomic data (medical attention, schooling level etc.).

US$325 million/year). This amount is enough to build three to four kilometres of new subway lines (MMA, 2000 B).

### 11.5.3 Loss of Environmental Amenities

Pollution has a direct impact on the quality of life. It immediately reduces the opportunities for bathing and leisure and recreational activities in rivers, bays, lagoons and oceanic beaches. It is also responsible for an unpleasant smell, characteristic of air and surface water pollution, as well as for the visual impact. In the case of air pollution, in addition to physical discomfort, there is also a loss of visibility. All of this can be translated into concrete material losses, such as reduced value of properties, interruption of important economic activities and endangering of the natural resources.

### 11.5.4 Damages to the Ecosystems

The protection and preservation of ecosystems are not only desirable, in terms of future generations, but they also have a great value for activities such as tourism, leisure, research and various other economic activities. The mangrove marshes, for example, have a great economic and ecological importance, since studies estimate that 90 percent of marine fish consumed by man come from coastal zones, of which 2/3 depend directly or indirectly on estuaries and mangrove areas. The damages caused by the destruction of these environments to the biodiversity of coastal and oceanic zones are immense, in addition to the economic losses and its social reflection on the populations that depend on them economically.

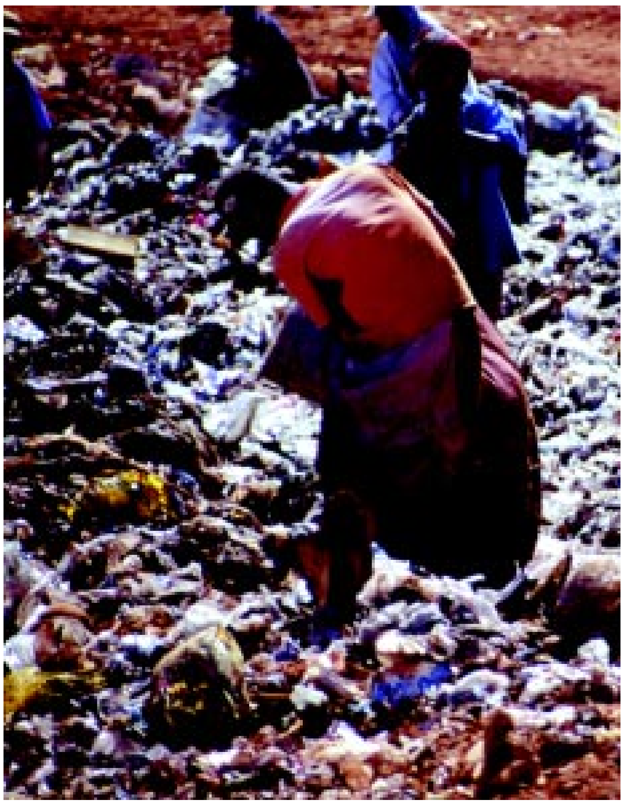
### 11.5.5 Poverty and Environment

According to UNICEF, over 40,000 people in Brazil depend directly on garbage dump collection and over 30,000 depend on street collection, as their only income option. The presence of children and teenagers is highly significant, representing about 50 percent of the number of informal garbage collectors, like in Olinda, in the State of Pernambuco (Ministry of the Environment, 2000 A).

# 12. STATE OF HEALTH AND THE ENVIRONMENT

## 12.1 Health and the Environment in Brazil

When establishing a concrete relationship between health and the environment, it is apparent that the influence the latter exerts can be either positive or negative. This is true because it promotes conditions that favour welfare and the full actualisation of human capacities for the population. On another level, it contributes to the appearance and maintenance of illnesses and traumatic injuries, as well as to the extinction and death of entire populations, or particular groups. In the environment, production, social development and economic processes interfere with the relationships that occur in the ecosystems by determining and contributing to the existence of conditions or situations of risk that influence the health quality of the populations. They undergo changes in their mortality profile due to different sources and kinds of pollution (increase of abiotic elements which cause aggravation), contamination (presence of biological agents which generate illnesses) and types of environmental dynamics which enable the uncontrolled release of specific sorts of energy. It is



acknowledged, however, that not all environmental states, dynamics or changes are capable of producing such results. Issues involving rapid urbanisation are related to the increase of poor neighbourhoods surrounding large cities. Non-sustainable developmental projects, greater deforestation – specially in the Amazon and the Brazilian outback, the quality of drinking water, and sewerage represent factors associated with the raise of infectious contagious diseases, malaria and diarrhoea to name but a few. The contamination of the environment by chemical pollutants is in turn an important factor that causes damage to health.

Nevertheless, in most cases, the presence of these agents should not be restrained to only one environmental sphere. Several environmental spheres may encompass the same abiotic (chemical or physical) agents if it acts as a vehicle or storage element. They may also include the same biotic (biological) one when providing the necessary requirements for survival, not to mention the cases in which both types of agents are elements or substrata of the ecosystem.

Scientific knowledge has progressed towards developing and establishing relationships among a large number of environmental and health indicators. This is true mainly for those related to particular kinds of morbidity and physio-pathological processes, but also for biological indicators of exposure. However, in order to scientifically approach and clarify the health-environment issue, there must be a set of both past and current data regarding the two elements of this equation. Unfortunately, this is not the case of the Brazilian reality, for these data are not available in certain regions of the country. There are but a few studies that aim at this relationship and its numerous possibilities, with the exception of infectious parasitical diseases (IPD). These diseases have been around longer. For this reason, there are official records, including compulsory notifications. Nevertheless, these records fail to represent the entire country and are not totally reliable. In spite of such failures, they provide an initial understanding of this specific relationship and identify its occurrence among selected groups of the population.

Regarding the historical perspective, the current health situation consists of three main areas conditioned to socio-environmental factors to a greater or lesser extent. The first is made up of cardiovascular and neoplastic diseases (the first and third causes of death, respectively). This situation has demonstrated a tendency for growth over the last ten years that follows the ageing of the population (Brazilian Institute of Geography and Statistics/*Instituto Brasileiro de Geografia e Estatística* – IBGE, 2001 and Interagency Network of Health Information/*Rede Interagencial de Informações para a Saúde*- RIPSA, 2000). This scenario is made possible since occurrences of disease and sickness are considered the result of genetic, living and work conditions experienced by population groups, specially those exposed to certain chemical pollutants. Moreover, this concept is reinforced by the increase in health care, the access to new technologies and health provisions, even if not available for the entire population.

The second scenario is made up of infectious parasitical diseases, clearly determined by socio-environmental conditions. The decreasing fatality rate for this group (the sixth cause of death) mainly reflects the use of technical intervention (massive vaccination programs) and therapeutic measures (provision of effective medicine by the sanitation programs), without mentioning the improvement of certain basic needs such as food and nutrition. These factors have affected different regions and specific social groups in an uneven fashion. It is important to point out that the above-mentioned factors do not guarantee the decrease of all IPD occurrence indicators such as dengue, malaria and hepatitis, but favour others, measles and poliomyelitis, for instance. Furthermore, as a result of new socio-environmental situations/conditions, old diseases reappear and new ones are produced. This occurs in different geographical areas with illnesses and diseases that tend to spread over the territory and increase in occurrence. This tendency originates in peculiar endemic-epidemic forms (AIDS, dengue and malaria, by way of illustration).

**Table 1 - Number and percentage of Brazilian urban and rural population, per region.**

| | Urban | | Rural | |
|---|---|---|---|---|
| | N. of inhabitants | % | n. of inhabitants | % |
| North | 9014365 | 69.9 | 3886339 | 30.1 |
| Northeast | 32975425 | 69.1 | 14766286 | 30.9 |
| Southeast | 65549194 | 90.5 | 6863217 | 9.5 |
| South | 20321999 | 80.9 | 4785617 | 19.1 |
| Central West | 10092976 | 86.7 | 1543752 | 13.3 |

Source: IBGE - 2001, Demographic census of year 2000

The third scenario is characterised by external factors that include accidents and violence. These are both considered socio-environmental events that cause trauma, injuries and illnesses. Fatality and morbidity tendencies are growing (the second cause of death) and require preventive therapeutic and control measures quite different from those traditionally used towards other health problems. The planning and implementation of such measures are still incipient.

As a matter of fact, the growing importance of damage and illnesses associated with these scenarios is directly related to the increase in social inequalities and the environmental impact produced by developmental policies. Bad income distribution and a high percentage of poor people and regional inequalities represent factors that together constitute the main driving forces which may result in the development of favourable conditions to environmental contamination and in the raise in the demand for environmental health services (General Co-ordination of Environmental Surveillance/*Coordenação Geral de Vigilância Ambiental*, CGVAM- 2001). The development indicators such as the Human Development Index - HDI mentioned in the United Nations Report and the United Nations Development Program (UNDP) and Panamerican Health Organisation-PHO reveal the inequalities observed in different geopolitical regions of the country, which directly affect the sanitation inequality scenario. According to UN data (CGVAM, 2002a), nearly half of the world population currently lives in cities and the urban population is growing two and a half times more than the rural one. In Brazil, the 2000 demographic census (IBGE, 2001) demonstrates a large concentration of people in the urban areas of all regions, as shown in Table 1.

## 12.2 The Urban/Rural and Regional Disparities Regarding Morbidity-Mortality

According to the Panamerican Health Organisation (PHO, 1998), the average national indicators do not clearly demonstrate the disparities between urban and rural areas, among large regions, among states located in the same region and among districts of the same state. It is estimated that, from 1990 to 1994, 20% of all deaths in the country were not registered. This percentage reached up to 60% in the Northeast. In most parts of the South and Southeast, however, records are above 90%, reaching almost 100% in the urban areas (Unified Health System Database/*Banco de Dados do Sistema Único de Saúde*-SUS-DATASUS, 2002).

Almost 15% of all deaths registered in the country in 1998 were not properly defined. The North and Northeast demonstrate the highest rates of improperly defined causes, 24.3% and 29.8%, respectively (DATASUS, 2002).. These numbers indicate that health care coverage in Brazil is still insufficient for large regions. This picture is expected to change after the national implementation of the Family Health Assistance Program (*Programa de Atenção à Saúde da Família*) and the Interiorisation of Health Assistance Program (*Programa de Interiorização da Assistência à Saúde*). However, growing attention to health does not mean an increase in equal access to medical technologies nor to integral health policies.

Over the last decades, there has been a significant decline in the mortality levels of children under 5 years of age. This percentage in the total number of registered deaths decreased from 24% to 7.8% in the subgroup of children under one year of age between 1980 and 1998. It has also dropped from 4.6% to 1.4% in the group made up of children from 1 to 4 years old. (DATASUS, 2002). 1999 figures (RIPSA, 2001) show that the decline in infant mortality rates is bigger in urban than in rural populations. Disparities among regions are also evident: in the Northeast, the 52.4 deaths for every thousand infants born is 3.5 times higher than the Southern rate of 15.1 deaths for every thousand infants born. The historical drop in the five-year-old mortality rate and the rise in the proportional mortality rate in the fifty-year-old group are observed. The reduction in mortality in the five-year-old group is definitely related to immunisation, oral rehydration (in cases of diarrhoea and dehydration), breast-feeding incentive programs and a slight increase of 10% in the sanitation sewerage system of urban regions (National Plan of Basic Sanitation/ *Plano Nacional de Saneamento Básico*-PNSB, 2000).

Analysing all causes of death groups, from 1990 to 1998, and excluding improperly defined causes, circulatory system diseases (mainly ischemic heart diseases and brain-vascular diseases) represent the number one cause of death, with an average rate of 27.59% of all occurrences in the country. Even in the poorest regions of Brazil (North and Northeast), where contagious diseases are responsible for a high mortality rate, this group is still the first cause of death (DATASUS, 2002). The increase in male mortality in the 15 to 29 year old age group due to external causes involving homicides, suicides and car accidents should be pointed out (DATASUS, 2002). This is the second cause of death and the result of the morbidity-mortality external causes, which represented 15% of all deaths in Brazil in 1998. Homicides stand out in this group, assuming great importance in all regions, but mainly in large urban areas (DATASUS, 2002).

In 1999, homicides ranked first in external causes, at a 26.2 rate for every 100,000 inhabitants, followed by car accidents, registering a 18.37 death rate (RIPSA, 2001). It is worth mentioning that homicides committed in the countryside due to land possession conflicts added up 1520 deaths from 1980 to 2000 (Pasture Land Commission/*Comissão Pastoral da Terra*-CPT, 2001). The figures also indicate that accidents which occur at the workplace have become more serious and the resulting deaths rose from 0.77% to 1.40%, when compared to the total number of all registered accidents from 1990 to 1996.

Regarding regional differences, the 1998 external cause mortality coefficients (for every 100,000 inhabitants) for the Southeast (88.4) and Central West (80.6) surpass the average Brazilian rate (72.7). The other regions present lower coefficients: South (68.1), North (55.9) and Northeast (54.0). It should be pointed out that all regions have experienced a raise in these rates since 1980, revealing intrinsic conflicts in our development and urbanisation processes in this period (Tambellini et al, 2001).

Neoplasia corresponds to the third group of death causes in all macroregions. The mortality rates increased approximately 10% in the 1990s. The most relevant types are: stomach, lung, breast, uterus and prostate gland cancer, which represent 11.92% of the properly defined registered deaths in 1998. Cancer records in Brazil are not well established in all regions. Moreover, possible environmental exposure to carcinogenic agents is not recorded as in developed countries.

Deaths resulting from respiratory problems represent the fifth cause of mortality, with a total of 11.8% of all the properly defined registered deaths. The South and Southeast numbers are higher than the national average (RIPSA 2001), and in certain industrial areas this could be one of the most important causes of death, as observed in the Cubatão Petrochemical and Metallurgic Areas. It should be stressed that respiratory system diseases correspond to 16.22% of all hospitalisation in 2000, being the second among the most common diseases (RIPSA, 2001). According to the World Health Organisation (1998), acute and chronic respiratory diseases are related to environmental exposure in 50% to 60% of all cases.

Infectious parasitical diseases represent the sixth cause of death among the Brazilian population, corresponding to 5.24% of all properly defined deaths. The South of Brazil is the only region in which the occurrence of such cases is significantly lower than the national average of 3.89%. Several infectious parasitical diseases occur due to the presence of animal vectors and reservoirs of infectious agents which are harmful to humans as a result of bad environmental conditions due to anthropic actions, lack of sewerage, unplanned land occupation and trespassing of natural systems for the sake of production activities, such as mining, timber and agriculture.

In 1999, diseases related to inadequate environmental sewerage (DRSAI) represented 29.5%of all deaths due to infectious parasitical diseases, and their highest incidences occurred in the Northeast (46.5%), and Central West (46.3%) regions. Most deaths are related to diarrhoea, which remains a significant cause of death among children under five years of age, even though these figures are clearly underestimated, owing to notification problems in certain Brazilian states (Costa et al, 2001).

Regarding morbidity, the available general data belong to the following Information Systems:

- National System of Epidemiological Surveillance (*Sistema Nacional de Vigilância Epidemiológica*) for diseases which require compulsory notification;
- National System of Toxic-Pharmacological Information (*Sistema Nacional de Informação Tóxico-Farmacológica* - SINITOX);
- Primary Assistance Information System (*Sistema de Informação de Atenção Básica*) and Hospital Information System (*Sistema de Informação Hospitalar*) established in private institutions associated with the public health system and accounting for 75% of all hospital assistance provided throughout the country (IBGE, 2001).

In 2000, approximately 63.6% of all hospitalisations caused by infectious parasitical diseases were related to DRSAI and the North and Northeast accounted for more than 70% of them. This was true mainly because of the high incidence of hospitalisations owing to diarrhoea (Costa et al, 2001).

According to Sá, 1988, the main causes of hospitalisations in all regions except for the South of Brazil, occurred during the time period involving pregnancy, delivery and post-partum (national average of 23.89%). Respiratory causes were also representative (national average of 15,81%),

specially in the South of the country, where they ranked first. They are increasing in large urban areas, where diseases such as asthma and allergic bronchitis occur due to the greater exposure to pollution derived from industrial pollutants, vehicle combustion and the use of pesticides. Next in rank, circulatory diseases accounted for a 8.47% national average of all hospitalisations, followed by digestive diseases, 7.58%; mental problems, 7.21% (national average of 7.21%, and a very low incidence of 0.84% in the North); infectious parasitical diseases (national average of 7.16%, registering higher incidences in the North and Northeast which surpass digestive diseases and mental problems); urogenital (national average of 6.15%); external injuries (national average of 4.97%); neoplastic diseases (national average of 2.81%, endocrinal and metabolic illnesses (national average of 2.35%); and perinatal sickness (national average of 1.78%). Regarding neoplastic diseases, it is worth mentioning skin cancer, not melanoma, which tends to be the most frequent kind (DATASUS, 2002).

The results of globalisation became more evident and intense in the 1990s. These results have been more precarious work conditions, a decline in the number of formal jobs and an increasing number of informal jobs. Added to that, changes in labour protection legislation in regard to dangerous and unhealthy conditions favour a greater variety and an increase in the number of risk situations at the workplace. These changes also make access to the necessary means that enable the worker to support himself and his family more difficult. This scenario results in greater vulnerability towards a large variety of illnesses for the working population. In fact, certain groups, black people who occupy less qualified and more dangerous work positions, for instance, are affected by this process and also register a greater number of children and adolescents in the job market (IBGE/PNAD, 1999).

Even though not all work related diseases are properly notified, there has been an increase in the number of registrations, approximately 35,000 cases registered in 1996. These figures, however, do not represent the complexity of this problem for they do not include informal workers. Consequently, this limits the analysis to 18.8 million workers situated in the Southeast (58%) and South (19%), according to 1998 data (RIPSA, 1998). From 1990 to 1996, the percentage of work related diseases rose 8% and their incidence rate in 1998 was 16.24 for every 10,000 insured workers, 18.52 of which representing typical work accidents and 1.92, work accidents on the way to or from work.

## 12.3 Infectious and parasitic diseases

The widely accepted model for infectious diseases in the 1970s and 1980s – called epidemiological transition – presupposed that these diseases would soon cease to be relevant and be replaced as health problems for diseases caused by lifestyles and change in habits, specially those related to the consumption of industrialised products, which promote the development of non-communicable chronic diseases. This model was reconsidered during the past decade, specially in developing countries, where infectious/ parasitic and chronic diseases both occur, overlapping throughout time. While analysing the magnitude of infectious and parasitic diseases, its expression at the regional and local level should be considered, in view of the complexity of its social and biological determinants and the environmental factors conditioning their occurrence.

Today, it is acknowledged that the life conditions no longer offer guarantees against the dissemination of infectious agents, even in developed countries. Acceptance of this presupposition leads to a rather pessimistic perspective as for the behaviour of endemic communicable diseases in peripheral countries, where basic issues such as malnutrition, environmental sanitation, adequate housing conditions, vector control and access to basic health care, have not been satisfactorily addressed yet. Thus, the past few years were characterised by a gradual increase of these diseases, both recently originated (emergent), and those of an older nature (re-emergent).

According to data published by the Ministry of Health/ FUNASA in 2002, since the beginning of the 1980s and specially in recent years, there has been an increase of various endemic diseases in the country, such as: malaria, tuberculosis and Hansen's disease, several outbreaks or epidemics, such as meningococcal meningitis, cholera, dengue, leptospirosis, leishmaniasis, yellow fever, in addition to the dissemination of AIDS, and other diseases not very well known up to that moment, such as hantavirus. The increased occurrence of these endemic diseases contributed towards consolidating society's impression – and among health professionals – that public health services, such as they are currently organised, can no longer contain the advance of these problems. (Tables 2, 3 and 4).

The increased incidence of these diseases did not happen uniformly throughout the entire country. As for dengue and malaria, Tables 3 and 4 show, respectively, the geographic differences in their transmissions during that period. For dengue, the incidence rate predominates in the Northeast and Central West, and it is also high in the Southeast. Malaria has high incidence rates in the Amazon and in the Central West, specially in the 1990s. The significant increase in malaria rates, specially in the Central West, is linked to the expansion of gold exploration in that region during that

**Table 2 - Time evolution of the main infectious and parasitic diseases registered in Brazil during the 1980s and 1990s.**

| Disease | 1980/84 | 1985/89 | subtotal | 1990/94 | 1995/99 | subtotal |
|---|---|---|---|---|---|---|
| AIDS | 191 | 15,630 | 15,821 | 71,443 | 107,493 | 178,936 |
| Cholera | 0 | 0 | 0 | 151,339 | 16,380 | 167,719 |
| Dengue | 11,000 | 141,663 | 152,663 | 211,448 | 1,346,469 | 1,557,917 |
| Meningococcal Disease | 6,771 | 12,743 | 19,514 | 26,631 | 30,109 | 56,740 |
| Yellow Fever | 122 | 67 | 189 | 131 | 132 | 263 |
| Hansen's Disease | 86,294 | 111,841 | 198,135 | 158,800 | 203,963 | 362,763 |
| Hantavirus Infections | 0 | 0 | 0 | 3 | 41 | 44 |
| American tegumentary leishmaniasis | 26,802 | 101,784 | 128,586 | 140,428 | 151,321 | 291,749 |
| Visceral leishmaniasis | 4,991 | 8,003 | 12,994 | 11,031 | 15,772 | 26,803 |
| Leptospirosis | 0 | 7,179 | 7,179 | 12,138 | 20,072 | 32,210 |
| Malaria (all forms) | 1,264,903 | 2,489,008 | 3,753,911 | 2,713,818 | 2,518,373 | 5,232,191 |
| Tuberculosis | 422,024 | 412,637 | 834,461 | 396,127 | 421,883 | 818,010 |

Fonte: MS/FUNASA - 2001

**Table 3 - Evolution of the incidence rate of dengue cases registered in Brazil, per region, in the 1980s and 1990s (per 100,000 hab.).**

| Regions | 1980/84 | 1985/89 | 1990/94 | 1995/99 |
|---|---|---|---|---|
| North | 152.68 | 0 | 21.56 | 607.63 |
| Northeast | 0 | 117.34 | 174.74 | 1661.84 |
| Southeast | 0 | 161.73 | 187.82 | 618.07 |
| South | 0 | 0 | 0 | 56.38 |
| Central West | 0 | 0 | 155.49 | 820.17 |

Source: MS/FUNASA - 2001

**Table 4 - Evolution of the incidence rate of malaria registered in Brazil, per region, in the 1980s and 1990s (per 100,000 inhabitants).**

| Regions | 1980/84 | 1985/89 | 1990/94 | 1995/99 |
|---|---|---|---|---|
| North | 14406.2 | 23085.1 | 17943.8 | 19110.4 |
| Northeast | 327.1 | 640.7 | 297.8 | 353.5 |
| Southeast | 21.0 | 36.7 | 14.1 | 6.0 |
| South | 3.9 | 80.3 | 41.9 | 10.0 |
| Central West | 1242.7 | 1942.5 | 20650.0 | 22140.0 |

Source: MS/FUNASA - 2001

period. Actually, this geographically unequal distribution relates to the particularities of these diseases' dynamics. More specifically, and in what concerns the vectors involved, they have entirely different biological characteristics and behavioural habits. In the case of dengue, the environmental crisis in the regions that were most affected has allowed the proliferation and dispersion of its vector, *Aedes aegypti*, which has exclusively urban habits; while in the case of malaria, the disorganised occupation has been promoting the multiplication of its vector, *Anopheles darlingi*, which uses large collections of clear water as its main breeding sites.

Although there was an increase in the incidence of these diseases, there was also a greater capacity to recognise and register these illnesses due to an improved epidemiological surveillance system. This improvement is the result of the decentralisation and extension of basic services, in addition to the dissemination of information through communication means, also contributing to a better comprehension of the scenario of communicable diseases in the country. Nonetheless, it is alarming to note the prevalent medicalisation of health issues, where promoting health is still considered less important than taking care of complaints and agony.

In terms of communicable diseases, on the other hand, it should also be noted that there was a substantial reduction of diseases that can be controlled through precise actions, by means of immunisations (Table 5). The elimination of poliomyelitis transmission, the drastic reduction in the incidence of measles, tetanus – including neonatal - whooping cough, among others, were significant victories achieved by the Health System in recent years.

**Table 5 - Time evolution of some infectious diseases that are preventable by means of immunisation, registered in Brazil, in the 1980s and 1990s.**

| Doença | 1980/84 | 1985/89 | subtotal | 1990/94 | 1995/99 | subtotal |
|---|---|---|---|---|---|---|
| Whooping cough | 188282 | 87172 | 275454 | 37222 | 9538 | 46760 |
| Diphtheria | 18050 | 6675 | 24725 | 1908 | 623 | 2531 |
| Poliomyelitis | 1656 | 1278 | 2934 | 0 | 0 | 0 |
| Human rabies | 630 | 243 | 873 | 275 | 136 | 411 |
| Measles | 338420 | 321026 | 659446 | 114560 | 5911 | 173671 |
| Accidental tetanus | 6574 | 9538 | 16112 | 6644 | 4223 | 10867 |
| Neonatal tetanus | 1892 | 2348 | 4240 | 1188 | 462 | 1650 |

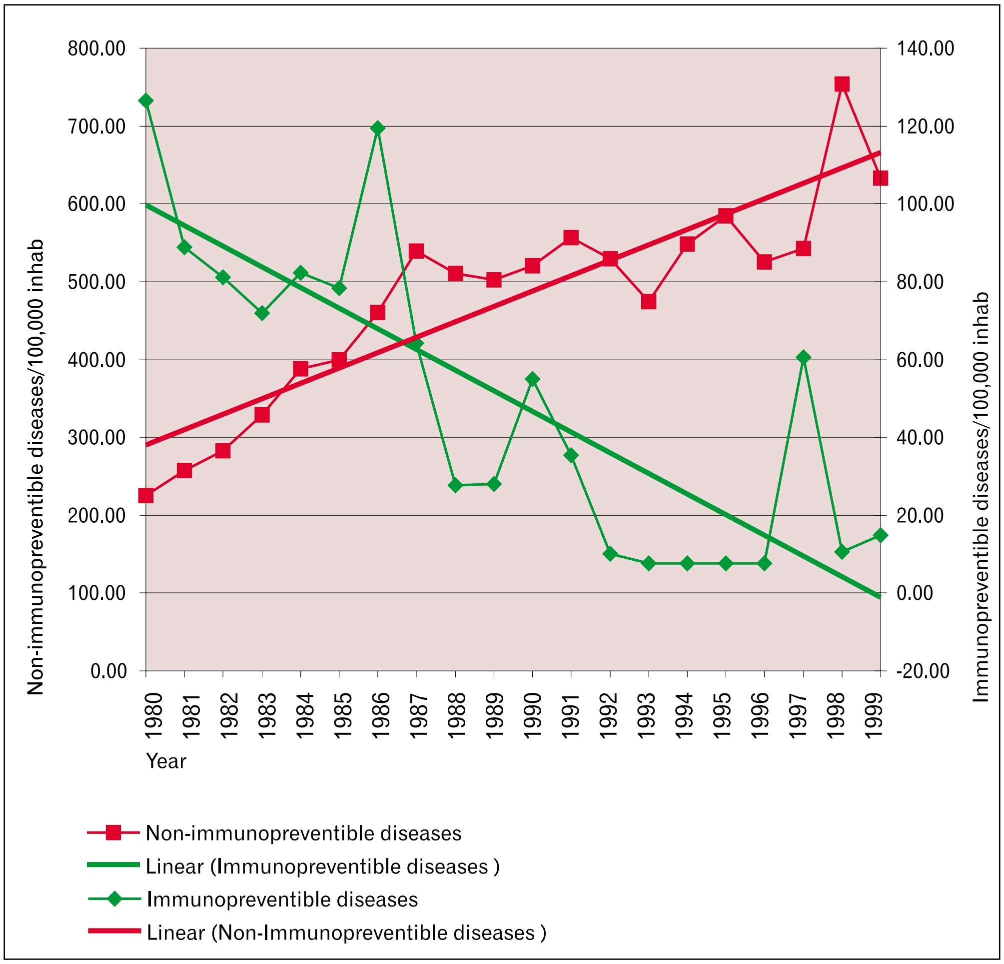
Source: MS/FUNASA - 2001

The data and considerations presented above are considerably sensitive indicators of the continuously growing inequities and persistence of precarious life conditions of a significant part of the Brazilian population. For a comparative analysis of the problem's complexity, we can observe in Chart 1 the significant disparities in the dynamics of infectious and parasitic diseases in the past two decades; while there was a significant increase in the coefficient of incidence of non-immunopreventable infectious illnesses, there was also a substantial reduction in the rates of the diseases which can be controlled through vaccines.

Similarly, there are disparities between the evolution of morbidity and mortality coefficients by infectious/parasitic diseases as a whole for the same period, that is, while morbidity rates increased, mortality rates decreased (Chart 2).

Among the health problems associated with poor quality of potable water, and precarious wastewater coverage and quality, diarrhoeic diseases most certainly stand out, specially among children. However, between 1995 and1999 (DATASUS, 2002), the number of children under one year old admitted to the public health system units with diarrhoeic diseases decreased in 32 per cent (probably due to the restricted access of the populations most exposed to the conditions mentioned above to health services), and deaths related to these admissions decreased in 54 per cent (certainly due to the efficacy of the therapies introduced).

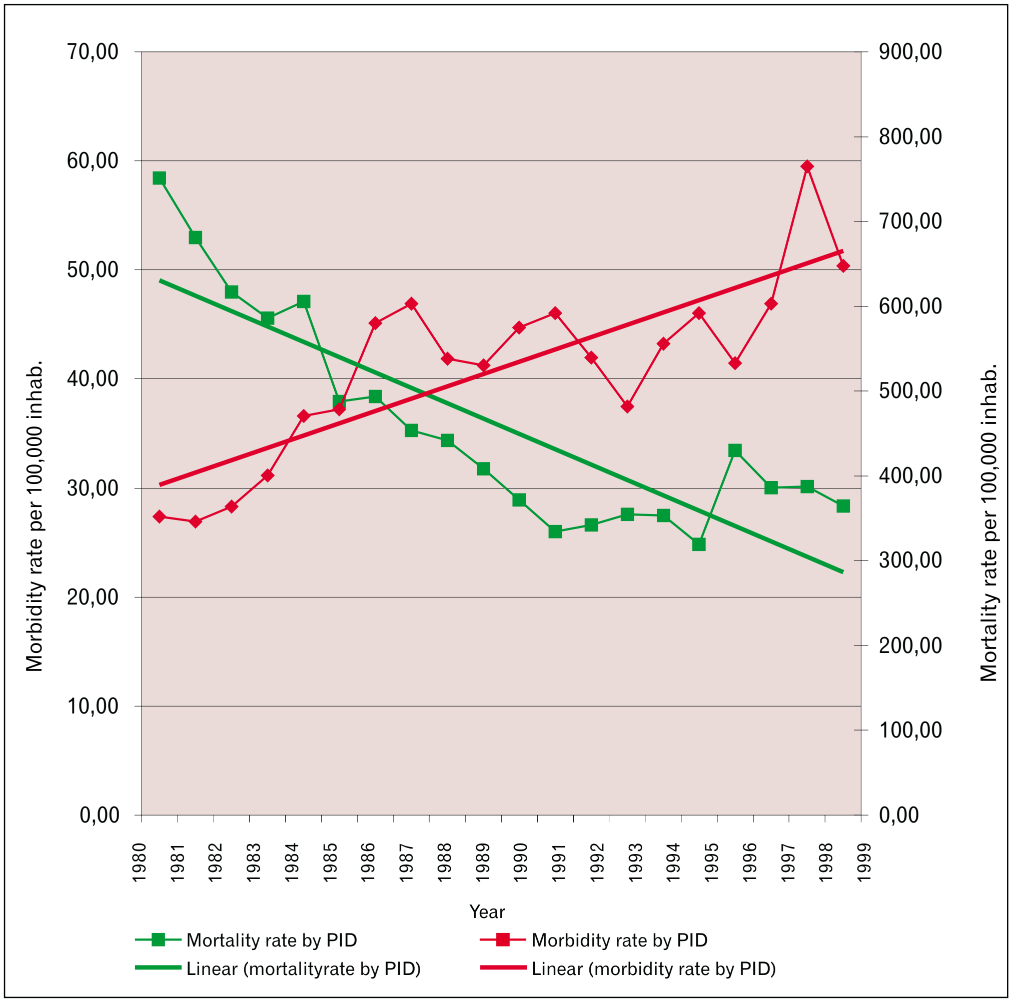
**Graphic 1 - Rate and trend of immunopreventible infectious diseases from 1980 to 1999**




As for cholera, since its re-introduction in 1991, there were 163,099 cases registered in Brazil, resulting in 1,922 deaths up to 1998. In 1999, the cholera incidence rate was of 2.52 per 100,000 inhabitants. In some states, this rate reached 29.81 cases per 100,000 inhabitants (RIPSA, 2000). The transmission of this disease was more frequent in municipalities with poor sanitation conditions. Today, despite the abatement of the epidemics, it is essential to continue the health surveillance of these populations and to carry out environmental sanitation and health promotion actions in risk areas, in order to ensure an effective control over this disease.

As for solid residues, it was observed that the vectors of diseases which adapted their breeding sites to the new composition of urban waste, which is rich in environmentally persistent materials, such as plastic and glass bottles, aluminium cans and tyres, now count on easier hideouts, making it ever harder to control communicable diseases.

**Chart 2 - Morbidity and mortality rate and trend per infectious diseases in Brazil from 1980 to 1999**




In addition to the range of illnesses transmitted by vectors associated with the inadequate disposal of solid waste and the absence of adequate drainage systems, we can also mention the case of leptospirosis. This disease is endemic to the country's main urban centres, with seasonal peaks associated with floods. From 1995 to 2000, there were 22,651 cases registered, resulting in 1,951 deaths. The periodic risk of these epidemics to which the Brazilian population is submitted is related to the difficulties found in implementing a policy of permanent control which involves expedition in the allocation of financial resources, and priority for community mobilisation actions and for local environmental quality improvement interventions (MS/FUNASA, 2001).

The increased rate of malaria transmission in gold mining sites and in agricultural settlement projects, the outbreaks of leptospirosis and filariasis in slums built in flood areas, the new endemic quality of schistosomiasis and leismaniasis in many cities' poverty belts, the dissemination of AIDS in drug circles, are other examples of how various pathogenic agents are adapting to new transmission conditions, produced by the process of development.

In view of the lack of care and social demand, the public investments in sanitation services and infrastructure are still limited, which reduces the possibilities for survival strategies of the social groups that are more at risk of illness and death by these diseases.

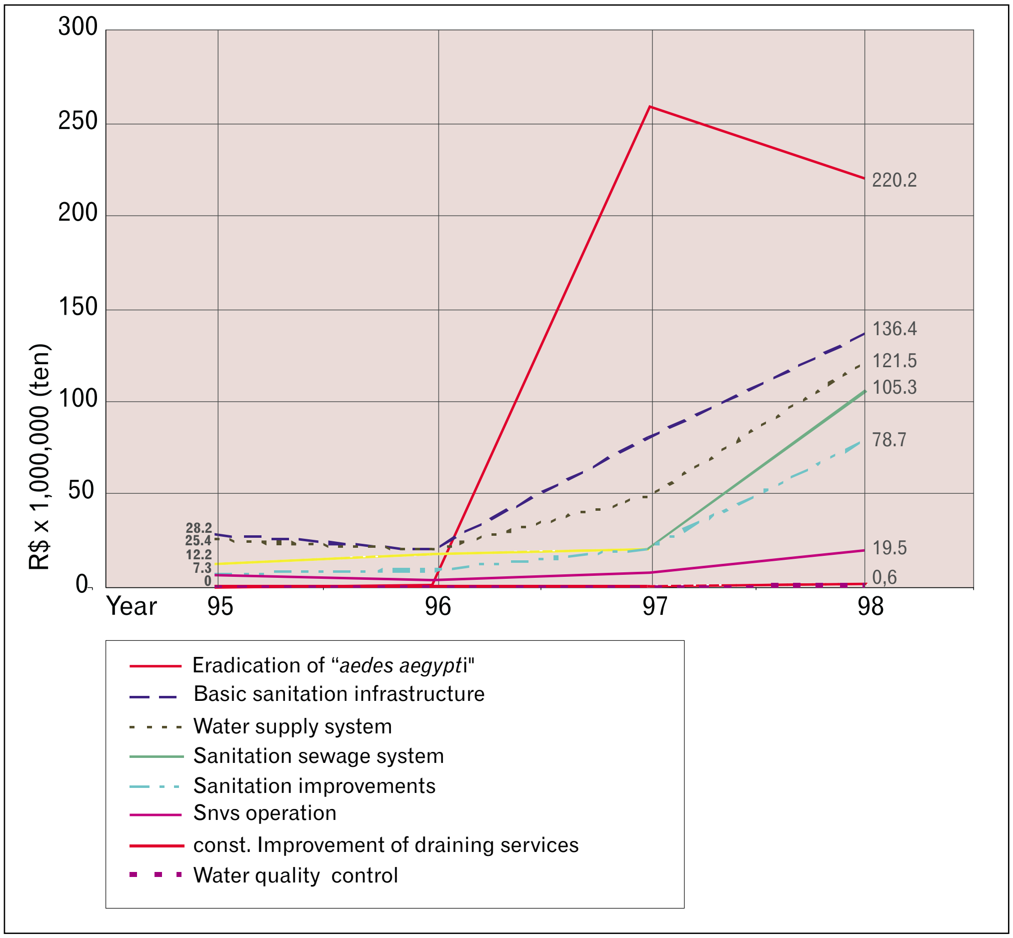
Just as an example of what was discussed above, Chart 3 shows the Brazilian Ministry of Health's expenses with several environmental sanitation programmes and those carried out to control the dengue epidemics during 1995-1998. It can be observed that these expenses already existed in 1995, and they increased considerably from 1996 on. During this year the efforts to control the disease were intensified. This attempt, subsequent to the emergence and intensification of epidemic outbreaks, reveals that this greater effort was undertaken not as a preventive measure, but as a way to minimise the consequences of an inadequate preventive policy. On the other hand, it can be suggested that, in a more adequate control and prevention model, part of the funds spent on a single disease could be better distributed, helping solve the complicated current epidemiological scenario, related to vector waterborne diseases.

## 12.4 Environmental Chemical Pollutants

Among the several situations of risk to human health, originated from productive processes, it is important to highlight the contamination by chemical agents. That is because they are in great number and, for most of them, there still is not available knowledge on toxicology, ecotoxicology, methodologies and techniques, both for the diagnosis of those situations and the development of surveillance activities aiming at their prevention and control. Since World War II, several chemical products were synthesised and large growth and development of the chemical industry was observed. The large production of biocides is in the interests of health, among the production of other chemical substances used in the control of plagues and vectors. The use of such substances, which was intensified by farming mechanisation, provided an intense process of population's exposure to those agents, in addition to rural-urban migration and concentration of properties. The disorganised occupation of urban soils, and cities with no environmental sanitation infrastructure also promote the proliferation of plague, inducing their populations to use biocides in their homes, not considering individual susceptibilities for such exposures. Among the chemical pollutants, according to their negative impact on human health, the most important are chemical fertiliser substances, lead and mercury.

Rio 92 produced a considerable collection of conventions, protocols and agreements. From the 175 countries that signed the Convention on Biological Diversity (CBD), 168 have already reaffirmed their commitment to preserve their biomes.

**Chart 3 - Expenses with the main environmental programmes in the country (1995-1998)**




Source: Ministry of Health - 1998

The conception of "*integrated management of natural resources*" is essential to regulate the social and individual relationship between man and nature, highlighting ecological, environmental, social, political, demographic, cultural, institutional and spatial dimensions.

The basic strategies of natural resource management have an impact on the health of living beings and, therefore, human health. In them, the guarantee of medicine and healthy food is emphasised. These issues are directly related to agriculture, fishery, flora and fauna protection, including micro-organisms. Even pathogenic organisms (for plants, animals and humans) must be handled within correct ecological conceptions, that is, in an integrated and systemic way, not isolated within monocausal analyses, the strategy of which is its elimination (eradication) as species. The organic agriculture and the integrated management of plagues are still incipient in Brazil. As a consequence, we have a present chemical risk all over the environment, in the food chain and in food, the impact of which on health has not been an object of systematic assessment, nor of health surveillance programmes.

The use of biocide products, as a sole or preferred instrument to tackle certain endemic vectors, must be revised urgently. For example, until not long ago, malaria control was based on the use of DDT (organochlorine product highly persistent in the environment), a product that causes damages to flora, fauna and human health. Being a clear example that a large part of health problems originated from environmental risks must be treated with integrated policies. The recent term of technical co-operation signed by the Brazilian Ministries of Environment and Health must contribute towards this process.

The deaths by poisoning are mainly related to acute exposures to chemical fertiliser substances, domestic cleaning products and industrial chemical products. The Brazilian National Poisoning Information System – SINITOX (*Sistema de Informação Tóxico-farmacológica*) registered 398 deaths by exposure to chemical fertiliser products in 1999. Of those, 140 were considered of occupational origin. This kind of data do not mirror the reality, once the registration presents a considerable secondary notification, due to the small coverage of the data collection system at national level, that counts on 29 centres only, most of them located in state capitals (SINITOX 2002). The World Health Organisation informs that 70 per cent of human intoxication cases by chemical fertiliser substances occur in developing countries (WHO 1995). Some studies seeking to assess levels of occupational contamination by chemical fertiliser products in Brazilian rural areas have registered human contamination levels varying from 3 to 23 per cent (Almeida & Garcia 1991, Faria et al 2000, Gonzaga et al 1992). By using the minimum limit reported in these studies and knowing the Brazilian rural population involved in agricultural activities, it is possible to estimate that the number of contaminated individuals directly by chemical fertiliser products in Brazil must be approximately 540,000, with around 4,000 deaths a year.

Also in accordance with SINITOX 1999 data, 66,584 cases of human intoxication were registered in Brazil. The Southeast presents a proportion of 42.37 per cent of all registered occurrences and the South, 33.65 per cent. The poor registration of intoxication cases in other regions is mainly originated by the lack of intoxication control services, or their disorganisation. There are 4,760 cases related to work environment.

The use of biocides in urban areas surpasses their use in rural areas, due to insufficient basic sanitation. The populations get uncomfortable with insects or rodents that lower their quality of life and some of them objectively pose risks to human health. Several products are proven harmful to human health and their consumption, however, is promoted by permissive advertisement and by how easy it is to obtain licences for their commercialisation and use, without any technical guidance. This situation is also likely to aggravate the problem related to respiratory diseases, specially allergy-based ones, and the occurrence of haematological and immunological diseases. There are only few studies that investigate the association of diseases to the use of domestic biocides, and they are based on acute intoxication cases only.

The rural population, consisting mostly of workers with no qualification, became even more vulnerable to damage by exposure to these toxic products. The use of chemical fertiliser substances was promoted by an official policy of conditioning the rural financial credit to the compulsory use of chemical fertiliser products. This situation is responsible for a large number of deaths by acute intoxication of rural workers.

The contamination that results from this agricultural productive process is not limited to the area or the workers, it is exported through environmental (air and water) and food contamination. It is more difficult to elaborate estimates on contaminated urban population; but the official numbers clearly show the importance of this segment. The contamination resulting from the direct use of pesticides and the indirect exposure occurring mainly through the contact with contaminated environments or food contribute towards data production.

A preliminary study carried out by the National Institute for Quality Control in Health/ Oswaldo Cruz Institute – INCQS/ FIOCRUZ – to assess the level of contamination by residues of pesticides on Brazilian fruits (strawberry, tomato and papaya) sold to consumers, revealed contamination in around 35 per cent of the samples, and a large regional variation was also observed. In the specific case of papaya, it was noted that this contamination reached 70 per cent of assessed samples in the Northeast. It is also important to emphasise that the contamination observed occurred due to the use of a determined chemical fertiliser product (dicofol), which is not authorised for those crops. This proves a complete lack of technical guidance and inspection on the part of relevant governmental organisms. Besides, this chemical fertiliser product is being submitted to a reassessment by North American health and environment agencies, because it is suspected that it causes carcinogenic, endocrine, immunotoxic and neurotoxic effects. The base substance of this product is considered one of the most toxic substances to the ecosystem and human health (Scorecard).

Another study carried out in an important agricultural area in the State of Rio de Janeiro found significant levels of anticholinesterase chemical fertiliser substances in water samples from a river across that region. Although these results are preliminary, they reached values of up to 76.80 ± 10.89 $\mu$g/L (Alves 2000), and are much higher than those recommended by the Brazilian legislation for domestic supply water and the water used to irrigate vegetables and fruit trees (total organophosphorate and carbarnate: 10 $\mu$g/L) (National Council for the Environment – CONAMA (*Conselho Nacional do Meio Ambiente*) 1996). These levels have determined not only biota contamination, but also favoured the area colonisation by more resistant species, causing several effects on local ecological balance (Moreira et al 2002).

It is important to highlight that agricultural activity, which is near large centres, is mostly small and notably family-based, where adults and children work helping each other. Usually, agricultural families also live in the surrounding areas of plantations. That makes children, young people and women of fertile age also subject to a high risk of contamination. This is a serious situation due to little available knowledge on the effects of a continuous and multiple exposure to those substances on a human organism. Today it is known that several chemical fertiliser products are suspected of having carcinogenic or hormonal effects.

The involvement of young people and children in work and the fact that most families live in the proximity of cultivation areas make exposure via environment easy and make women – in all life stages – and children, even before birth, continuously exposed to those chemical agents. Moreira et al (2002) report the contamination of 17 per cent of young workers and children (ages 7-17) by anticholinesterase pesticides (organophosphorate and carbarnate) in an agricultural region in the State of Rio de Janeiro, evidencing the seriousness of this problem. Such scenario is of even more concern when it is known that several pesticides of these and other classes, used likewise in the Brazilian rural environment, are suspected of producing endocrine effects that will manifest late in life or even in future generations. Among these pesticides, it is possible to mention, for example, mancozeb (thyroid inhibitor in rats, goitrogenic), maneb and metamidofos (reducer of sperm count and viability) (Coco 2002). An epidemiological study carried out from data collected from 11 Brazilian states, establishing the relation of pesticide sales in 1985 and human reproductive disorders observed in the 90's, show a positive association and suggest a co-relation between both factors (Koifman et al 2002).

This globalised type technological model is characterised by the logic of risk transfer from North countries to South countries. In the 70's, whilst the 1st World Conference on Environment and Development was discussed in Stockholm, Brazil received the transfer of chemical industries, considered highly pollutant in their origin countries. Cubatão (State of São Paulo), for example, was internationally famous due to its intense environmental pollution and the resulting harm on human health. This environmental contamination resulted in a large number of congenital malformation, intoxication cases by occupation exposure to Benzene and organochlorine products and the large number of hospitalisations due to respiratory diseases (Augusto 1992 and 1994).

The transgenic biotechnology, nowadays, has been introduced as an alternative to agricultural productive processes, and the same speech used during the "Green Revolution" era is used to justify its usage. In fact, the genetically modified organisms can determine, in the medium term, the complete dependence of rural producers on a multinational monopoly. The uncertainty about the risks originated from the consumption of transgenic food to human health and the environment requires these technologies to be submitted to the Precaution Principle. In this sense, public and collective interests must prevail over capital ones. Studies carried out by competent public institutions must be prioritised to assess such risks (Brazilian Federal Senate 1999).

The localised increase in levels of lead found in the environment originates from human activities (Agency for Toxic Substances and Disease Registry – ATSDR 1999a). The most common sources of lead contamination of the environment are airborne and occur through fuel and solid waste burning, which forms aerosols, and through industrial processes, forming vapour. The population in general is exposed to lead through environment air, food, water, soil and dust. Some of the most important exposures occur as a result of work in industries, contaminating houses in urban environments, specially where near emitting sources.

To illustrate the situation, data collected by the Federal University of Bahia and the Centre for Studies of Workers' Health and Human Ecology (CESTEH/FIOCRUZ) will be used. These institutions have been studying several aspects of human and environmental contamination by lead and their consequences to human health.

In 1980, 1985 and 1992, in Santo Amaro (State of Bahia), Silvany-Neto et al (1996) investigated lead exposure in children living near a casting plant and workers' children, finding lead levels that were higher than the limit (30mg/dl) recommended by the Centre for Disease Control (CDC-USA), and lead intoxication symptoms. Other sources of exposure occur in house and building refurbishment using lead-based paint, abnormal feeding, occupational exposures (both primary and secondary) and smoking. (ATSDR 1999a).

In the place where the study was carried out, there was a lead casting plant that was operational between 1960 and 1993 (Silvany-Neto et al 1996). The population characteristics related to the higher levels of zinc protoporfirine in these children were: female, living near the casting plant, abnormal feeding, being a worker's child and black-skinned. In addition to that, the place occupied by the child within the urban space was strongly associated with lead intoxication, and migration and the socio-economic situation were important factors in this spatial distribution, as shown by a study carried out in the same region by Silvany-Neto et al (1985).

The environmental (internal and external air) and human contamination, in four battery manufacturers and/or reformers and their surrounding neighbourhood, located in the urban region within the city of Rio de Janeiro, were studied by Mattos et al (2001), Caldeira et al (2000), Quiterio et al (2001) and Araújo et al (1999). These studies showed the high contamination level in all segments (workers, internal and external environments). Interior air monitoring measured within the workers' breathing zone evidenced contamination levels varying from 0.068 to 0.802 mg/m$^3$. Of all workers of the studied industries, around 60 per cent presented lead concentrations in their blood, that were higher than 40 ìg/dL, which is the maximum limit recommended by the WHO. Of these workers, 81 per cent also presented concentrations of the delta-aminolevulinic acid urinary bioindicator (ALA-U) that were higher than what it is considered normal (ALA-U <10 mg/g creatinine), indicating the organisms were already suffering undesirable biochemical effects caused by lead. Measurements of lead concentration in the external air, taken at variable distances from the battery reform plant, indicated dispersion of lead particles in a radius of around 25 metres. The atmospheric concentrations found varied from 0.07 to 183.3 ug/$m^3$. Several sample points exceeded the limit value recommended by the Environmental Protection Agency – EPA (1.5 ug/$m^3$), and these concentrations were also much higher than those observed in non-impacted environments (0.07 ìg/$m^3$). The dust collected in the external areas of houses located at a distance of up to 50 metres from the industries showed values varying from 2.2 to 5500 ìg/$m^2$, and in around 50 per cent of the sample points those values exceeded the ones observed in the analysis of the dust collected in non-contaminated areas. These results show clearly the contamination of workers and the pollutant dispersion from the industries, which harms the environmental quality of neighbouring areas, posing risk to the health of people living in the area.

The proximity to lead casting plants was also identified as a risk factor of lead intoxication among fishermen populations (Carvalho 1986). In addition to the children, another population group studied was formed by battery reform plant workers. Studies carried out by the Federal University of Bahia in 1985 showed that 15 per cent of the workers presented lead levels that were higher than the biological tolerance limit established by the Brazilian legislation at the time (Carvalho 1985 a,b). These increased lead levels were related to the older age of the worker, more time of service in the sector, poor ventilation of the work environment and the lack of knowledge of prevention measures. It is important to mention that only 17 per cent of the workers knew they benefited from a legislation that considers lead intoxication in this group as a professional disease.

Anaemia was one of the most common clinical symptoms found in populations exposed to lead, and the concomitant infection by ancylostoma seems to contribute towards the development of such anaemia (Loureiro et al 1983). In the studied populations, malnutrition and iron deficiencies are also an important contribution towards the development of anaemia (Carvalho 1985a).

In children, excessive irritability and nervousness were the most reported symptoms by their parents or guardians (Silvany-Neto 1996). Alterations in kidney function were observed in the workers of a Bahia State lead casting plant in a greater number than when compared to non-exposed workers. The degree of kidney dysfunction was associated with the length of time workers were exposed and the worker's age. In addition to that, there seems to be a greater association between arterial hypertension and kidney dysfunction in this group of workers.

Mercury chemical forms have different exposure patterns and health adverse effects (ATSDR 1999b). The exposure to metallic mercury is generated by its industrial use, occurring mainly in the South and Southeast, and it is also used to form dental amalgams.

In the Legal Amazon, the metallic form of mercury is largely used in gold mining. It is used in this activity because it forms an amalgam with gold dust, which makes the exploitation of gold easy. Later, this amalgam is burnt, a process that allows the separation of these two minerals, and the gold keeps in its almost pure crystal form. The mercury, transformed in vapour, is released into the atmosphere. The gold obtained in this stage of mining process still contains around three to five per cent of mercury, and is burnt again in shops where traded. In this stage, the released mercury can cause intoxication both in the working population directly involved in the process and the population living near those shops (Câmara and Corey 1992).

A study carried out with 365 inhabitants – not exposed in their occupation (mainly women and children), in the municipality of Poconé (State of Mato Grosso), presented two types of exposure. The first in people living up to 400 metres far, and in the prevailing direction of the wind, from shops that buy and purify gold. These residents presented an average of mercury in their urine (4.89 mg/L) that was higher than presented by the people who lived in a control area (1.25mg/L). Also, 14 people presented Hg levels in their urine, which were higher than 10 mg/L, compared to a WHO recommended limit of 4.0 mg/L for non-exposed people. A second type of exposure was found among people who lived in the surrounding areas of the city, and burned gold-mercury amalgams inside their houses. Of those people, 13 presented mercury levels in their urine that were higher than 10 mg/L, and this study was used to develop a special health education programme (Câmara et al 2000).

The metallic mercury released in the environment can be deposited in rivers and, through the biological chain, be transformed in an organic compound called methylmercury. This substance, which is the most toxic form among mercury derivatives, has been found in bottom silts and in omnivorous (up to 0.7 ppm) and carnivorous fish (> 0.5 ppm, with the possibility of reaching 6 ppm in larger samples), captured in metallic mercury polluted Amazon rivers. Considering that the major protein source for riverbank populations is fish, human contamination has also been reported. Relatively high concentrations of methylmercury have been identified in hair samples from indigenous and riverbank populations (10 – 150 ppm) in that region (Malm 1998). Also, studies carried out in three fishermen villages along Tapajós River presented mercury concentrations in their hair, which varied between 14 and 21 ppm, and 73 per cent of the assessed fishermen presented higher concentrations than the limits considered normal (maximum normal limit = 10 ppm). There were also studies carried out by the Evandro Chagas Institute, in Tapajós River Basin, that indicated averages of mercury levels over 10 mg/g for most communities in the study, compared to a WHO established limit of 2.0 mg/g (Santos 1997), which places these populations at the risk of diseases caused by this substance.

However, there are still some divergences in relation to the clinical effects observed in Amazon populations exposed to mercury, due to poor living conditions and the occurrence of endemic diseases in that region. Nevertheless, some scientific studies have been finding strong relations between methylmercury concentrations observed in the hair and some motorial (Dolbec et al 2000), neurological (Lebel et al 1998) and cytogenetic problems in lymphocytes of the populations living in the banks of Tapajós River (Amrin et al 2000).

It is difficult to establish the number of people directly exposed to mercury in gold mines, given the Amazon amplitude. In the end of the 80's, approximately 300,000 miners were registered, in accordance with a census carried out by the National Department for Mineral Production. Today, this number is certainly a lot smaller, considering the substantial reduction of gold exploitation in the region, both due to falling prices of this mineral in the market and the international pressures related to the suspension of the activity, because of its negative impact on the environment.

## 12.5 Atmospheric Pollution

Atmospheric pollution is also a major factor that causes diseases to millions of people. The high death rates associated to respiratory problems are an indirect indication of how serious the degradation of air quality is as a disease-provoking factor, especially in metropolitan areas. The Brazilian Ministry of Health recently started to work on the development of a surveillance framework that allows the establishment of a correlation between health conditions and air quality. In the near future, the expected results will be able to provide more detailed data on the epidemiological profile of respiratory diseases and their relation with types and levels of atmospheric pollution in the country.

The dramatic effects of atmospheric pollution are also associated to respiratory and cardiovascular diseases. Nevertheless, it is now possible to establish a link between the emergence of incidences of neoplasia and asthma related to chronic effects of contamination. In such cases, the most vulnerable people are children, the elderly and pregnant women, who can have their pulmonary functions altered.

In a pioneering study conducted in Rio de Janeiro in 1991, Duchiade examined the influence of socio-economic, climatic and air pollution variables on infant mortality in Rio de Janeiro City's metropolitan area in the period 1976-1986. With a falling infant mortality rate and a concomitant increase in mortality caused by pneumonia and a decrease in mortality caused by diarrhoea, the study showed that average infant mortality rates were consistently higher in the metropolitan periphery as compared to the capital, and that there were yawning gaps between the figures of the various municipalities and between the figures of the various administrative districts when upper-class areas were compared with lower-class areas, whose figures were five times higher. On the other hand, variables related to economic conditions and sanitation, along with air pollution and climate indicators, accounted for the discrepancies in mortality caused individually by pneumonia and diarrhoea and perinatal mortality. This revealed a convergence of the worst environmental and socio-economic conditions in a single area, which in turn caused excessive infant mortality.

In Brazil, a significant portion of diseases and deaths provoked by respiratory conditions over the past few years is undoubtedly associated to the deterioration of air quality, most notably in major cities. It is important to point out that in the period 1970-2000 emissions increased substantially in Brazil, which experienced a 200 per cent change in the case of sulphur dioxide ($SO_2$) and increased as much as 500 per cent in the case of hydrocarbons. These gases, together with the dark smoke released by vehicles, can help disseminate respiratory diseases (GEO 2000).

More detailed studies have been carried out in the metropolitan region of São Paulo, where, according to estimations, 17,000,000 people suffer an impact of atmospheric pollution (Saldiva, 1995). As pollution goes up in São Paulo, there is an increase in respiratory problems, which then represent 20-25 per cent of admittances and 10-12 per cent of deaths. Specialists in São Paulo University's Atmospheric Pollution Research Laboratory were able to draw this conclusion by crossing meteorological data collected by São Paulo's Environmental Sanitation Agency - CETESB with the average number of hospital stays and deaths associated to respiratory illnesses.

In the municipality of Rio de Janeiro, a study built on data by the State Environmental Engineering Foundation - FEEMA showed the degradation in atmospheric air conditions according to the extent the standard stipulated by the National Environmental Council - CONAMA was exceeded, when compared with periods 1981-1987 and 1988-1995. The incidence of patients suffering from respiratory problems in emergency wards showed an increase in such diseases during the winter season when compared to those in summer. This was indicative of a correlation between climate and pollution factors as such degradations take place more often. (Brilhante et al, 2001).

Silica and asbestos are important agents that cause pneumophathies. They can be found primarily in some work environments (for instance, in extraction, textile and civil construction industries, among others). If their emissions are not effectively controlled, they can endanger not only workers in those sectors, but also populations living in the surrounding areas. In Brazil, identification of pneumopathies caused by such agents only takes into account workers, and it was intensified during the 1990's. The number of reported cases, however, is small when compared with the number of actual victims.

Some studies have attempted at establishing a link between the differential distribution of material standards of living and the differential distribution of morbidity-mortality (Peiter & Tobar, 1998). In the municipality of Volta Redonda (Rio de Janeiro State), the authors used analyses of correlations between the polluting substances released by the National Steel Corporation – CSN and socio-environmental data to demonstrate that the lower class segments of the population live in the most polluted areas. This situation highlights the historical socio-economic divide affecting the lower class population and its clear-cut impacts on the current arrangement of the Brazilian urban space (CGVAM, 2002b).

In addition, for a solution of the Brazilian population's health problems caused by air pollution to be found, burns must also be a case in point. These are common practices in extensive agricultural areas in Brazil for clearance purposes and little information is available about the issue. In Alta Floresta, in the State of Mato Grosso, a twenty-fold increase in the number of patients suffering from respiratory diseases was reported in 1997, in an incident where biomass was burnt (Brauer, 1998).

### 12.6 Healthcare and the Environment over the past two decades

- 1983 – Cubatao - São Paulo: Hundreds of people were intoxicated by benzene, a problem that was also detected in various petrochemical and steel hubs in the country (Volta Redonda, Rio de Janeiro State; Ouro Branco, Minas Gerais State; Camaçari, Bahia State; Vitoria, Espirito Santo State). Over 4,000 cases have been identified.

- 1985 – Rogue landfills containing organochlorines were found in several areas of the "Baixada Santista" region in São Paulo. Local inhabitants and workers suffered the effects of residues of pentachlorophenol, carbon tetrachloride, perchlorethylene and hexachlorobenzene. Residues of hexachlorobenzene were detected in breast milk in the contaminated area, and cytogenetical and hepatic alterations in people who worked in the industry that caused the contamination.

- 1986: Vila Soco, a slum in Cubatao City, São Paulo, was virtually destroyed by fire due to a leakage of gasoline in the piping system of an oil refinery industry.

- *1986: Greatest radiological accident outside a nuclear plant. The substance involved was Cesium $^{137}$, and the accident occurred in Goiania, Goias State.*

- 1996 – Caruaru, Pernambuco State: Over 60 patients in a haemodialysis clinic died due to the use of water contaminated by hexotoxic cianobacteria (blue algae), in the dialysis process. In addition to the sanitation problem associated to a lack of water quality surveillance, the environmental cause – poorly explored up to now – is probably associated to water eutrophication.

- 2000: Three major environmental, health-threatening problems were reported:

**a)** one in Maua City (São Paulo State), where there were emanations of aromatic hydrocarbons, including benzene, in a gated community built on a lot previously used as an illegal dump for industrial residues, though the community's inhabitants were unaware of this. Consequences for human health are still being assessed;

**b)** in Paulinea (São Paulo State), chlorine residues and heavy metals from a large producer of agrochemicals and incinerator of organochlorine residues contaminate the soil and water tables, thus endangering the people living in the surrounding area of the company.

**c)** in an area of manganese exploration – in the influence zone of this production chain – in Serra do Navio, Amapa State, contamination of the environment is intense, especially by arsenic. The contamination has reached areas far from the mining zone, including urban areas. Manganese can provoke neurological syndromes, and arsenic can cause cancer in human beings. The situation is currently the object of environmental risk studies.

In addition to such events, the so-called "environmental disasters" are also relevant, as they are considered as natural disasters that occurred during the period 1990-1999 on the Brazilian territory, including floods, dry spells, droughts, landslides and forest fires. Except for landslides, all other disasters were directly associated to the "EL NIÑO" phenomenon, which affected climatic conditions and precipitation levels across the country. Examples of impacts caused by this phenomenon include forest fires in the North, droughts in the Northeast and floods in the South.

Every year, landslides during heavy showers of rain in vulnerable urban areas account for the death of many people in some major Brazilian cities. Floods in urban areas have also been responsible for epidemics of leptospirosis. In Rio de Janeiro City, both in 1988 and 1996 for instance, the disease's annual incidence increased 10-30 times (Confalonieri, 2002).

Climatic changes have also been associated to a large-scale incidence of wild yellow fever, as was the case in Brazil from January to June 2000. This provoked 77 cases of the disease in 8 Brazilian states; 39 people died. It should be pointed out that the latest cases of indigenous yellow fever had been reported in some of the above mentioned states (São Paulo and Bahia) in 1953 and 1948 respectively [Vasconcelos et al, 2001].

With regard to the impact caused by such disasters, one can affirm that one of the most significant problems occurred in the Northeast's economy, where approximately 30 per cent of the Brazilian population – the poorest – live. In 1998, 75.5 per cent of the Northeast area was affected by droughts – 1,429 municipalities and 24 million people suffered with the problem (CGVAM, 2001).

On the other hand, Brazil has reported some large-scale industrial accidents (therefore these accidents were not natural) considered to be serious. Nowadays, Brazil can be included in the group of countries that experienced the most serious accidents involving immediate death, with five or more casualties at the moment the accident occurred. Considering that Brazil is currently ratifying the International Labour Organisation's Convention 174 on the prevention of large-scale industrial accidents, the Ministry of Health's National Health Foundation is now developing training programmes for professionals in the healthcare sector, environmental and civil defence agencies with a view to providing technical training intended to tackle the problem (Civil Defence, 2000).

In view of the above, two milestones contributed over the past decade to the emergence of a new frame of mind: the first is associated to the enhanced importance of Earth; and the second is related to the estimation of seriousness of accrued environmental problems which in the not very distant future could undercut not only the economic development model, but also the very survival of human race.

The notion that health, economic development, quality of life and environmental sustainability are correlated is now being supplanted by the idea that the human ability to interfere plays a critical role in the harmony and evolution of complex systems. It is thus necessary to identify the potentialities and responsibilities derived from the human society's ability to influence its own destiny and ultimately the destiny of the entire planet's life.

Just like the control over other relevant elements of life conditions, control over transmissible diseases is now more and more transferred to locations and to people in the hope that they will build new relations between individuals, communities and environment and that they will establish a vision of self-sustainable human development.

The expansion of old diseases, now with a new socio-environmental bias, and the emergence of countless other diseases, are an indication of a need to develop a broader collective sense. No matter how much we stress the importance of new behaviours and an environmental management geared towards health and sustainability, these issues cannot be dissociated from the broader picture, where they take on a new significance.

This is certainly a paramount achievement towards greater autonomy and integration between society and nature and nevertheless it is inconsistent with the current policy-making trends of States, including Brazil, within the globalised world in which they operate, which end up diverting from the real needs and concerns of different segments of the population. In this sense, health and life conditions can only be relevant when associated to a place and a people, where they should be figured out to the extent of available resources.

chapter 3

# policies feedback

# policies feedback

## 1. Inheritance and Conditioning of Policies feedback

The free appropriation process nowadays does not only threaten the natural mechanisms of environmental resources renewal. It affects our own lives as well, whether we live in the city or in the country. It also affects the lives of species which, despite the systematic destruction of wildlife and plants, insist on their survival in spite of our immediate actions.

The growth of certain economic sectors in the last 40 years by means of agricultural and mineral exploration has caused the consequent swelling of existing cities as well as the appearance of new agglomerations even in the Amazon, considered to be the last expansion frontier. (IBGE 1990, 1996). In the 60s, 70s and 80s, the adopted standards of production and consumption of goods and services characterised a sectorial, spoliation and economic-based development model. The relationship these elements had with the economic, socio- cultural and ecological environmental dimensions, which are specific of territories where the economic growth of those previously mentioned sectors occur, have caused (Veras, 1994) visible deterioration of these dimensions that directly affected the quality of life of local population, as well as of migrating contingents.

Awareness of the need to alter this progressive degradation framework confronts the myth of a hypothetical contradiction between development and environment. It also raises questions as to the models, policies and traditional instruments of action adopted by the State in their ordinance of National Territory occupation.

### 1.1 Context: Brief History of the Sectorial Treatment of the Territorial Management

Territorial policies oriented towards the viability of objectives which are predominantly characterised as an immediate economic action run the risk of promoting non-sustainable ecological interventions once more. From the old Rationalist vs. Empirical dichotomy and geometrical forms of gravitational models of regional development to the export corridors and scientific and technological parks, apparently substantial changes are, in fact, irrelevant and, in their essence, do not alter the sectorial and isolated view which they reflect. The spaces between urban concentration areas, irrespective of whether they are occupied by formal or informal economic activities, are seen as the distance between economic poles. On the whole, these spaces are seen as food producers and, in a linear fashion, as raw material suppliers or, even in isolation, as nature to be preserved for recreational or moral purposes. A strict view of territorial occupation prevails.

The complexity of exchange relations between cities and the environment, taking into consideration the territory under its ecological influential area, remains obscured in what persists as the analytical framework. This framework apparently insists on the idea of endowing many with the cost relationship and few with the resulting benefits. This occurs on an immediate time span horizon. In an attempt to avoid the social costs involving non-economic agglomerations identified in the large urban concentrations, some people have defended the elimination of these non-economic agglomerations (Gazeta Mercantil 1992), whereas others have defended their existence as a means to recover the remaining natural resources in these areas . However, in view of the inevitable worsening of the already difficult social, economic and environmental conditions (Yale 1999), others have defended the densification of these areas.

Persisting sectorial approaches, soil occupation, massive construction and the substantial volume of public and private resources invested by both the State and by citizens in the social and economic infra-structure throughout the years, occupation runs the serious risk of not being considered a significant social cost.

### Legal and Institutional Macro -Framework for Territorial Planning

**a)** The Federal Constitution - deals with the environment in Chapter VI. Article 225 in conjunction with the depositions in articles 21, 23, 24, 25 and 30, among others, constitutes an adequate basis, though not perfect, for the development and improvement of ruling on soil use.

**b)** Despite the well-developed characteristics of environmental and natural resources legislation, it still needs compatible rules within the legislation. This is true for the existence of specific laws ruling over the same theme. These laws are contradicting in view of unsuitable sectorial focus, and this causes fragmentation of the reality which these laws intend to regulate. The issues covering management of water and forest resources are specially in need of revision, as already highlighted in Chapter II.

**c)** A complex institutional framework is characterised by a diversity of agents comprising MMA, IBAMA, OEMAs, NGOs, among others. Environment is not a sectorial theme - it encompasses all activities. The link between forest fomentation and rubber extraction, and IBAMA's environmental control and inspection, for example, require several adjustments in regards to topics related to forest conditions and biodiversity.

**d)** The territorial management treatment is divided among several ministries and it is separate from other environmental and territorial issues.

**e)** The management of national and regional territory (territorial ordinance) is mentioned in the Federal Constitution as a subject under the Union's responsibility. Although it is of utmost importance in the previously presented geopolitical context, this management has not yet been institutionally empowered in a deserving fashion. The Ecological-Economical Zoning programme is the main instrument the State has to regulate the Brazilian territory. Its main objective is the gradual transformation of the development parameters adopted in the country with a view to adopt the social, economic, cultural and ecologically sustainable development model. Its co-ordination has previously been the responsibility of the CCZEE - Ecological-Economical Zoning Co-ordination Commission, created and established (Decree no. 99.540, of 21/09/90) with the aim to conduct and manage the process of zoning implementation in its various phases and its related detailing levels. This Commission, presided by SAE (Art.15, Law no. 8.028 of 12/04/90) was constituted by representatives of several ministries and government agencies, and also representatives of states in whose territory the zoning activities were being planned. The Commission should then plan, co-ordinate, follow up and assess the execution of projects and, finally, link with the states involved and give them support in the sense of making federal and state interests compatible. To this end, the Commission had the power to create Work Groups and designate sub-commissions (Decree no. 99540 of 21/09/90).

However, CCZEE limited itself to implementing the ZEE as an instrument to subsidise the Territorial Ordinance and in a way left open the issue related to political institutionalisation aiming at proposing the Territorial Ordinance Plans. The CCZEE limited power was demonstrated in the lack of operational and administrative support to the implementation of their decisions. Finally, with the extinction of **SAE/PR,** through the government's Provisional Measure no. 1911-8/99 of 29/07/1999, the co-ordination of **ZEE** was taken over by Ministry of the Environment**.** The execution of projects previously attributed to ZEE had a new institutional arrangement now being exercised through a partnership called Brazil ZEE Consortium under the co-ordination of the Sustainable Development Policies Secretariat – SDS/MMA, comprised of IBAMA (MMA), INPE (MCT), IBGE (MOG), EMBRAPA (MA) and CPRM (MME).

The National Development Plan (1985-1989) dealt with the environmental policy with a specific chapter. From this period and up to 1996 government actions were developed based on special programmes such as the National Environmental programme, Our Nature programme, and the Brazilian Tropical Forests Protection Pilot programme (PPG7). These programmes were almost always financed by loan agreements or donations from international or multilateral credit agencies. From 1997 the Pluriannual Plan - PPA, which is a main strategic planning instrument in the country, incorporated the environmental government-related area under their ownership.

## 1.2 Integration and Fragmentation

The Brazilian territorial occupation has, historically, been a consequence of spatial isolation which was a characteristic of several economic cycles, namely the gold and cattle cycles, as well as others already mentioned in Chapter II. More recently, the one which could be labelled as "the road transportation cycle" had their most significant examples with the inauguration of the highways Belém-Brasília, Trans-Amazon, Cuiabá-Santarém and BR-364 highways.

This occupation pattern has only changed in this century with the polarisation caused by industrialisation. This occurs in São Paulo, the Paraíba Valley and Rio de Janeiro and its surrounding areas its most typical models of urban agglomerations. This model, while not contributing to an adequate quality of life standard, requires the incorporation of an environmental dimension in the planning of urban space occupation. Mainly, this is true in the treatment of the urban/rural spaces "relationship". These spaces are

considered as "environmental systems" with characteristics of their own, though synergistically interactive. Within this context it can be said that the environmental system consists of results of "energetic flows" interaction – both material and informational (symbolic and non-symbolic), bio-cultural strategies of survival and bio-cultural processes of adaptation, in an open context of spatial and time-related dimensions" (Almeida Junior 1990). These are characteristics of environmental units with a dynamics and evolution of their own, within time and space, and which are endowed with different levels of ecological organisation.

This knowledge necessarily goes through the adoption of an integrated territorial approach. This occurs as a planning and management strategy, thus discarding the Cartesian and segmented treatment which has still been impregnating a few environmental studies since the 1960s.

Although it possible to identify a series of efforts in different institutions which aim to promote the concept of integration and a holistic vision, the most frequent practice has still been that of a technical project by sector aiming at the partial solution of localised problems and the political decision to attend to sector clients. It is common knowledge that a great part of the country's wealth generation sources function in an enclave economy. This type of economic integration policy has promoted, in many cases, the fragmentation of the territory by creating some developed centersand by leaving other territories completely without resources. When considering the issue of predatory exploration of natural resources, it can be said time and again that the integration policy leads to a "disintegration" of territories, thus producing spaces which can not be productive without some expensive recovery.

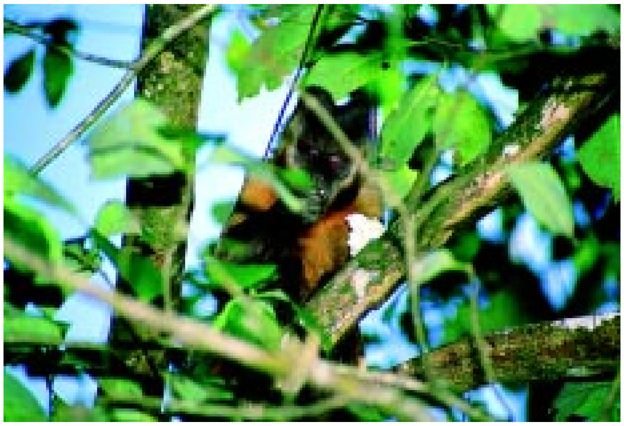
Despite all ecological culture, created in the last 30 years, the environment continues to be treated as a sectorial and fragmented theme. It is worth mentioning that this happens not only in Brazil but all over the continent. There are Environment Ministries all over Latin America. Within each of these there are sectors fully dedicated to water, where Water Councils have been created. However, no concern has been shown to make them compatible with the several different uses of the soil, their agents, future demands and projects. Therefore, it can not be said that there is an integrated treatment among water, forests, biodiversity or the adequate use of such resources for the development of society and the country.

### 1.3 In the Counter-current of Segmentation: the Bias and the Challenge

The technological evolution enabled by instruments which use satellite images and the geo-coded treatment of information related to natural and social-economic resources opens means to set up databases that are adequate to the identification, characterisation and assessment of urban and rural environmental systems. This type of assessment corresponds to a process which, undergoing a previous diagnosis phase, enables the identification of capacity to maintain, extend or recover the appropriate its of the systems..

Statistical treatment given to several uses of soil seems to float in an abstract space deprived of mass and natural resources which still characterise the regions of this planet. This is due to prevailing aspects such as economic and, in some cases, social factors, and to sectorial analysis. The cumulative deterioration of this type of resources results, in most cases, from negative impacts which in turn result from questionable bases of effective functioning of the economic systems. This seems to indicate the urgent need of a multidisciplinary effort to tackle the problem. A new conceptual framework is necessary and should be oriented towards the formulation of human-environmental information system which, in turn, benefits the inter-relations between social-economic processes and the environment. This should be aimed at desired sustainability of the development process to be implemented. The methodological basis for an adequate assessment of the impacts of natural phenomena and of human activities on the environment require a new definition referential. This is also true for the environment's impact on human life conditions.

The concept of new territorial management instruments is closely and insolubly linked to the development of society. It embraces the task of ensuring equity of access to natural, economic and cultural resources which may be transformed into opportunities for sustainable development provided



they are used in an adequate fashion.

In turn, this sustainability notion relies on the notion of environmental fitness (economic, social, cultural and ecological) of the adopted means of exploration. This notion is guaranteed, and inspected, when founded on the practice of equity of access to those resources by society. Either collective or individual participation of citizens will occur.

Duly warned, they shall defend their rights and those of their children and grandchildren in order to be able to enjoy their territorial heritage.

Significant efforts have been made throughout the last decade in view of promoting the desired integration on a sustainable basis. Among those which should be highlighted are the participation of Brazil in the United Nations Conference for the Environment - known as Rio-92, and the development, in both social and political terms, of Agenda 21. The institutional and technical-scientific alliance process which supported the elaboration of the present Report of Perspectives for the Environment in Brazil, also called GEO – Brasil 2002, also constitutes a landmark in this process.

## 2. International Agreements Resultingfrom Geo-political Interaction Processes

### 2.1 Precedents: Rio 92 and Agenda 21

The fact that Brazil hosted the Rio 92 Conference contributed to reinforcing and spreading environmental awareness in the country. Ten years after the event a set of actions taken by governmental, entrepreneurial and civil society sectors with the aim to focus on sustainable development management are still emphasised.

The old environmental preservation concept is based on the premises that natural resources are untouchable. This idea has been replaced by another notion that adapts preservation to a new model of development founded on the rwise use of natural resources, so that they may continue to be available to future generations. Development which does not deplete but preserves and constantly nourishes its source of natural resources and is not moved just by immediate interests but is in fact ruled by planned actions is essential. This is called sustainable development.

This new concept has been consolidated as a guideline for changes in the global development directions and was defined by the 170 countries present at the Rio 92 Conference. This Conference approved the Agenda 21 document that contained a series of commitments agreed on by the signatory countries. Among such commitments were the incorporation of sustainability principles in countries' public policies, placing them directly on track for sustainable development.

Building sustainability in Brazil is an enormous challenge - as vast as the Brazilian possibilities themselves. These possibilities are founded on a continental territory that has still abundant natural resources. They are also founded on the greatest biological diversity in the planet, on relatively abundant water resources, year round solar energy and a complex society of almost 174 million people (IBGE 2002).

### 2.2 Environmental Multilateral Agreements and Non-Binding Instruments

The return to the democratic process, the opening of the discussion of environmental issues to civil society, the increase of external pressure and, moreover, the magnitude taken by post 1985 environmental degradation confer great visibility on environmental matters.

The Rio 92 Conference signatory countries, which have also signed the documents and declarations resulting from world conferences which followed Rio 92 in the 1990s, have committed themselves to the adoption of sustainability and sustainable development notions in a global framework of deep transformations.

The first point to be considered in this process is knowing what is and what should be the country's place in the current stage of internationalisation of the economy, knowledge and communications.

According to recent Human Development Reports (1998 and 1999) published by the United Nations Development programme – UNDP the outlook is reason for concern.

The industrialised countries, where 19 percent of the world population is located, accounts for 86 percent of world production and consumption, 82 percent of the exports of goods and services, 71 percent of world trade, 68 percent of direct foreign investments, 74 percent of telephone lines, 58 percent of all energy produced, and 93.3 percent of Internet users. Meanwhile, the 20 percent of the poorest population accounts for 1 percent of the world production planet's, 1 percent of exports, 1percent of direct investment, and 1.5 percent of telephone lines (MMAA/ PNUD 2000).

In particula, in what refers to the Amazon, Brazil has been the target of world fear with respect to the consequences of the changes in the use of the earth. The Kyoto Protocol establishes mechanisms, like the one for clean development, by wich industrialised countries will be able to finance projects which may contribute to the permanent reduction of greenhousegases in other nations. .

**Knowledge and income tend to become more rapidly and acutely concentrated than ever. According to the previously mentioned UNDP reports, "privatisation and concentration of technology are going too far. This has enabled corporations to define research agendas and strictly control their findings. Poor people and poor countries risk being pushed to the margin in this proprietary regime controlling the world's knowledge. The new technologies are priced for those who can pay. Strict property rights raise the price of technology transfer, blocking the developing countries from the dynamic knowledge sectors." According to these reports the countries' own governance is at risk: "Governance does not mean mere government. It means the framework of rules, institutions and established practices that set limits and give incentives for the behaviour of individuals, organisations and firms. Without strong governance, the dangers of global conflicts could be a reality of the 21st century - trade wars to promote national and corporate interests, uncontrolled financial volatility setting off civil conflicts, untamed global crime infecting safe neighbourhoods and criminalizing politics, business and the police."**

### 2.2.1 Forests and Biodiversity

Aiming at biodiversity conservation, the sustainable use of its components and the fair and equal distribution of the benefits derived from the use of genetic resources, Brazil signed the Biological Diversity Convention in 1992. This Convention establishes the of a National Biodiversity Policy (Provisional Measure No. 2,126/2001).

Also aiming at the contribution to the reduction of deforestation, the Ministry for Land-related Matters has issued a regulation prohibiting the dispossession of primary forest areas for agrarian reform purposes in the Amazon biome and in the Atlantic Forest.

Genetically Modified Organisms – OGM have been a n object of intense debate within the scientific, environmental, agroindustrial, industrial and international trade communities.

The negotiation of a Protocol on Bio-Security addressed to the Biological Diversity Convention is in progress and aims to establish an international regime which regulates the transboundary movement of these organisms. Within Brazil this issue is ruled by Law no. 8.974 and by Decree no. 1.752, of 1995

In turn, the National Biosafity Technical Commission – CTNBio, formed by representatives from the Health, Science and Technology, Agriculture and Environment ministries, and also by consumers, workers, private sector and scientific community, is in charge of examining and approving any activity which may involve experiments related to genetically modified organisms.

### 2.2.2 Climatic Changes

The Vienna Convention for the Protection of the Ozone Layer stipulates Destructive Substance the international co-operation for the development of research, the exchange of information, the establishing of monitoring systems and the formulation and implementation of measures of effective control of problem causes. The Montreal Protocol for Substances which Destroy the Ozone Layer foresees the protection of the ozone layers by means of the adoption of cautious measures in order to control, in an equitable way, the global emissions of substances which may destroy the ozone layer – Ozone Layer – SDO.

These international agreements, in turn, are related to the Agenda 21 chapters dealing with international co-operation in order to accelerate sustainable development and related policies in developing countries. This includes protection of the atmosphere, environmentally healthy technology transfer co-operation and institutional strengthening (**Synoptic Picture 1**).

**Chart 1 - Internacional Conventions**

| | | |
|---|---|---|
| **Convention on International Trade in Endangered Species of Wild Fauna and Flora. Washington,U.S., On March 3, 1973** | | |
| Ratification: Legislative Decree no. 54 | 06/24/75 | Objective: to limit the international trade of endangered species. Reference: Chapters 14 and 15 of Agenda 21. |
| Decree no. 76,623 | 11/17/75 | |
| **Convention on Biological Diversity- CBD Rio de Janeiro, 06/05/1992** | | |
| Ratification:Legislative Decree no. 2 | 02/03/94 | Objectives: conservation of the biological diversit, sustainable use of its components and fair and equitable division of the benefits derived from the use of genetic resources. In effect in Brazil: 05/29/94. Reference: Chapters 2, 15, 16, 33, 34 and 37 of Agenda 21. |
| **United Nations Framework Convention on Climate Change. New York, 05/09/1992** | | |
| Ratification: Legislative Decree no. 1 | 02/03/94 | Objective: regulate the concentration levels of greenhouse gas caused by intensive use of Fossil fuels, so as to avoid climatic changes at an obstructive level of sustainable Economic development, jeopardising, among others, the water resources and the Production of food. In effect in Brazil: 05/29/1994 |
| **Ramsar Convention on Wetlands of International Importance. Ramsar, Iran, 02/02/1971** | | |
| Legislative Decree No. 33 | 06/16/92 | Objectives: to promote the rational use of these wetlands, specially as the habitat of waterfowl, and to ensure the preservation of these wetlands - important as a source of potable water, in addition to suppliers of environmental services: sanitation, flood Control and production of food -, avoiding negative changes in their ecologic state. Reference: Chapters 14, 15, 18, 26, 27 and 37 of Agenda 21. In effect in Brazil: 09/24/1993 |
| | | Actions: Areas designated by Brazil to be included in the Ramsar List: National Park of Pantanal, State of Mato Grosso (135,000ha); National Park of Araguaia, State of Tocantins (562,312ha); National Park Lagoa do Peixe, state of Rio Grande do Sul (34,400ha); Mamirauá Sustainable Development Reserve, State of Amazonas (1,124,000ha); and Environmental Protection Area of Reentrâncias Maranhenses, (2,680,911ha), Environmental Protection Area of Baixada Maranhense (1,775,036ha),State Park of Marinho do Parcel de Manuel Luís (45,237ha), all three in The State of Maranhão. Brazil is identifying and forwarding the following projects:Monitoring of Continental Migratory Birds in Ramsar Areas;development of Environmental Education programmes In National Parks (Lagoa do Peixe, Pantanal Mato-grossense, Araguaia and surrounding areas); Execution of an Environmental Management Course on Wetlands; and a Remote Sensoring Course Applied to the Mapping of Coral Reefs in Conservation Units. Other actions: creation of the Brazilian Committee on Wetlands - participation of governmental and non-governmental organisations, Experts |
| **The Vienna Convention for the Protection of the Ozone Layer - Montreal Protocol on Substances that Deplete the Ozone Layer. Vienna, Austria, on 03/22/85 and Montreal, Canada, 09/16/1987** | | |
| Ratification: Legislative Decree no. 91 | 12/15/89 | Objectives of these agreements: the Convention: to protect human health and the environment from Negative effects of changes in the ozone layer, due to development - Supported by international co-operation - researches, exchange of information,creation of Monitoring systems, design and implementation of effective measures to control the causes; and the Protocol: to protect the ozone Layer by adopting cautionary measures to control equitably the global emmissions of substances That deplete the ozone layer - SDO. Reference: Chapters 2, 9 and 34 of Agenda 21. In effect in Brazil: 06/07/1990. Actions: Design of the Brazilian Programme to Eliminate the Production and Consumption of Ozone Layer- Depleting Substances - PBCO (1994); institution of the Interministerial Executive Committee for the Protection of the Ozone Layer – PROZON (09/19/1995); 178 companies had projects approved by the Executive Committee of the Multilateral Fund, enabling the internalisation in the country of an amount of about |
| Promulgation: Decree no. 99,280 | 06/06/90 | |

The national concern in relation to climatic changes resulted in the creation of an Inter-ministerial Commission of Global Climate Change in July 1999, by decree of the President of the Republic. This commission is headed by representatives from the Ministries of Science and Technology and of the Environment, and have the aim of defining national criteria for eligibility for climatic changes-related projects; assessing proposals related to sectorial plicies, legal instruments and regulations that are relevant to the theme and, subsidising the government's negotiation position in relation to climatic issues.

### 2.2.3 Preservation of Humid Zones

Brazil has been working hard in order to promote the rational use of the country's humid zones, specially the habitat of aquatic birds. Efforts have been made to ascertain the preservation of these humid areas – important as a source of drinking water and act as the supplier of environmental, sanitation, flood control and food production services. In order to avoid adverse changes in its ecological state, Brazil has been not only working in identification but also in conducting monitoring projects of continental migrating birds in Ramsar areas. There have also been Environmental Education development programmes in National Parks, as well as promotion of courses in environmental management in humid zones as well as in remote sensing applied to the mapping of coral reefs in conservation units.

**Chart 2 - Areas indicated by Brazil to be included in the Ramsar List**

| Area | Location | Dimension (ha) |
|---|---|---|
| Pantanal National Park | Mato Grosso | 135,000 |
| Araguaia National Park | Tocantins | 562,312 |
| Lagoa do Peixe National Park | Rio Grande do Sul | 34,400 |
| Mamirauá Sustainable Development Reserve | Amazonas | 1,124,000 |
| Reentrâncias Maranhenses EPA | Maranhão | 2,680,911 |
| Baixada Maranhense EPA | Maranhão | 1,775,036 |
| Parcel de Manuel Luís Sea State Park | Maranhão | 45,237 |

Source: MMA - 2002

**In the same way, an Interministerial Executive Committee for the Protection of the Ozone Layer was established in 1995. A total of 178 firms had their projects approved by the Multilateral Fund Executive Committee, with a consequent internalisation of approximately US$52.4 million. Out of all those projects, 45 have been concluded, which represents a 2000 ton/year reduction in the emissions of ozone destroying substances.**

In order to meet the indispensable necessity to amplify the conservation and preservation areas in the country, Brazil has proposed to the Convention on Humid Areas (Ramsar Convention) new Brazilianhumid zones as Ramsar sites (**chart 1**). Special emphasis has been given to the insertion of the entire swamp region, which would create the necessary conditions for conservation, throughout time, of one of the most important areas of this type in the world.

### 2.2.4 Hazardous Residues and Toxic Products

Among the actions directed at the regional and global environmental protection and related to transboundary movement of hazardous residues (Basilea Convention 1989), to the control of transboundary movement of chemical products hazardous to the environment and to human health (Rotherdam Convention, 1988), and to the reduction and elimination of emissions of persisting organic substances – POP (Stockholm Convention 2001), the country has been moving towards promoting actions which may meet the common internationally established objectives.

Mechanisms as well as procedures for control and international co-operation result from these conventions and aim at reducing the generation of dangerous residues to a minimum. They also aim at guaranteeing the environmentally safe handling of trnasboundary movement of such residues, thus minimising the quantity and toxicity level of the generated residues by guaranteeing their treatment (deposit and recovery) in an environmentally safe manner and in a location next to the generating source. They aim at assisting developing countries in the implementation of such provisions.

During recent years a few legal texts have been edited in the country which deal with the regulation of the law that attributes responsibility to producers, traders and users of agrotoxic products, their return, collection and final destination of the empty packages and product remainders. The resolutions of the National Environmental Council – CONAMA are included as well and discipline the environmental management of used batteries and the adequate destination of unusable tires in the country. However, the National Residues Policy, which is responsible for several draft law moves at a very slow pace within the National Congress where its approval has been pending for years.

### 2.2.5 Conservation of Marine Environment

Since the Stockholm Convention in 1972, several international conventions have focused on the protection and preservation of the marine environment from all sources of pollution. Among these, emphasis should be given to the International Convention for the Prevention of Pollution Caused by Vessels – MARPOL. A focus on the objectives of these international agreements is the prevention, control and inspection of pollution caused by oil spills and other dangerous or hazardous substances in waters under national jurisdiction. Another highlight is the control of pollution generated directly by vessels during their cargo transportation activity or caused by the necessity to maintain their navigation conductions.

Brazil has been participating as a member-State in the main important conventions and international agreements about environmental issues that occulted in recent years. Brazil is an active participant in negotiation processes where there are no adequate international legal instruments. The external environmental policy has been occupying an important position in the set of Brazilian public policies in recent years.

## 3. Institutional Context and Legal Ordinance in the Environmental Sector

The role of the State has been changing substantially in view of differentiated political contexts throughout the last few decades. Since 1972, when the first world conference on the environment took place in Stockholm, and continuing throughout the 80s, this role has primarily been characterised as a supplier of goods and services and as a regulator of the use and occupation of the national territory. From the 90s to the present, the Brazilian State has suffered a series of re-formulations oriented not to predict but to strengthen its role as manager of a programme the implementation of wich is society's responsibility. The implied fact that these programmes integrate a set of policies whose formulation of wich is still the State's responsibility, with the participation of the society, has not always been given due consideration.

### 3.1 Legal and Institutional Ordainment

The amount of laws, decrees, provisional measures and their variations approved in the last three decades is, per se, an important indicator of significant alterations in the relationships of the State with society, the territory and the environment in the 1970s. The centralising and concentrating resources planning system used to submit other government levels to their precepts and held territorial ordainment of the country as a development condition in view of the model of nation they wished to substantiate. The strategic perspective which permeated the various policies of impact on the territory – which emanated from the federal government at that time, liased with the centralisation of the public management then being practised. This used to be refuted by legislation in categories identified as management, definition of parameters and disputes over the allocation of financial resources. The Federal Constitution of 1988 introduced deep changes in the role of the Federation with the consequent alteration of

**Chart 3 - Policies and Programmes**

| | | |
|---|---|---|
| **Environmental Management** | | |
| DECREE 73,030 | 30/10/73 | Ministry of the Interior/ Special Secretariat for the Environment |
| LAW 6,938 | 31/08/81 | National Environment System |
| Actions | | Public Interest Civil Society Organisations (defence, preservation and conservation of the environment and promotion of sustainable development) |
| | | Policy Formulation: Participation in national Councils and agencies responsible for the formulation of Policies on the Environment, Water Resources etc. |
| | | Participation in State Environment Councils and Municipal Councils For Environment Defence |
| | | Participation in the operational scope - field research, advice and implementation of environment conservation projects and sustainable development experiences |
| **National Policy on Biodiversity** | | |
| Provisional Measure 2,126 | 22/06/01 | Objective: define a national strategy based in directions and instruments in order to Preservingthe environment and the biological diversity |
| **National Biodiversity Programme - PRONABIO** | | |
| DECREE 1,354 | 29/12/94 | Objectives: (I) promote partnerships between private and public sectors to support biodiversity conservation and sustainable use; (II) develop policies, promote research, establish information networks and international co-operation, participate in instrumental and methodological standardisation, support the capacitation of human resources and the institutional development, support demonstration projects of biodiversity conservation and sustainable use . |

**Chart 3 - Policies and Programmes (cont.)**

| Actions for Regional and Global Environment | | |
|---|---|---|
| PROBIO - Brazilian Biodiversity Conservation and Sustainable Use Project | | Objective: identify priority areas, promote initiatives, disseminate knowledge on biodiversity conservation and promote the sustainable use of its elements, with equal share of the benefits from such use. |
| Brazilian Programme on Molecular Ecology for the Sustainable Use of Amazon Biodiversity, PROBEM. | | Objectives: (I) implementation of the Amazon Biotechnology Centre. - PROBEM; (II) industrial use of biological resources, specially in germoplasm, molecular biology, phytochemistry, animal venoms, insect-insect and insect-plant interaction (III) realise the potential that already exists in Brazil in this sector, focusing on bioprospection researches: short- and medium-term industrial use of pharmaceutical products (antibiotics, antineoplastic drugs, anti-hypertensive and neuroactive substances, immunomodulator) and various products (cosmetics, natural dyes, flavouring agents, essential oils, iodegradable polymers, pheromons, selective bioinsecticides and e enzimes of biotechnological interest, among others). |
| PROBEM/Amazon | | It provides the contractual participation of local traditional communities - both extractive and indigenous communities - in the activities of identification and collection of products from regional flora and fauna. It must also count on the support from governmental and non-governmental institutions from Brazil and abroad, and it is open to the participation of national and foreign researchers. |
| Brazilian Biodiversity Fund - FUNBIO | 1995 | Objective: meet the demand of an agile, transparent and long-term financing mechanisms for biodiversity conservation and sustainable use projects. |
| | | Action: Fund formation: amount of US$ 10 million of the Global Environmental Facility - GEF, managed by the World Bank, resources raised from the private sector. |
| | | Amounts and Allocations of Resources committed until December 2000 to support projects:<br>Amount from Funbio – US$ 4,384,617<br>Offset from partners – US$ 5,166,205<br>Total – US$ 9,550,822 |
| National System of Environmental Information - SINIMA | | Objective: sistematise the necessary information to support environment decision-making processes allowing for quick recovery and updating, as well as international resources and service sharing at the level of the Environment National System |
| LAW 9,985 | 07/18/00 | Brazilian Parks - objective: co-ordination and integration of protected area management efforts at federal, state and municipal levels, carried out by the Conservation Unit National System - SNUC |
| LAW 8,974 | 01/05/95 | Biosafety - The genetically modified organisms - GMO - are the object of an intense debate In international scientific, environmental, agroindustrial and trading communities. The negotiation process of a Biosafety Protocol to the Convention on Biodiversity is in progress. It aims to establish an international regime for the transboundary movement of those organisms. |
| DECREE 1,752 | 12/20/95 | |
| LAW 8,171 | 01/17/91 | Agricultural Policy and Environment - Objectives:(i) integrate at Federal Government level the States, the Federal District, the Territories, the Municipalities and the communities in environment preservation and natural resource conservation; (ii) discipline and inspect the wise use of soil, water, fauna and flora; (iii) carry out agroecological zonings that allow to establish criteria for occupation disciplining and spatial ordering by the several productive activities, as well as for the installation of new hydroelectrical plants; (iv) promote and/or stimulate the recovery of areas in a desertification process; (v) develop environmental education programmes at formal and informal levels that are targeted to the population; (vi) promote the production of native essence seeds and sprouts; (vii) co-ordinate programmes to stimulate and incentive the preservation of water springs and the environment. |
| LAW 9,605 | 02/12/98 | Law on Environmental Crime |
| LAW 9,608 | 02/18/98 | Voluntary Work |
| LAW 9,637 | 05/15/98 | Conception of "social organisations" (activities related to teaching, scientific research, technological development, environment protection and preservation, culture and health) |

the previous centralising management trend and inevitable strengthening of decentralising management forming a country/society consortium (Carvalho 2001).

Under the view of sustainable development, the environmental management in Brazil relies on inadequate instruments to achieve the objectives of environmental policy. The command and sectorial control principles have prevailed, and this has occurred many times in detriment to principles of integrated management and to the use of adequate economic instruments (**Chart 4**).

**Chart 4 - Natural resource legislation**

| Ordenamento dos Recursos Naturais | | |
|---|---|---|
| Water Code | 10/07/34 | National Department of Waters and Electrical Energy |
| Mining Code | 29/01/40 | National Department of Mining Production |
| Forest Code | 15/09/65 | Brazilian Institute of Forest Development |
| Hunting Code | 03/01/67 | Brazilian Institute of Forest Development |
| Fishing Code | 28/02/67 | Fishing Development Agency |

The control, management and planning instruments established by Law 6,938/81 are limited to the sphere of the State environmental sectorial agencies. This reinforces the sectorial character of the environmental management practised in the country and presents results which are limited specially in combating industrial pollution. There is even questionable efficiency.

The responsible institutions for the environment have very little control over concrete problems generated by public sectorial agriculture, industry, urban development, mineral exploration, forest resources and other infra-structure policies in general. The environmental management practices are many times limited to damage repair, such as reforestation, recovery of degraded areas, reconstruction of urban environments, restoration of natural habitats and rehabilitation of conservation units and ecological sanctuaries (IPEA 1997).

At present in Brazil, the population lives mostly in urban areas. Therefore, urbanisation is an irreversible process intrinsically associated with the current development model. The pressure that the concentration of people and activities exercise over the space and the natural resources basis is rather substantial. The condition of the urban environment expressed in the quality of the water, air and soil, and the impacts of this process, specially over the health and quality of life of the population, all require responses which encompass both protection and recovery of the natural environment as well as reduction of deep social inequalities in the production of environmental goods and services.

### 3.1.1 Decentralisation, Municipalisation and Globalisation

A strong trend which emerges from the dynamic territorial occupation in the country points to strengthening the complexity and fragmentation in the use of the Brazilian territory. It also points to the direction of the risks originating from the deepening of the inequalities which derive there from. Indeed, according to "Furtado" (1992), from the moment the growth motor stops forming the domestic market in order to integrate the international economy, the synergy effects generated by the inter-dependence of the distinct regions in the country disappear, thus considerably weakening the links of solidarity among them.

In this sense, one of the great challenges nowadays has to do with the limitations of the regulating capacity of the national State over society, the economy and the territory in a globalised world in which people already live with a number of factors that make the national sovereignty hazy. Maintaining internal cohesion and amplifying social democracy through participative management of society over the territory and its resources seem definitely to be themes that are already being entered in the political agenda of the country in the 21st Century.

The governmental guideline towards decentralisation has been requiring significant changes in the policies and programmes of development and management of the national territory. Law 9,433, the Waters Law, determines that "the management of water resources must be decentralised" (Article 1,VI), and adequate to the "physical, biological, demographic, economic, social and cultural diversities of the several regions in the country"(Article 3,II), and linked ofsoil use management (Article 3,V).

Within the decentralisation issue lies the perception, ever more conscious and politically recognised, of the enormous dimension of economic development. This perception, therefore, includes the inherent characteristics of each space as determinant elements elements of the reduction or increase of differences among the regions and their diverse social groups.

The mentioned process of decentralisation of political management of the territory, when accompanied by the necessary spatial concentration of economic activities enables the gradual consolidation of a new territorial dynamic and of sub-spaces thus configured in the less industrialised regional economies. In this context, once more, new challenges are presented by the growing alliance of regional economies with the international, commercial and financial circuits. These alliances are stimulated by world globalisation phenomena and by the formation of international blocs and result in a new territorial fragmentation within national boundaries. A return to the "archipelago", an image frequently used in order to characterise the Brazilian territorial dynamics before 1950.

### 3.1.2 Municipalization and Globalization

The administrative decentralisation desired by the country holds the strengthening of the municipality as a pre-requisite. The transfer of responsibilities, mainly in the areas of education, health, basic sanitation and transportation, among others, without the resources needed to carry them out, may stir up the social, economic and environmental inequalities among the municipalities, who may or may not be financially able to cope with these new functions.

Consequently, this reality presents new challenges which require the formulation of indicators and appropriate policy instruments, linked among themselves and oriented towards a common purpose for social, economic and sustainable environmental development and for integrated territorial management.

Where means for transboundary integration of productive chains prevail, the national market has been reducing its power to explain the dynamic behaviour of production and goods distribution. The institutions in charge of the environment have very little control over the problems generated by sectorial public policies related to agriculture, industry, urban development, mineral exploitation, forest resources and infrastructure work in general. Environmental management practices are often limited to damage correction, such as reforestation, restoration of degraded areas, reconstruction of urban environments, restoration of natural habitats and restoration of conservation units and ecological havens (IPEA 1997).

Nowadays, as the majority of the Brazilian population lives in urban areas, urbanisation is an irreversible process. Urbanisation is intrinsically associated to the development model in place. Concentrations of people and activities exert pressure on space and natural resources. The current state of the urban environment in terms of water, air and soil quality and the impacts caused by this process, specially on the population's health and standard of living, call for responses that address both protection and recovery of the natural environment regarding the reduction of wide social gaps in the production of environmental goods and services.

Likewise, the notion of limits as a dividing line between territories and national markets has lost a lot of its power due to the fluidity of the international circuits of goods and capital. Consequently, this power has now been transferred to the multinational companies who are able to define their respective areas of influence through economic mechanisms.

In this sense we have seen the rising of the industrial clusters system. Today, the Belo Horizonte metropolitan area is the largest Latin America biotechnological centre. In the south of the State of Minas Gerais electric-electronic important industrial centres are being developed, such as in Santa Rita do Sapucaí. In the “mineiro” triangle, Uberaba and Uberlândia are outstanding because of their agro-industrial complex. The Minas Gerais state organization relied for many years on the balance between the forces historically exercised by the central region and the forces which enabled the state’s opening to the remainder of the Brazilian regions. However, a trend to spread out is quite noticeable as we observe the South being integrated in the dynamics of the Rio-São Paulo axis. The “mineiro” Triangle is absorbed by the dynamics from São Paulo. The Northwest turns itself to Brasilia. The North and Northeast regions are the only ones which actually remained linked due to their economic dependence on the central region.

## 3.2. Public Participation in Environmental Management

The new view of public policy that has been incorporated in Brazil is a very relevant aspect of the change in the course of environmental management in the country. This new view is based on decentralisation of responsibilities and procedures and also on solidarity in enterprising practices. These practices are still in their beginning stages, but are being stimulated.

Advances in environmental management in the country have also been made in terms of the participation of social sectors, particularly in urban areas, through committees, co-operatives and community councils. The following subjects have brought these movements together: water resources, solid residues and environmental protection areas. Water basin committees unite distinct social participants and lead to the expansion from a local to a super-local scale. These committees also lead to the management of multiple interests regarding the use of water.

In this sense, the National Policy on Water Resources (Law 9433 of 1998) has already become a milestone in the construction of a new code of ethics in the traditional relationship among the State, society and the nation’s territory. Its effects and impact on the regulation of other user sectors, not only waters but also, for obvious reasons, soil as well, are still in a beginning phase. The same can be expected regarding the enforcement of Law 9985 of 2000, which established the National System of Conservation Units and brings innovations to the pre-existing arrangements regarding the management of the territory. (CIORD/UnB 2001).

Participation initiatives have reached significant levels with the population and have been recognised by public agencies. This takes place through consultation on management processes or when construction work is being carried out. These are processes that require constant improvement.

The natural resource and ecosystem management boards are normally based on parity. They make room for the incorporation of the contributions made by the community in several ways. Public-private partnerships are included and have made the improvement and conservation of natural and cultural heritage possible.

### 3.2.1. Environmental Education and Training

In the first place, Brazilian priorities in this area were based on the formation of critical masses in order to make the subject a part of the educational system and to implement Environmental Education programmes on a large scale.

In 1977 the environment theme was first included in basic and secondary education curricula all over the country. From then on, Environmental Education became increasingly important in the school system and communication media, and it gained a place in training programmes at universities and research centres.

In 1999 the curriculum was reinforced with the creation of the Policy and the National Environmental Education programme, carried out by the Ministry of the Environment and guided basically toward non-formal education. Its purpose, among other functions, was to create environmental education centres in the country aimed at disseminating “good practices” and making the participation of society in environmental management even greater.

Because of these actions, concern for environmental matters in Brazilian society has experienced a great and healthy increase. This has been due to several factors. The following stand out: effort on the part of the government in the area, action of the communication media and opinion formers, increase in perception on the part of urban masses regarding the losses, risks and discomfort brought about by environmental degradation. There has also been pressure from the international community concerning the control of activities that generate an impact and potentially contribute to a loss in quality of the global environment and in the development sustainablility.

The offer and the democratisation of access to environmental information in Brazil have both expanded rapidly. These elements have benefited from the development of research, the creation of content and the dizzying evolution of microelectronics. This technology of systems and communication is represented by the Internet, which promoted the integration of communities of users and producers of information on a global scale.

Environmental communication through printed materials is also growing in Brazil. There are several publications linked to non-governmental organisations. Others are independent, and a great number of these publications is linked to the Brazilian Environmental Journalism Network – RBJA, which has contributed towards integration among communicators all over the country. This makes it possible for agendas, sources and information to be exchanged, and it allows for the incorporation of new communicators into the area.

## 3.3. Management Tools

During the 90s, new tools were acquired for environmental management. In the current global market context, some argue that economic tools tend to be more effective than command and control tools. Those that criticise this view say that the set of economic tools is insufficient to assess the environmental issue and to define frameworks.

### 3.3.1. Economic Tools for Environmental Management

In regards to the use of economic tools in the management process, current thoughts in the technical field regard economic tools as being a way to make a sustainable policy for the use of natural resources and territorial organisation possible. Economic tools – taxes and fees, a system of environmental rights negotiable in the market, a system of certificates of rights to pollute, a system for deposit-reimbursement, subsidies for environmental projects – allow for the incorporation of environmental costs into production and consumption costs. They also stimulate the reduction of costs on environmental control, and lead to technological changes which are compatible to sustainability. The President's Office and the Ministry of the Environment, together with the five federal public banks and the Ministries of Agriculture, Planning, and Finance launched the Green Protocol programme in 1995/6. Its main objective is the inclusion of the environment variable in the concession of public credit. This programme is among the most emblematic initiatives of the Brazilian Government in terms of management tools for sustainable development, and is one of the most outstanding. It is a document containing guidelines, strategies, and operational mechanisms for the inclusion of the environmental variable in the process of management as well as for the concession of official credit and tax benefits to productive activities.

Issueing environmental securities negotiable in the market is a controversial issue in Brazil and abroad. It generates fierce discussions. This is the case, for example, of the Kyoto Protocol – Convention on Climate Change, in which clauses were included that allow a country whose emissions have increased to buy "emission rights" from another whose emissions were kept below the generation level observed in 1990. Thus, there is a surplus.

According to the Ministry of the Environment, during the elaboration of the bases for discussion of the Brazilian Agenda 21 "these tools assume credibility, trustworthiness, and stability in environmental policy, as well as a decentralised system for planning and decision making which is able to react flexibly when faced with the multiple and complex changes of reality in progress." (Ministry of the Environment/UNDP 2000)

### 3.3.2. Industries and Clean Technologies

Regarding business actions and greater environmental responsibility in the private sector, there is an observed growth in the use of clean production technologies that minimise the generation of residues and the emissions and effluents released into the environment. The social responsibility of private agents is also a demand which is present in the current development process. The increase in environmental demands on the part of the consumer market world-wide has lead national companies to adopt conducts that follow patterns in the dispute for room in international trade.

The industrial consumption of water and the impact of the contamination of water resources, significant in the 80s, have shown positive changes due to the need to reduce production costs and energy consumption. This has occurred as well due to meeting legal demands and adaptating to market requirements.

The implementation of an Environmental Management System within companies represents the adoption of a tool capable of generating differential quality in internal and external markets. This happens in an effort to improve the quality and performance of activities linked to the environmental issue, through the incorporation of the respective costs.

Regarding environmental certification, the number of companies that have ISO 14000 certifications in Brazil went from two in 1995 to 330 in 2000. This number may still be considered low when compared to the total number of companies, potentially polluting or not, in the country.

In relation to meeting the requirements of the Polluting Activity Licensing System, some of the large potentially polluting companies in the country have begun restructuring so as to make environmental issues a part of their decisions and business strategies. This implies the adoption of new procedures such as holding periodic environmental audits and designating resources to control and operational improvement large programmes.

### 3.3.3. Public Investment and Environmental action

The significant change in the focus of development policies in the country, from developmental to environmental, brought about profound changes. These changes were not only institutional as in territory planning and management. Changes also occurred in the criteria for investment in the economic and social infrastructure. Resources offered for investment in environment preservation multiplied at the same rate that investments made in urban infrastructure, like sanitation, decreased.

Some lines of financing and support to governmental investments and programmes have been created, directly or indirectly linking the environmental area (agendas: green, blue, brown and social). Thus, investments and programmes in essential areas such as basic sanitation, popular housing, and urban transportation start being created with the inclusion of the environmental issue. However, they are not necessarily linked to economic development programmes.

The National Fund for the Environment – FNMA, created in 1989 (Law 7.797/89), is one more financing tool for projects. It is important for the decentralisation of the environmental policy in the country once it has a wide reach and sufficient flexibility to include municipal proposals. This is important in linking the plans of public administration, NGOs and society. The Environmental Crimes Law (Law 9.605/1998) previewed the designation of a percentage of the resources originating in fines and infractions of the FNMA, just as the growing petroleum exploitation in the country has guaranteed the investment of royalties in environmental projects in primary and secondary production zones.

On the other hand, the Brazilian Fund for Biodiversity – FUNBIO has supported projects for the conservation and sustainable use of biodiversity. This fund was created in 1995 with an amount of US$ 10 million from the Global Environmental Facility – GEF and is administrated by the World Bank and joint resources from the private sector.

Correcting the effects of environmental degradation on people's health and on the survival and integrity of environmental resources that are essential to human life usually involves high costs. The programmes for depollution and environmental sanitation that are in progress or that were carried out involve answers that represent substantial investments and long financial operations with international financing agencies (BID, World Bank, among others) and international co-operation organisations. This has been true specially in the last decade, in various metropolitan regions in the country. They affect an equal proportion of populations in several regions in the country.

## 4. Sectorial Policy Responses and Activities

During the creation and implementation of sectorial public policies, the environmental issue becomes concrete in the form of the adoption of the unit of water basins as the jurisdiction for planning and managing conflicts regarding their multiple uses.

When the concept is broadened, it shows that the effects of pollution and degradation on human life are comprehensive. This makes them important variables to be considered when decisions are made on where polluting economic activity is to take place, on the use of water resources as sources of supply or receivers of effluents, on the technology to be adopted for the implantation of sanitation projects, and on the universe of people to be attended to.

Regarding the environmental policy related to the mineral sector, the Ministry of the Environment created public policies that were compatible with the principles of sustainable development in 1997. Several programmes were presented, and their objectives are shared by individuals who work in the mineral sector. These objectives included monitoring, the creation of economic tools and mechanisms for self-regulation. The need for identifying the main areas suffering impacts and the respective diagnoses defining current and potential risks was also identified.

In the sphere of the states of the federation, supplementary policies have been gradually introduced in different ways. This aims at filling existing gaps and establishing guidelines for the protection and recovery of degraded areas, the protection of palaeontological heritage, and for demanding previous licensing for mining activities. It is important to say that this public action is the result of a great deal of involvement on the part of the government and society.

In municipalities, this concern is shown through the elaboration of environmental protection codes and through the creation of municipal councils with the same purpose. These councils deal with issues linked to the mineral sector.

The pressures and impacts resulting from the use and abuse of the territory and its natural resources are some of the situations that the Brazilian government and the society have tried to face. These attempts, however irregular and fragmentary, have been made through a series of policies and sectorial programmes that will be presented in this section.

## 4.1. Biodiversity Responses

**On September 28, 2001, the Brazilian Government established that provisional measure by means of a decree. On February 21, 2002 tne Government created the Generitc Resources Management Board through Decision no. 69. The board operates under the Ministry of the Environment and recieves inputs from several government agencies. The Board´s goal is to regulate acess and uses the genetics resources. By establishing the Board, the Government ignored a draft law that was under consideration by the scientific community and by the Lower house of the National Congress in Brasília. The Deree of September 2001 goes into much detail to regulate the access to and availability of genetic resouces for scientific research purposes. Howver, its coverage of business access to genetic resources is quite poor. This became a responsability of the Board. The Government is still working on the regulation of the use of genetic resources in Brazil, but there is little hope that the measures adopted by the government will match the concerns of society and the scientific community. This are continues to be weak and poorly supported both from the technical and legal point of view.**

Over the ten years that have elapsed since the United Nations Conference on Environment and Development took place in 1992, there have been noticeable advances in the knowledge base of Brazilian diversity. From 1992 to 1997, initiatives to identify and catalogue existing species were carried out both at local and national levels. Some of these were spontaneous, such as scientific meetings (Bicudo & Menezes 1996) and the registration of specialists by scientific societies (SEB & SBE 1994). Others were promoted by NGOs or governmental organisations or sectors, several of which were created as a response to the Biological Diversity Convention. This happened either at federal level (Probio) or at state level, with the Biodiversity programme of the State of São Paulo, for instance.

The World Conservation Union (WCU) recognises the need to preserve biodiversity on three levels: genetic diversity, species diversity, and ecosystem diversity. Genetic diversity is essential for species to endure because it allows for their adaptation to environmental change. This diversity is strategic to man in areas ranging from medicine to the production of food. The maintenance of genetic diversity is fundamental for long-term conservation of ecological communities. Several ecological processes, from the extinction of a species to the existence of highly diversified taxonomic groups, intimately depend on genetic diversification within and among species. This is what sustains biological diversity.

Brazil has adopted a few strategies in the past 10 years for the protection of biodiversity on the three levels mentioned above. The ones presented here are the advances in legislation, planning, and programmes for the management of species and recovery of native vegetation.

### 4.1.1. Advances in legislation

The accelerated loss of biodiversity and the adoption of measures to protect it are connected to the creation of public policy and tools for intervention (Leitão et al. 2002). Among the existing policies and public tools for intervention, three are directly linked to the maintenance of native forest coverage and, consequently, to the in-situ conservation of biodiversity. These are the National System of Conservation Units – SNUC, the Forest Code, the National Forest programme – PNF, and the Environmental Crimes Law.

Perhaps the area that has advanced the most is legislation, in the wake of of the Constitution of 1998. It deals specifically with the protection of biological diversity and genetic resourses in article 225. The most significant changes in legislation are described below:

a) **SNUC Law – National System of Conservation Units**
Law no. 9.985 of the 18th of July, 2000, which established the National System of Conservation Units – SNUC, was a major accomplishment for the environment in the country. The law organises and updates the

criteria for the creation and management of conservation units, thus establishing means and encouranging effective participation of society. The process becomes more democratic with the ultimate purpose of showing the Brazilian society understand how valuable these areas are and decide to ensure their protection once and for all. However, the draft law for SNUC was discussed in the National Congress for over eight years, and it has not been regulated yet. This shows that the government does not consider this tool to be a priority.

**b) Environmental Crimes Law**

Environmental Crimes Law no. 9605, of the 13th of February, 1998, was considered an important advance toward the conservation of nature in Brazil. The new law provided the Brazilian legal system with well-defined penalties and sanctions in a clear and objective way. It turned most actions that were previously considered infractions into crimes. This includes those contained in the Forest Code and other legal documents. It corrected distortions in the Hunting Code and established the penal responsibility of corporations for environmental infractions committed according to decisions made by their legal or contractual representative or by the board in the interest or for the benefit of their organisation.

**c) Biosecurity Law**

Law 8.974 of January 1995 established the guidelines for the control of activities and products resulting from modern biotechnology and created the National Technical Biosecurity Commission – CTNBio, aiming at developing a national biosecurity policy and establishing rules and regulations concerning the activities involving genetically modified organisms (GMOs). CTNBio is linked to the Ministry of Science and Technology and made up of 36 members from the academic community, federal government, business sector, consumer protection departments, and the organisation for the protection of workers' health.

The Biosecurity Law establishes that supervising and monitoring activities involving GMOs is a responsibility of the supervision departments in the Ministry of Health, the Ministry of Agriculture, and the Ministry of the Environment within their scopes. Issuing registration for products to be marketed or released into the environment containing GMOs and their derivatives is their responsibility too. In this way, besides the usual control that products made through other technologies are subject to, genetically modified (transgenic) products will be subject to additional control by CTNBio regarding the biosecurity aspect. Despite the fact that its modern format should favour exemption, CTNBio almost always works with partial perspectives considering the risks of releasing GMOs into the environment. There are no independent studies on the ecological impact of GMOs being carried out in Brazil, and access to experimental crops is restricted by the Company that holds the patent on the organism planted.

**d) Genetic Heritage Management**

Up until the year 2000 there was no regulation on the law regarding access to the genetic resources of national biodiversity. Due to pressure from society and events that seemed to uncontrollably lead the country into bioprospecting that was harmful to national interests. The government took on a drastic course of action and issued a provisional measure (no. 2.186-16). This blocked access to any kind of Brazilian fauna or flora as a genetic resource. This measure further restricted scientific development in the area even more. Research and international co-operation stopped, which resulted in an involuntary and pernicious xenophobic process.

### 4.1.2. Advances in Planning

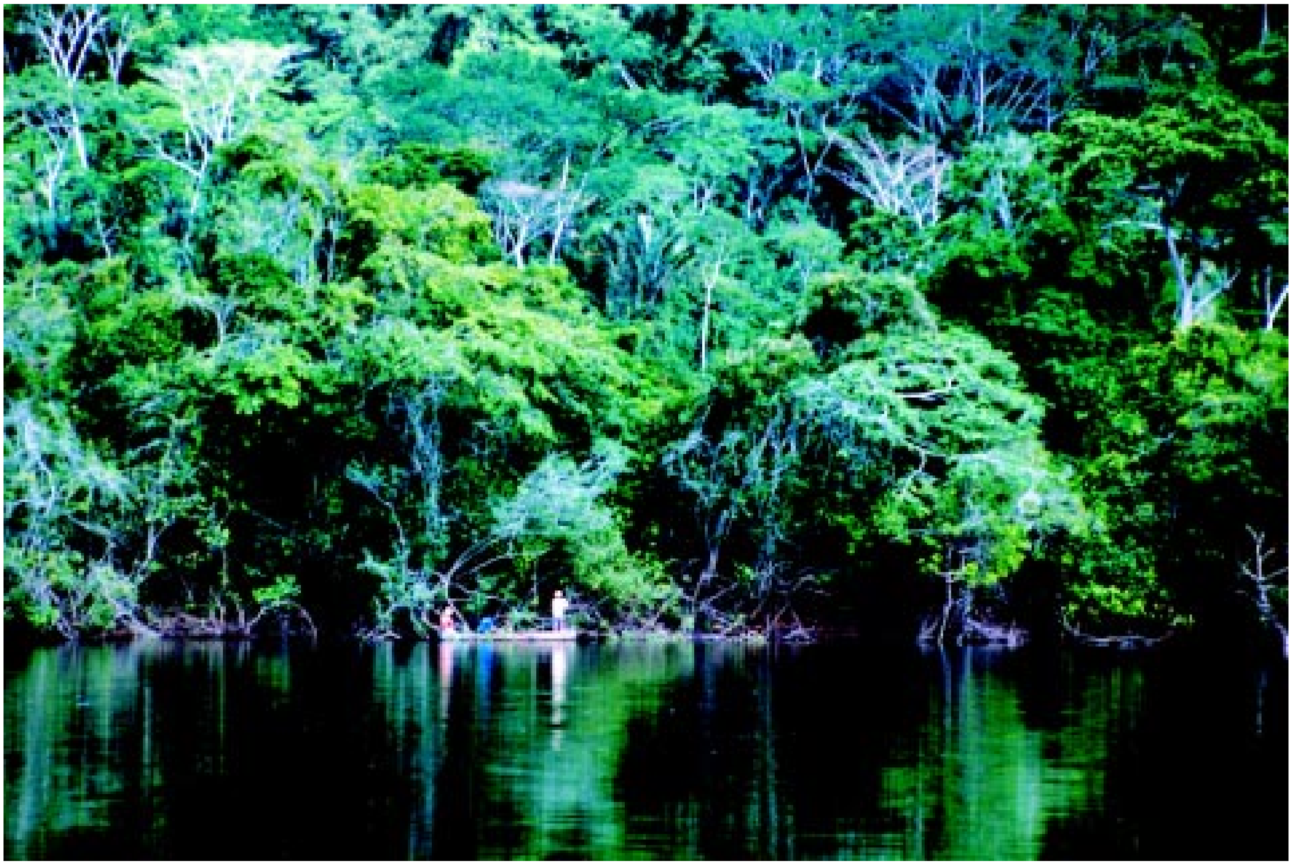
Experience has shown that the maintenance of "viable" portions of natural environments has taken place only in areas destined to the protection of natural resources, that is, in conservation units. Thus, it is very important to include the environmental variable in regional planning, and it is also important to strengthen the existing system of conservation units and to propose the creation of new units in areas of great biological importance.

Studies carried out in natural environments warn about the danger of extinction of species and ecosystem imbalance in isolated environments that underwent a drastic reduction in size. These studies show the need for making up a mosaic of natural environments free of human presence and also for promoting the connection of the remaining natural vegetation. These actions theoretically make it possible for the area available for the survival of native flora and fauna to be enlarged, thus guaranteeing ecosystem balance in the long run (Herrmann, 1999).

### 4.1.3. Identifying priorities for the conservation of biodiversity

In order to fulfil the country's obligations to the Convention on Biological Diversity and aiming at gathering subsidies for the elaboration of the National Strategy for Biodiversity Conservation, the Ministry of the Environment held a variety of workshops (subprojects) where the biological richness of each Brazilian biome and their socio-economic conditioning factors were evaluated. This happened through the project "Conservation and Sustainable Use of Brazilian Biological Diversity" (Probio). Important proposals that have been utilised for guiding new actions for the conservation of biodiversity in the country were elaborated as a result of these workshops.

Five subprojects were carried out so as to involve all of the Brazilian biomes. In March, 1998 a workshop was held in order to define priorities for conservation in the biomes of Cerrado and Pantanal. After that there was a subproject for evaluation of the Atlantic Forest and the Southern Fields in August, 1999; of the Amazon in September, 1999; of the Coastal Marine Zone in October, 1999; and of the Caatinga, in May, 2000. As a result, 705 areas were given priority. 182 were Atlantic Forest and Southern Fields areas **(www.conservation.org.br/ma/index.html)**. 87 were Cerrado and



Pantanal areas **(www.bdt. fat.org.br/ workshop/cerrado/br)**. 57 were Caatinga priority areas **(www. biodiversitas.org/caatinga)**, and 379 were priority areas for the conservation of the Amazon **(www.socio ambiental.org/web site/bio)** In addition, there are coastal environment areas that are still being organised **(www.bdt.org.br/work shop.costa)**.

The workshops were developed through associations between non-governmental organisations, governmental agencies, universities, and research institutions. It is a milestone in the integration of these different institutions.

As a result of the Cerrado workshop, efforts are being made in order to increase the protected area in the Cerrado by 46% through the creation of new conservation units. The creation of the Serra Geral do Tocantins Ecological Station, with an area over 700,000 ha, the expansion of the Chapada dos Veadeiros National Park, and the implementation of the Cerrado-Pantanal Ecological Corridor are actions that are already in progress.

Important actions for the implementation of the areas and activities prioritised by the Probio workshop are also in progress in the Atlantic Forest. The creation of the Descobrimento National Park and of the Pau Brasil National Park and the actions for the implementation of the Atlantic Forest Central Corridor have already become reality. The creation of the Serra da Bodoquena National Park, in Mato Grosso do Sul, and that of the Restinga de Jurubatiba National Park, in Rio de Janeiro, are also a consequence of the results of the workshop.

Priority areas are also being used by IBAMA and by non-governmental organisations to guide the creation of ecological corridors all over Brazil. This happens through partnerships with local organisations, universities, and research institutions.

### 4.1.4. Incentives To Research

The greatest risk for most species is becoming extinct in total anonymity. This is true not only for invertebrates but also for groups of plants and vertebrates that are harder to study. There are certainly thousands of small, inconspicuous species that exist in very special habitats and/or in very small geographic areas. It is clear that in Brazil, as well as in other countries with a huge diversitythe continuous work of gathering, recordig, studying and describing new species is doomed to failure in the race for species that disappear due to loss of and change in habitat.

The most promising actions to complement lists of species are studies that establish co-relations between the diversity of different taxon species and the length, place, characteristics and level of integrity of different ecological units. These include habitats, ecoregions and biomes. Extensive inventories with a large number of survey items will be an indispensable tool to establish these co-relations. In response to this demand the programme for the Conservation and Sustainable Use of Brazilian Biological Diversity (Probio) issued a document for the development of biological inventories in priority areas on which scientific knowledge is still lacking.

Other important conservation initiatives have been developed in the country based on other prioritising methods that identified the richest and most endangered regions of the planet, the so-called hotspots (*Myers et al*. 2000). It is important to point out the creation of the Critical Ecosystems Partnership Fund (CEPF). The CEPF resulted from an alliance between the World Bank, the World

Fund for the Environment, Conservation International, and the MacArthur Foundation. Its purpose is to invest on strategies for biodiversity conservation at hotspots. In Brazil, the Critical Ecosystems Partnership Fund is already acting in the Atlantic Forest and should soon also include the *Cerrado*. Undoubtedly, these are extremely positive measures for the conservation of biodiversity.

### 4.1.5. Managing and Recovering Fauna Species

In Brazil there are official managing programmes that comprise seven species of turtles, five species of birds and 26 species of mammals (**Annex** 3). Some of these programmes are *in situ* projects or conservation and research centres linked to the Brazilian Institute for the Environment – IBAMA. They emphasise monitoring and recovering natural populations. These are:

- The Neotropical Otter Project
- The Brazilian Humpback Whale Project
- The Spinner Dolphin Project
- The South Coastline Marine Mammals
- The Red-Browed Parrot Project
- The Manatee Project
- Research Centre for the Conservation of Wild Birds - **CEMAVE** (*Centro de Pesquisa para a Conservação de Aves Silvestres* ). This includes the Lear's Macaw Project.
- National Centre for Research, Conservation and Management Aquatic Mammals
- National Research Centre for the Conservation of Natural Predators – **CENAP (***Centro Nacional de Pesquisa para a Conservação dos Predadores Naturais*)
- Center for the Conservation and Management of Reptiles and Amphibians – **RAN (***Centro Nacional de Conservação e Manejo de Répteis e Quelônios*). This includes the National Centre for the Conservation and Handling of Chelonians in the Amazon.
- National Center for the Conservation and Handling of Sea Turtles –**TAMAR (***Centro Nacional de Conservação e Manejo das Tartarugas Marinhas*)

The level of consolidation of these centres and projects varies. The most successful experiences combine conservation and involvement on the part of the community and are managed through partnerships between the government and non-governmental organisations (NGOs). There are some excellent examples such as the TAMAR Sea Turtle Project, *Red-Browed Parrot, Gold Lion Tamarin, and Black-head Lion Tamarim*. However, long-lasting experiences with significant budgets amount to fewer than ten. The main limitation is lack of resources. All of these projects are the result of considerable material and human investment for Brazilian standards. This investment has to continue for a long period of time. In addition, since these projects depend on sponsorship and on the involvement of society, they will always be restricted to species that draw public attention.

The other action on the part of the Brazilian Institute for the Environment - IBAMA – regarding conservation management is the creation of Committees and Project Groups to elaborate official plans for management and research, propose regulations and carry out activities for the recovery of endangered species. Currently there are Committees for Spix's Macaw, for Lear's Macaw and for six species of primates. There are Project Groups for the Amargosa or Pomba-Arribaçã, for aquatic mammals (49 species), small felines (six species) and canines (six species) (Ministry of the Environment 1998; Fonseca 1999).

The Plans for Reproductive and Conservationist Management of Endangered Species are the most comprehensive initiatives for *ex situ* management of fauna in Brazil. They are developed by networks of zoos, breeding facilities, universities, non-governmental organisations (NGOs) and governmental agencies. The objectives of the plans are the maintenance of self-sustainable captive animal

populations, the maintenance of the genetic diversity of species, and providing support to re-insertion programmes. The main activities have included recording and monitoring ofcaptive animals, integrating inter-institutional actions, and researching technology for breeding in captivity. Currently, Brazilian institutions either manage lead or participate in these programmes aiming at the conservation of two species of reptiles, ten species of birds and eighteen species of mammals.

In sum, the most important programmes for the management of animals in Brazil include a few successful experiences, but they still include a very small part of the fauna. This is true even when considering species officially recognised as being endangered. The main reason for this situation is lack of financial resources. Therefore, it is a paradox that there has been substantial governmental investment to rescue animals from areas flooded by hydroelectric plant reservoirs in the last decades. Each of these operations collects and transfers from dozens to hundreds of thousands of animals generally without prior evaluation regarding the feasibility of the operation and follow-up. A single operation cost US$ 30 million[1], seventeen times the annual budget for the *Tamar* Sea Turtle Project, or 200 times the cost of the Lear's Macaw Project (Ministry of the Environment, 2000e). Most specialists condemn these programmes. They consider them to be innocuous or even harmful for animal conservation. Thus, although more investment is necessary, a more rational use of the resources available would result in a great deal of progress in the programmes for management and conservation in the country.

### a) Control of Exotic Species Considered Harmful For Environmental Balance

Control of exotic species is very difficult due to Brazil's continental dimensions and lack of financial resources. The costs are too high for a developing country. A single eradication programme comprising a restricted area will cost around US$ 9 million. The programme for the eradication of the carambolae fruit fly, co-ordinated by the University of São Paulo (USP – Universidade de São Paulo), has already spent US$ 5 million, and an other estimated US$ 4 million will be necessary for it to be concluded (Folha de São Paulo Newspaper, 2001). Currently, the greatest governmental plan for controlling exotic species is the plan to combat dengue. It estimates US$ 180 million in costs to combat the vector of the disease (*Aedes aegypti*) for the 2001-2002 period (National Health Foundation 2001). However, according to an evaluation performed by the Ministry of Health, this investment will not be enough, and complete eradication of the mosquito in the country is not yet possible (Estado de São Paulo Newspaper 2002).

Prevention is a better alternative than control and mitigation. Brazilian legislation made an important progress in this field in the last fifteen years. Annex 2 of this publication, which refers to the compilation of federal legislation related to the various subjects dealt with in this report, presents the current federal legislation regarding the control of exotic species and introductions of any kind in nature. The Hunting and Fishing Codes (1967) already prohibited the introduction of

**In many hydroelectric power plants in Brazil, the fauna that would have drowned in the reservoirs was rescued beforehand. The best documented case is that of Tucuruí, in the state of Pará, where the reservoir flooded 285,000 hectares in the Amazon Forest. While it was being filled, a team of 611 people captured approximately 280,000 animals, which were then released randomly in four different areas around the reservoir. The total cost of the operation was US$30 million, and there was no subsequent follow-up on the animals rescued. Even without a proper assessment of the survival rates among the rescued animals, the scientific community is extremely sceptical as to the efficacy of such operations. They claim that the animals are stressed and weakened by the whole situation, and have few chances of surviving in an unknown area. Besides, those that survive will represent an abrupt population increase in the areas where they are released, with the consequent increase in competition, predation and diseases, not to mention a possible lack of food resources. Finally, many of those species have a clear social organisation and will not survive unless they find their own groups again, or else manage to join a new group, which are both highly improbable events. These rescue operations represent some of the highest management investments ever made in Brazil. The rescue costs in Tucuruí alone correspond to 60% of the total costs of all 6,300 research projects funded by the National Council for Scientific and Technological Development - CNPq in 2000, or to 17 times the annual budget of the TAMAR Project.**

Sources: Ferreira M.N. & Gribel R. 2000. O impacto da hidrelétrica de Tucuruí sobre os mamíferos terrestres. pp. 91-95 dos Anexos In: La Rovere, E.L. and Mendes, F.E. *Tucuruí Hydropower Complex, Brazil*, A WCD case study prepared as an input to the World Commission on Dams, Cape Town. Versão on-line em http://www.damsreport.org/docs/kbase/studies/csbranxb.pdf; Duarte J.M.B. 1999. Relocação de fauna no Brasil: Necessidade, Ignorância ou calamidade? Anais do Seminário da Secretaria do Meio Ambiente de São Paulo. SMA/SP, São Paulo; home-page do CNPq (www.cnpq.br).

species without an authorisation from proper authorities. Specific restrictions with the objective of protecting biodiversity came twenty years after that. This happened through the prohibition of caiman alligator breeding outside its natural environment (Brazilian Institute for the Environment regulation 3284/87, Annex III) and of African catfish breeding in the Amazon and Paraguay water basins (Brazilian Institute of the Environment R egulation 142/94).

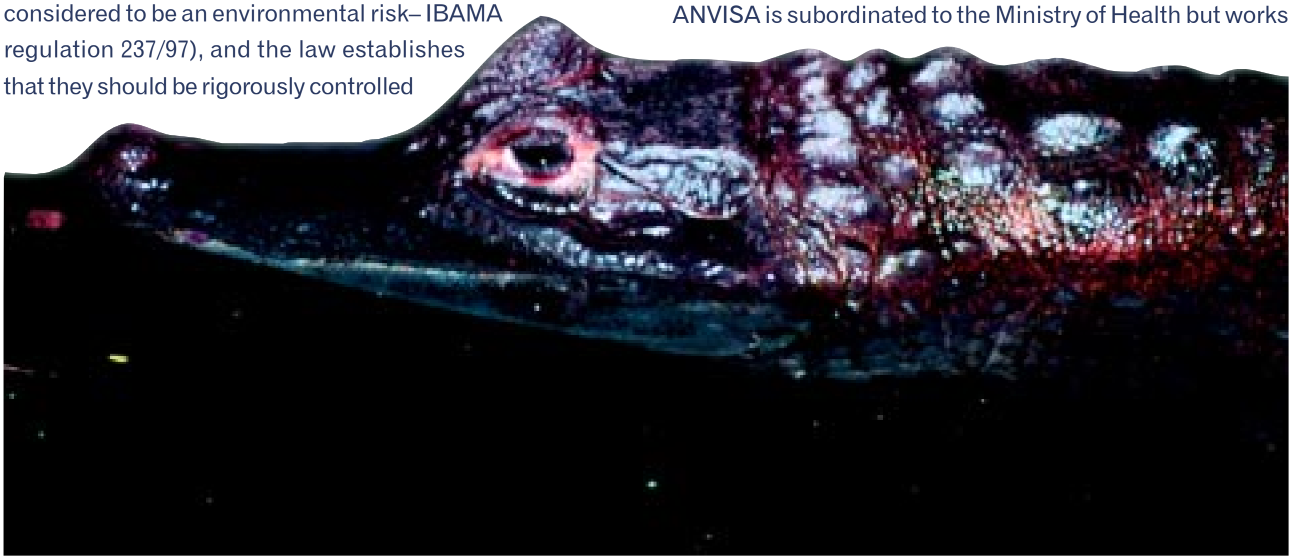
The main response to the problem results from drastic change in the national policy for the environment. In accordance with the Convention of Biological Diversity, this policy started regarding exotic species as a threat to biodiversity. As a consequence, in the last decade the country established rigorous legislation for the restriction and control of activities that might bring exotic species into the country. The following regulations stand out:

- Bringing animal species into the country and importing aquatic species without authorisation from the responsible agency are now environmental crimes (Law 3179/99);
- The importation and breeding of exotic species of invertebrates, reptiles, amphibians, and several kinds of mammals has been prohibited (Brazilian Institute for the Environment regulations decrees 93/98 and 102/98);
- The introduction of exotic fresh water species is prohibited, and there are restrictions regarding their reintroduction into water basins where they are already present (Regulation 145/98).

Detailed regulation has been applied for species whose importation and/or breeding are allowed so that for trading and breeding can take place. These activities are now considered to be an environmental risk– IBAMA regulation 237/97), and the law establishes that they should be rigorously controlled (IBAMA regulation 102/98 and Normative Instruction 01/99). One of the most recent rules establishes that captive animals or those destined for trading must be marked individually, usually by an electronic system (IBAMA Normative Instruction 02/01).

According to the Brazilian Wild Animal Breeders, Buyers and Sellers Association), 95% of the bird trade in Brazil is illegal and the country is one of the major illegal exporters of exotic animals (http://www.abrase.org.br). According to Globo Rural Magazine no. 195, of January, 2002, Brazilian boar breeders estimate that half of the boar breeding facilities in the country is illegal. The Fishing and Aquiculture Department itself considers it difficult to register aquiculturers as defined by law. It points out that only a small number of these individuals is registered by IBAMA (http://www.agricultura.gov.br/aquicola/aquicola05.htm). In the case of “pay-what-you-fish” fishing clubs, only 0.1% are licensed as previewed by IBAMA Regulation no. 1.853 of December 21, 1989 (Graziano *et al.* 1999).

Sanitation supervision is a responsibility of the Ministries of Agriculture and Health. It is a great deal more consolidated, so plague species and pathogens are still the exotic organisms whose entry and transit in the country are best controlled. The integration between sanitary supervision and environmental supervision is essential not only to strengthen the latter but also reduce the cases in which mandates overlay. A recent example of this integration was the inclusion of the Ballast Water Information Form among the documents that have to be provided by ships arriving at our ports (ANVISA Resolution RDC 213 of the 13th of November, 2001, see **Annex III**). ANVISA is subordinated to the Ministry of Health but works



in co-operation with the Ministry of the Environment and research institutions.

Despite its rigorous nature, legislation is normally not respected and there are no means available for environmental authorities to change this situation. Environmental supervision in the country is still lacking. Activities involving exotic species are not an exception. They rarely follow all legal demands as most are developed illegally.

The fact that there is not enough environmental supervision in Brazil is widely recognised and acknowledged by society and also by the government itself. In 1998, the National Audit Office – TCU created a project for environmental auditing in governmental agencies. One of the objectives of this is to prevent action on the part of the government, as its legal and constitutional obligation, to recover the environment whose degradation was the result of the action or omission of government agencies. The legal consequences brought about by the lack of environmental supervision by the agencies responsible are one of the main concerns. The assumption in the document that defines the programme is that "In Brazil, however, environmental supervision has not proved itself effective" (page 22 of: Brazil – National Audit Office – TCU - 1998. A Strategy for Action on the Control of Environmental Management - National Audit Office - TCU, Audit and Inspection Secretariat, Brasília, a strategy document approved by TCU Regulation no. 383, of August 5, 1998, published in the Union's Official Diary Section 1, of September 10, 1998, p. 65. This fact once again demonstrates that one of the greatest challenges for the implementation of international agreements signed by Brazil when rectifying the Convention on Biological Diversity will be to see that the existing environmental legislation is respected.

## 4.2. Soil

Governmental actions that target soil use and conservation are mostly identified in the country's environmental policy. The concept of self-sustained development has been increasingly consolidated in this policy. Among the National programmemes that deal with self-sustained natural resources use and that bear relation with Brazilian soil use and occupation, either directly or indirectly, the following ones can be mentioned:

### 4.2.1. Main programmemes

a) **Green Protocol (*Protocolo Verde*)**, one of the Brazilian government's most significant initiatives in terms of self-sustained development public policies. This is comprised of a document that contains directives, strategies and operational mechanisms for the incorporating of the environmental variable into production activities, management and concession; of official credit and fiscal benefits.

b) **National Forests programmeme *(Programa Nacional de Florestas*)**, was conceived due to the need to perform or regulate ongoing actions in the Brazilian Forest Sector and to make the forest policy compatible with other government public policies, in order to regulate the country's forests use and preservation;

c) **Ecological-Economical Zoning programmeme (*Programa Zoneamento Ecológico-Econômico*),** was conceived as a technical information instrument capable of orienting or re-orienting the Country's territorial planning, occupation and management and conciliating economic development with the rational utilisation of environmental resources in a self-sustained manner;

d) **Pesticides Use National Rationalisation programmeme (*Programa Nacional de Racionalização do uso de Agrotóxicos*),** which is being constructed within the Green Protocol programmeme, co-ordinated by the President's Office aims to promote progressive reduction in the use of pesticides and to provide incentives for integrated crop management;

e) **Pilot programmeme for the Protection of Brazil's Tropical Forests (*Programa Piloto para Proteção das Florestas Tropicais do Brasil - PPG-7*),** has the implantation of a self-sustained development model into Brazilian tropical forests as its goal, seeking to match economical development and environmental protection;

f) **National Environment programmeme *(Programa Nacional do Meio Ambiente – PNMA*),** was conceived to strengthen the Country's environmental area's legal and regulating structure and institutions; to protect environmentally important areas for policy-making purposes; and to broaden the protection of ecosystems that are under imminent degradation risk;

g) **Environmental Education National programmeme (*Programa Nacional de Educação Ambiental – PRONEA*),** with the purpose of qualifying informal, formal, supplementary and professional teaching, bearing in mind that environmental education is an essential and permanent component of national education, and that it should be present, in a linked manner, in all levels and modalities of the education process;

h) **Solidary Amazon programmeme (*Programa Amazônia Solidária*)**, created with the purpose of providing social and economic ascension to the Amazon's extraction workers, using the government's economic aid to natural rubber producers and, in particular, to the Legal Amazon's rubber tappers, by means of specific forest use incentive mechanisms and social promotion programmemes;

i) **Family Agriculture Strengthening programmeme (*Programa de Fortalecimento da Agricultura Familiar – PRONAF*)**, which aims at supporting farming and cattle-raising activities performed directly by the producer and his/her family, the family farmer's training and qualification, the building of infrastructure in family agriculture based counties and, finally, rural technical assistance and extension;

j) **National Desertion Combat programmeme (*Programa Nacional de Combate à Desertificação – PNCD*),** Which is being formulated within the Ministry of the Environment, as a consequence of the United Nations Desertification Convention results;

k) **Forest Fires and Deforesting Combat programmemes (*Programas de Combate aos Desmatamentos e incêndios florestais*), worth noting:**

**Forest Fires, Land Burning-over, and Deforestation Combat and Prevention programmeme (*Programa de Prevenção e Combate a Desmatamentos, Queimadas e Incêndios Florestais*),** aims at preventing, combating and monitoring deforestation and clearing and burning;

**Agriculture Land Burning Monitoring, Prevention and Control programmeme (*Programa de Monitoramento, Prevenção e Controle das Queimadas na Agricultura*),** has the purpose of monitoring, preventing and controlling clearing and burning in Brazilian agriculture;

l) **Agriculture Soil Conservation programmeme (*Programa Conservação de Solos na Agricultura*),** has the purpose of working with small rural producers, the agriculture sector and local public agency specialists, for the spreading of conservation-oriented water and soil use methods, and to support actions directed at recuperating degraded agricultural areas.

As far as international commitments go, it is worth noting the consequences of some Conventions and Treaties that directly affect the use of soil by Brazilian agriculture, as described below.

Biological Diversity conservation and use have become important topics since Brazil ratified the **Biological Diversity Convention**, in February 1994. Agriculture was treated as a theme, for the first time, at the Parties' 3rd Conference, but it was after the 5th Conference, in 2000, that a bio-diversity in agriculture project programmeme had its four main components defined, as follows:

**a)** To run a trend and stateanalysis in the world's agriculture bio-diversity;

**b)** To identify practices, technologies and management policies that cause positive impact and reduce agriculture's negative impacts in bio-diversity;

**c)** To strengthen agriculture workers, their communities and organisational training, to support national plans and strategies for the conservation and self-sustained use of bio-diversity in agriculture.

Among the bio-diversity in agriculture's main actions implemented by Brazil, within the first component, the following deserve to be mentioned:

**a)** 27 *ex-situ* vegetal germoplasm banks, with more than 200,000 accesses, with 24% of these made up of native species; 12 animal germoplasm banks with in vivo and in vitro samples, specially extinction endangered species;

**b)** 10 agricultural interest micro-organism's germoplasm banks, including viruses, bacteria, fungi and protozoan,

**c)** Organisation of an international workshop on pollen agents in agriculture.

Within the second component, the identification of the best bio-diversity conserving handling practices, some of which already have broad practical application, must be highlighted:

**a)** **Direct Planting** – A soil handling conservationist system that consists of planting without revolving the soil and previous crop residues; it is based on crop rotation and is being used, nowadays, in about 14 million ha.

**b)** **Biological Control** – Actions that strive to find replacements for pesticides in pest control.

**c)** **Agriculture-forest Systems** – Consist of combining forest and agricultural species and have several advantages, such as extended agricultural production in already deforested areas. This reduces the need for more deforestingand improvements to agriculture workers' living standards since the need to occupy large areas for plantation is reduced and an increase in their awareness to the importance of forest resources conservation. There have been several such experiences in the Amazon region. However, they still represent a minuscule portion of the land being used for plantation in that region.

**Examples:** Combined and Concentrated Reforesting Project (*Projeto de Reflorestamento Consorciado e Adensado - RECA*) –occurring between Rio Branco, AC and Porto Velho, RO. BONAL Project, by Natural Rubber Inc. and the Forest Centre programmeme, in Rio Branco, Acre.

**d)** **Organic Agriculture**: there are more than 50 certified organic agriculture products, both "in natura" and processed products (e.g. açaí, acerola, sugar, sugarcane liquor, cotton...). In 1999, according to the International Trade Centre, in Geneva, Switzerland, the amount relative to organic produce in Brazil was US$ 150 million. According to the International Trade Centre, in Geneva, Switzerland and the Bio-dynamic Institute (*Instituto Biodinâmico*), which is Brazil's biggest certification agency, the amount produced in 2000 was US$ 195 million. Organic agriculture production in the country should present continuous growth, since consumption has been growing by 10% a year. According to Bio-dynamic Institute, the area occupied by type of agriculture in 2000 was 61,000 ha.

**e)** **Environmental Impact Evaluation System**: Technological Innovation Environmental Impact Evaluation System - Ambitec-Agro - (Rodrigues et al., 2000) was developed and, as of 2002, shall be used to evaluate some of the environmental impact of technologies in place.

Within the third component, actions by National Environmental Education programmeme (*Programa Nacional de Educação Ambiental – PRONEA)*, where biodiversity is not treated in a specific manner, are worthy of mention. Within the fourth component, important pieces of legislation are as follows: those related to organic production and consumption systems; bio-security, biological control agents registration, control, cultivated areas protection and, finally, the environmental crimes law.

The United Nations Summit convention on climate change went into effect as of March 1994, in order of "to reach, as per the pertaining dispositions from this Summit, the stabilisation of greenhouse effect gases concentration in the atmosphere, on a level that thwarts dangerous anthropic interference in the climatic system" It establishes that its parties shall:

**a)** Prepare, periodically update, issue anthropic emissions national inventories;

**b)** Design, implement, publish and regularly update national programmes to mitigate climatic change;

**c)** Promote and co-operate for the development, use and spreading, of technologies, including transference, practices and processes that help control, reduce or prevent greenhouse effect gases anthropic emissions;

**d)** Promote self-sustained management, as well as promote and cooperate in the conservation and strengthening, as each case requires, of disposal facilities and reservoirs for all greenhouse effect gases.

As far as Brazil's response to the Climate Summit goes, the following actions should be noted:

**a)** Elaboration of the national greenhouse effect gases emissions inventory;

**b)** Creation of the Inter-ministry Global Climate Changes Commission, which is responsible for negotiating with the Summit's representatives. Inception of the Climatic Changes Executive programme, which has supporting greenhouse effect related gases emissions studies as its goal;

**c)** Eight actions from Move Foward, Brazil programmeme (*Programa Avança Brasil*) that target inventory studies, research models, vulnerability and adaptation to the changes' impacts, mitigation plans, emissions reducing technologies development and studies for creating clean development mechanisms;

**d)** The fact that non-governmental institutions were invited to discuss climatic changes and, finally, the dissemination of information on climate changes.

Brazil joined the Montreal Protocol officially in 1990. Then, the Brazilian programmeme for the Elimination of Ozone Layer Degrading Substances Production and Consumption – PBCO was created, in which the gradual elimination of such substances in Brazil was determined. This programmeme had its rules outlined in 1995, forbidding the use of any such substances as of 2001. It should be noted that ever since 1998, the Brazilian industry has been using propane and butane gases, which are petrol derived,

as propellants for their aerosol systems. The only use of CFCs that still allowed in the country is that for medical purposes, such as in asthma pumps, in which case it is difficult to find a substitute for CFC.

As Brazil has been one of the signatories of the United Nations Convention to Combat Desertification since 1994, it has been implementing several actions under the Ministry of the Environment's leadership. Highlights include:

**a)** The construction of a legal base, that approved and sanctioned the convention which defines the National Desertification Control Policy; which strengthens institutions for action within the theme, incorporate coordination, financial resources and trained personnel provisions, in addition to the creation of a Desertification Information and Documentation Network – REDESERT and of PNCD's Consulting Group;

**b)** Performance of basic studies, specially desertification susceptible area environmental diagnosis and the production of manuals and monitoring proposals for the desertification process and for the self-sustained development of the Semi-Arid region, focusing on emergency actions. However, it was not until the completion of the National Desertification Combat Plan, elaborated by the Ministry of the Environment, that the Brazilian commitments before UNCCD were clearly outlined. To that extent, the basic diagnostics have already been issued, including desertification susceptibility maps, annual losses and estimates for amounts to be invested.

### 4.2.2. Response of the Agrarian Reform Policies and Actions

The Government has established policies and measures on several fronts in an effort to promote changes in the land related national scenario. Better land distribution will follow. Towards this end, programmes have been implemented that range from combat to irregular occupation of land, specially in the North and Mid West land states to the implementation of actions targeting natural resources conservation in INCRA's settlement projects, coupled with broader interaction with the country's environmental programmes.

Thus, the Brazilian government, still in the second half of 1999, took some new measures unheard of at the time public registry. For Rural real estate that equalled or surpassed 10,000 hectares in area was cancelled until property regularity was proved in addition to other demands,. This measure was reviewed in 2001 and extended to include properties ranging from 5,000 to 9,999 hectares in Agrarian Reform interest areas, notifying occupants of approximately 3.0 million hectares, always with the goal of inhibiting illegal land possession.

This government directive led to the enacting of Law nº 10,267, of August 28th, 2001, which mandated the information exchange between INCRA and real estate registration services, creating the National Rural Information Census – CNIR. This regulation shall enable cross-referencing information from the various governmental agencies that retain information on the rural environment, such as: INCRA, Federal Reserve Secretariat – SRF, Brazilian Environmental Institute – IBAMA National Indians Foundation – FUNAI, The Union's Wealth Secretariat – SPU, among other rural environment information producing national and state agencies.

As far as the environmental issue is concerned, INCRA and IBAMA have been promoting actions that target the fulfilment of rural real estate social function which encompasses natural resources conservation among other things. One of the actions to be mentioned was the recent designation of areas for the creation of conservation units, making up a 20,436,599 ha area. Other aspects concern fire preventative actions in settlement projects in critical states and counties, as well as a reduction of the number of expropriated hectares for rural settlements in the Legal Amazon.

An important line in the policies and measures implemented in the rural area is that of the Land' Bank (*Banco da Terra*), which is an alternative for land acquisition by new farmers' families, by means approved projects of local or regional sustainable agrarian development councils and of the Family Agriculture Strengthening programmeme – PRONAF, which sets credit lines for small family farmers.

Other equally important programmemes are the water micro basin ones:

**a) Santa Catarina State's Water Micro Basins Natural Resources Recovery, Conservation and Management Project (*Projeto de Recuperação, Conservação e Manejo dos Recursos Naturais em Microbacias Hidrográficas no Estado de Santa Catarina*).**

With support from the Bank for International Reconstruction and Development (*BIRD*), this programmeme has reached highly satisfactory results, such as: 534 micro basins worked on; 106,028 farmers served; 44,126 Individual Property Plans outlined; 806,000 hectares with soil conservation; 8,496 processors built, 13,985 water fountains protected; 500 collective toxic waste deposits built; 5,229 rural schools familiarised with environmental education. Results obtained at Lageado Sao Jose's micro water basin (Chapeco, SC), from 1991 to 1998 show significant advances in the soil and water conservation System (Bassi, 1999). Substantial improvements were seen in the quality of water, in soil degrading reduction, crop productivity evolution, and, consequently, in increased rural property income.

**b) Rural Paraná programmeme (*Programa Paraná Rural*).**

The Soil and Water Conservation and Management programmeme in the state of Paraná was implemented in the period spanning from 1989 to 1997, in partnership with the World Bank, and is dealt with the water micro basins as project teams considered work units took water erosion of soil as the most significant for the agricultural sector's environmental issue and incorporated the farmers' organisation in the search for alternatives and common solutions of utmost importance (Bragagnolo et al., 1997). This programmeme has been obtaining important results, there are environmental results; projects have reached 2,433 micro basins, spanning 7.1 million hectares. Erosion caused river pollution, as measured by the turbidity index, showed an average reduction to the tune of 49.3%. A comparative study of fountains from two processed micro water basins – a partially worked on one and an unprocessed one, showed a significant reduction in drinking water for human consumption treatment cost, which demonstrates the programmeme's indirect benefit to the urban population There are production results: in 120 micro water basins, increases in the bean, corn, soy and wheat production were noticed, relative to the programmeme's beginning as a function of the soil's fertile layer loss reduction, coupled with the incorporation of new management and resource use practices as outlined in the programmeme. The effective involvement and commitment by the rural producers has generated high levels of new recommended technologies. These one socio-economic results: a case study performed in the Southwest of Paraná, with 477 beneficiary producers, showed significant evolution in some indexes established at the programmeme's beginning: - an 8.14% increment in the number of tractors; 10.21%in the number of limestone distributors and 14.28in the number of manure distributors; - an increase from US$ 4,440.00 to US$ 5,475.04 per adult person/year in the family's workforce gross income; - an average increase of 5.04m2 in the size of homes; - an increase of 5.5% in the number of refrigerators and 9.7% in that of gas stoves. The rural roads maintenance cost, was reduced, and is used to be US$ 850/km/year, after the intervention was reduced by some 50%. Certainty of how correct programmeme interventions were comes mostly from the farmers' persistence in using the management practices brought about it, evidence that the benefits outweigh the associated costs. Thus, it is expected that these examples and reached impacts will work as a reference for the implementation of similar public policies in other states.

**c) Programmemes and Projects Run in the State of São Paulo.**

Mulch direct Planting Project (*Projeto Plantio Direto na Palha*) – that includes financing the acquisition of adequate equipment for this system. This is true specially for mini and small rural producers and their associations and co-operatives. It spans the entire state of Sao Paulo, and started in 1998. Better Road programmeme (*Programa Melhor Caminho*) promotes the conservation and maintenance of dirt roads (estimated at 300 km per county) by means of their technical and operational personnel. This programmeme focused on soil and water conservation, and the implantation of a model stretch of road. Micro Water Basins State programmeme (*Programa Estadual de Microbacias Hidrográficas*), started in 2000, with support from the World Bank. This programmeme has the following 5-year goals: 500 micro water basins worked on or about 4.5 million ha; 90,000 benefited farmers, with strengthening of farmers' associations, rural leaderships and environmental monitors qualification, riverside woods planting, etc.

#### 4.2.3. Positive Impacts from the Use of Direct Planting in Brazil

Direct planting is a highly conservationist management system, which was developed by public research with the fundamental private enterprise participation (farmers, co-operatives, companies etc.) From 1974 to 1992, this system's adoption area grew 132 times. In the '90s there was an 11 million hectare expansion and in 2000 this system already spanned some 14.3 million ha. In the Cerrado woods there was an increase of over 1.2 million hectares, from 1996 to 1999.

Acceptance of direct planting is due, mainly, to its effects on hydro erosion control since the problem is anything but eliminated. However, it also stems from other important advantages that encourage its adoption, such as positive impacts soil and water quality, and economic and financial stability in the rural communities. The tendency on the system's adoption rate is that of sustainable growth. However, that growth's magnitude will depend to a large extent on public policies and on the involved participants organisation of the participants that provide incentives.

Using conventional management systems as a comparison, estimates on the benefit generated by direct planting were performed in experimental parcels, calculating the losses and benefits to the total area used with direct planting. Thus, based on data organised by De Maria (1999) and Bragagnolo & Pan (2000), it was estimated that for the area currently under Direct Planting there is a reduction in soil losses through erosion of 178.8 million tonnes and 8.3 billion m3 of water retained in the soil.

Based on those calculations and using the same estimates as those used for erosion related losses, estimated financial benefit occurred from fertiliser economy, productivity gains in crops, production cost reduction, reduction in erosion related land depreciation and reduced use of pesticides. Including all previous amounts of other positive impacts obtained as of Landers et al., (2001a), it can be seen that the benefit from Direct Planting can be estimated as some **R$4.3 billion a year**. This amount that has been used for continual life quality enhancement, for farmers in a sustainable production system over the years.

## 4.3. Subsoil

#### 4.3.1. Evolution in the Subsoil vs. Environment Relation in the 1992 to 2002 Period

Since the 90s, public policies have been striving to associate economical development and environmental preservation within the sustainable development concepts. This has expanded to mining through the sustainable use of mineral resources.

The Mining Code is the main mineral activity regulatory instrument, having been put into action by means of Law Decree 227/1967. Since this has become outdated the text has been partially reviewed (Law n. 9,314/1996), and still doesn't approach environmental issues specifically. This flaw shall be addressed by the upcoming Mining Statute, which is being elaborated by the Executive Power (PRISMA, 2001); and that shall also control the deactivation and closing of mines as well as the large mineral sector's environmental debt.

In 1994, DNPM elaborated Pluriannual Plan for the Development of the Mineral Sector (*Plano Plurianual para o Desenvolvimento do Setor Mineral*), with projected actions until the year 2010. This plan estimates the demand for mineral goods and necessary investments. The plan considers the environmental issue as a decisive factor in the public image of mining.

Also noteworthy is the declaration of Law change no. 9,827/1999, the so-called City Hall Law, which regulates aggregate extraction for exclusive use in public construction by the Union, states the Federal District and municipal agencies, when performed directly by them.

**a) Subsoil and Underground Waters**

Over-exploration of springs, contamination of water resources, compromising of drainage systems, generalised spread of the use of underground waters, among other impacts, increased awareness for the need to regulate this sector This which finally occurred with the institution of the National Hydra Resources Policy (Law n. 9,433/1997), which controlled the use of this natural resources. Underground waters are, unduly part of state wealth, (Federal Constitution, art.26 – I), although it is the Union's responsibility to legislate waters (FC, art. 22 – IV). The states and the Federal District have been regulating the matter based on common responsibility (FC, art. 23 – VI) and concurrent responsibility (FC, art. 24 – VI). As a consequence, there are water resource state policies in 22 of the 27 states and in the Federal District.

As a complement to Resolution no. 10/1990 CONAMA established resolution n. 237/1997, which ratified the need for previous licensing by the environmental agency for mineral activities, well perforation, and petrol and natural gas production. This broadened those areas reached. Likewise, Law n. 9,605/1998 (*Environmental Crimes Law*) in article 55, elaborates on penal and administrative sanctions should mineral activity be performed in non-compliance with the legislation, having been previously regulated by Decree no. 3,179/1999 (42nd Art.), in which text the related sanctions are specified:

**b) Subsoil and Agriculture**

The expansion of the agricultural frontier, the internal migration in the 70s and the 80s, and the need to revert the urban concentration process have made an empty areas occupation governmental policy indispensable in order to effect rural settlements. This is true specially in the Amazon, in order to effect the rural settlements. However, natural resources such as soils, rocky subtract and relief were only superficially evaluated, and this led to bad results in some projects. This fact contributed to the creation of an environmental debt expressed in deforesting, water resources contamination and intensified erosion processes. One of the most outstanding phenomena is the spreading of the major erosion tendencies (*voçorocas*), a particular case of erosion, as seen in various states (*e.g. Paraná, Rondônia and in the high Paraguai river – Mato Grosso do Sul*), besides the destruction of the landscape model. Currently, new rural occupations have been performed more carefully, in an attempt to avoid duplication of past errors.

**c) Subsoil and Tourism**

Environmental management instruments have been developed for the protection of speleological wealth, which is often damaged mineral activity in many states. At first, these instruments, took shape in an indirect manner, by means of hydro sources or fauna protection (landmark preservation area and/or parks). Later, an improvement age process included the creation of Environmental Protection Areas – APAs, where ecological-economic zoning studies or tourist use management plans are needed. Specific legislation was addressed by CONAMA Resolution n. 5, from 08.06.1987, which approved the national protection programmeme of this wealth: according to the 1988 Federal Brazilian Constitution, which designates caves as part of the Union's wealth (Art. 20 – X) and Decree n. 99,556, of 10.01.1990, which established a national protection programmeme for natural underground cavities. Finally, in 1997, IBAMA created Centro de Estudo, Proteção e Manejo de Cavernas (Cave Study, Protection and Management Center – CECAV), which was commissioned to manage such public policies.

Besides the tourism industry's expressive interest, coupled with the landscape aspects, these caves represent a great tool for studying Brazil's Early inhabitants, by analysing the register contained relative to their occupation evolution in the quaternary period, expressed by their paleontological content and by the numerous rock inscriptions.

**d) Subsoil and Public Participation**

Public participation in the environmental issue has been intensified, coupled with legal orums, by means of civil demands – public and popular demands in addition to public hearings, where sector enterprises are questioned. This includes, for example, the installation of gas or oil lines. In the North Region, the use of the Urucu gas deposits by the cities of Manaus and Porto Velho, (through) the use of gas lines that should run through untouched areas has been analysed by means of public hearings.

As far as mineral sector environmental policy goes, in 1997 MMA formulated sustainable development principles compatible public policies, by presenting several programmemes. The goals of these programmeme are shared with the mineral sector participants. These goals are directed towards monitoring, creation of economic instruments and self-regulatory mechanisms. The need to identify the impacted areas and the respective diagnosis that define actual and potential risks was also identified (MMA, 1997).

### 4.3.2. Subsoil and Different Governmental Levels

Within the federation's states, supplemental policies have been gradually introduced in different ways, in order to fill existing gaps. This has occurred by including them into the state constitutions themselves (as was the case in Paraná and São Paulo), or by elaborating specific laws, as in Rondônia (Law n. 547/1993 – State Environmental Policy). This also occurs by the creation of specific codes, as in Rio Grande do Sul (Law n. 11.520/2000), which establishes directives for the restoration and protection of degraded areas, protection of palaeontological wealth, and necessary anticipated licensing for mining activities. It must also be highlighted that such public action is the result of broad involvement by the government and by society.

In the counties, such concern is reflected in the elaboration of environmental control codes, as well as in the creation of municipal councils that serve the same purpose, where mineral sector matters are discussed.

It should be noted that the National Environmental Education Policy's inception (Law nº 9,795/1999), which was supplemented at the state level, seeks to spread environmental preservation associated concepts to society as a whole, and that it shall certainly reach the mineral sector.

**a) Subsoil and Energy**

The need to cater to the internal market and to seek , self-sufficiency has caused the petrol industry to intensify exploration both of hydrocarbons and of gas. This has taken place both within the country and in the ocean, hydrocarbons and gas both generate significant environmental impacts most notably in the form of abandoned fields and/or leaks from transport lines or tankers. This situation is subject to the enforcement of National Environmental Policy, of the Federal Constitution and, more recently, of Law nº 9.966/2000, which establishes penalties for jemission of oil or other harmful or dangerous substances in waters under national jurisdiction. Environmental control mechanisms were also established by CONAMA's resolutions n. 265, from 01.27.2000 and 273, of 11.29.2000. However, the abandoned petrol fields' environmental debt still *persists (Reconcavo Region, in Bahia*).

**b) Subsoil and Urbanisation**

The constant growth of Urban areas' causes the demand for immediate use materials for the construction industry. The production of these materials is a very dynamic activity. This coupled with insufficient control, represents the most significant set of environmental liabilities. This becomes even more apparent when added to prospecting for gold and precious stones plus the small and medium mining companies. This situation stems from the lack of technical knowledge, financial capacity and official support. To a lesser degree it was caused by the lack of a social conscience or good will to adapt to the new environmental reality.

There has been a gradual return to the development of Mining Director Plans in Belo Horizonte, Porto Alegre, Brasilia, Recife and Curitiba. This began again in 2002 with DNPM, in association with SMM/MME and CPRM. These agencies brought new life to the organisation of metropolitan regions mining activities. They were also able to define parameters for medium sized cities. The City Statute, which was consolidated by Law no. 10,257/ 2001 and tackles the state of degradation in Brazilian cities is another partner in this search for a new urban area mining development framework.

CPRM's 2000 Annual Report presents the geophysical air survey of 1.57 million km$^2$ in the Amazon region as one of its goals, as well as geological and mineral resources studies on a 1:250,000 scale by the year 2005. Such information shall allow the discovery of new mineral deposits, specially gold, copper, zinc, soldering tin and diamonds.

The coal industry from the South Region of the country, which has been operating since the beginning of the last century, has been producing a large set of environmental liabilities, specially as far as hydra resources contamination goes. Mining companies, by means of restricted and isolated actions, have produced few advances towards the rehabilitation of the degraded areas. In Santa Catarina, this scenario led to the creation of a Managing Committee in the year 2000 , which was sanctioned by a presidential decree in 14/12/2000, with the purpose of restoring the coal basin.

According to Barreto (2001), mining is one of the sectors that has the best chances of harmony with environmental protection. This is due to its representing temporary land use, to its spatially restricted character, and to the ease of monitoring this area. This is mostlybecause of available technology and of the legal norms to which it is subjected. This norms demand control and environmental protection for the mined areas, as well as restoration and devolution to society at the end of the mine's lifespan. This devolution requires in equal or better conditions than the originally existing ones.

#### 4.3.3. Private Companies

As a result of the awareness raised in the Brazilian mining sector, associated to the existing legislation, according to Industrial Environment (*Meio Ambiente Industrial* - 2001), at least 13 Brazilian mineral sector companies hold an ISO 14001 certificate. There are also countless cases (big companies) of mined area rehabilitation programmes. According to Chaves (2000), there has been a lot of evolution in the recuperation programmes, showing that the mines he visited had been getting impressive results. He also points out that 76% of the Sao Paulo Metropolitan Region's mined areas were rehabilitated and had planned occupation; the others have been abandoned or disorderly occupied (*apud* Barreto, 2001).

World entrepreneurs, represented by the World Businessmen Council for Sustainable Development (WBCSD), have also expressed concern with mining's destiny in the acurrent context, which was expressed by –the Mining, Minerals and Sustainable Development Project - MMSD that's being developed by countries of significance in the mineral sector. As part of that project, the national project was recently concluded. This is the Mining and Sustainable Development: Challenges for Brazil, Barreto (2001), project and if presented, the participation of various institutions, a diagnosis of mineral sector and their adhesion to the environmental issues. The project suggests agendas and challenges for the inclusion of that sector in sustainable development.

In search for the country's sustainable development, the Brazilian government instituted, in 1990, by means of decree no. 99,540, the Brazilian territory's Ecological-Economic Zoning programme – ZEE. This shall develop an integrated diagnosis of the physical, biotic and socio-economic environment and will outline action lines for the development, recuperation, preservation or protection of the relevant area. After 10 years, only 11% of Brazil has been zoned. However, in December 2001, the ZEE-BRASIL Consortium was created, comprised of MMA, MIN, INPE, EMBRAPA, CPRM, ANA, IBGE, IBAMA and IPEA. This Consortium was set up to run ZEE on a national scale and to support the state ZEEs nonspecific interest areas (ZEE programme,2001).

At the Americas Mining Ministries Annual Conference – CAMMA, with permanent Brazilian participation, represented by SMM/MME, studies are run and principles and recommendations to the member countries are made in the search for mining sustainability in the continent. This is accomplished by means of analysing the following themes: mining and environment; small mining; health and safety in mining; safe use of minerals and metals; mining's relations with the community; access to minerals and metals markets; deactivation and closing of mines; modernisation and strengthening of public institutions and human resources training and mineral integration.

## 4.4 Water resources

### SURFACE WATERS

From the point of view of sector use, water has gradually been treated as an economic resource. This has occurred to the detriment of a holistic view – that this element belongs to the natural environment and that it should be thought of and analysed considering all the factors that interfere with and depend on it.

Water zoning and territory zoning have a close relationship. It would be impossible to maintain waters that are more often used a nobler fashion with the liberalisation as territory use requires the need of permanent control of the allowed occupation. Resolution 20/86 establishes that "in Special Class waters the discharging of residual, domestic and industrial waters, garbage and other solid residues, potentially toxic substances, agotoxic products, chemical fertilisers and other polluting substances will not be tolerated." (art. 18). This maps out the territory, as it drastically limits the use and occupation of the water basin, inducing occupation as of Nature Conservation Units, according to law No. 9,985/2000.

Uses such as power production and the control of floods may be complementary. This is not true for uses such as public supply and excrement dilution these are competing uses; uses such as irrigation and electric power generation that will move pumps from the irrigation system can be both complementary and cmpeting. Therefore, efficiency in the allocation of water resources requires that all possibilities of their use should be treated as a whole. Cases where a certain option of use may be seen in an isolated way are rare.

In Brazil, the management of water resources has been developed according to three basic referential lines that encompass technical issues, judicial organisation and systematic institutional organisation.

In the area of technical issues, for the management of water resources in the country, as well as for the development of projects and research in the area of hydrology and water resources, it is extremely important to understand river regimes and seasons, the amount of rain in different water regions and a series of other information of the hydrologic cycle. Therefore, basic hydrologic information should be stressed in constant collection and interpretation of data. This should take place in a fashion where trustworthiness increases as historical series become more extensive, involving flood and drought events. This should occur so that the data archive corresponds to the necessities of designers and scholars in the areas focusing on the use of water resources.

With technical issues, the management of water resources in Brazil is based on solid legal foundations. In this area, Brazil has the Waters Code, and the subsequent and related legislation. To complete the legislation in force, which is crucial for the Federal Constitution and for the state constitutions, there are also Laws that regulate sector use of water such as those created by ANEEL (No. 9427 of 1996), Law No. 9433 of January 8th,1997 (Waters Law) and Law 9984 of July 17th, 2000 (Law of ANA) and the Federal Constitution, highlighting the main aspects presented in **Charts 5 and 6.**

**Chart 5 - Relevant aspects of legislation**

| Object | Creation Instrument | Main points |
|---|---|---|
| Water Code | Decree no. 24,643 of 10 July 1934 | First legislation; it addresses the "water" issue under several aspects, permanent reference source |
| National Policy on Water Resources<br>National System of<br>Water Resource Management | Law no. 9,433 of 08 January 1997 | water resource management principles, guidelines and instruments |
| Agency for Water Resources - ANA<br>Legislation | Law no. 9,984 of 17 July 2000 | Implementation of the National Policy on Water Resources and coordination of the National System of Water Resource Management |

**Chart 6 - Main passages from the Federal Constitution on Water Resources**

| | Object |
|---|---|
| 20 | Establishes criteria for the definition of water bodies domain and water energy potentials of Brazil<br>Defines the participation of the direct administration agencies in the result of exploration |
| 21 | Establishes authority over the energy use of water courses<br>Defines the Union authority in the institution of the national system of water resource management and the definition of criteria for granting its right of use |
| 22 | Establishes the Union jurisdiction concerning water legislation |
| 23 | Establishes jurisdictions concerning grants of rights to research and explore water and mineral resources |
| 26 | Defines the domain of States over surface and underground waters |
| 176 | Establishes the distinction between water power potential and soil property |
| 225 | Establishes citizen rights regarding the environment |
| 231 | Establishes the rights of indigenous communities over water bodies, energy and mineral potentials |

It is also important to mention that most of the states have legislation that defines the administration of waters and their domains according to the chart summarised at the end of the chapter.

At institutional level, necessary and adequate institutional organisation is being implemented in the country for the management of water resources. Examples include the domains and uses of water, as well as the different governmental and non-governmental organisations that are busy with the water issue. In this way, corresponding to the hopes of the national water society, the 1998 Constitution established in article 21, paragraph XIX, that "it is part of the Union's obligation to institute a national system of management of water resources and define provision criteria for its use". The National System of Management of Water Resources, established by Law 9433 instituted the mentioned organisation in a systemic way. The referred constitutional precept was then followed.

An intensive training programmeme has been developed and promoted by SRH/MMA during this period. This programme me has been disseminated spread to most of the states, in support of the process of institutional organisation focusing on the original aspects of water resources management.

It is important to emphasise the actions developed in the area of the subprogramme created by the Brazilian government within the Brazil in Action programmeme, PROÁGUA – Semi-arid. This programmeme includes a structuring mission, with special emphasis on the institutional strengthening of all significant participants involved in the management of water resources, in the water basins owned by the Union as well as in the water basins owned by the states. Initially under the responsibility of SRH and nowadays of ANA, this programmeme's general objective is to guarantee the extension of the gross offer of high quality water for the Brazilian semi-arid region. This is done with the promotion of wise use of this resource so that its relative scarceness does not continue to constituting an impediment for the sustainable development of the region.

This subprograme encompasses the entire North-eastern region and the State of Minas Gerais. In its first phase, the programmeme should benefit a population of about 1,300,000 people, or 260,000 households. Priority actions include institutional development, technical basis for the management of water resources, studies and projects for planning and water resources, specially the management of the São Francisco River basin and preparation for the National PROÁGUA programmeme.

#### 4.4.1. Policies

Title I of Law 9433 defines the foundations, objectives, general guidelines for actions, and the instruments of the National Policy of Water Resources.

The National Policy of Water Resources for Brazil is based on the fact that water, a public domain, is a natural finite resource. This concept incorporates economic value and treats human consumption as the priority use. Water management should be decentralised, provide the multiple use and should treat the water basin as its management unit. This should take place respecting the physical, biotic, demographic, economic, social and cultural diversities of the different regions of the country. Moreover, it should be integrated in Environmental Policy, tied to the management of soil resources, estuary systems and coastal zones. It should also follow the basic principles of the sustainable development. As Brazil is a Federation, there has to be constant links between the Union and the states, treating the management of water resources as a matter of common interest. With the objective of implementing the National Policy of Water resources, a series of instruments designated by the Law are in phase of implementation or studying criteria for their application.

a) **Water Resources Plans** (Water Basins Plans, State Plans and National Plans) are basic management instruments. For the effective flow of the macro planning and decisive processes, the National Plan and the State Plans are supposed to be Indicative Plans while the Basins Plans are Director Plans of executive character.
b) **The Division of the bodies of water into classes, according to preponderant uses of water,** is the instrument for the recuperation and maintenance of the quality of available water.
c) **The granting of right of use of water resources** guarantees equity in the uses of **water as a public asset** according to plans and criteria established in relation to its availability in time and space.
d) Perhaps the instrument with the most difficult implementation is the **charging for the use of water resources.** This is because of the repercussions

charging on productive processes as well as users' willing to pay for it. Financial compensation for the use of water resources for electric power generation is already in force (Law 9984 of July 17, 2000) and it has been a reasonable source of income. Part of the amount collected is used for water monitoring, such as in the management of water resources, and part is used for the professional training in the area. Charging for water is already in an advanced process of implementation at the Paraíba do Sul River basin (Resolution No 19 of CNRH).

e) **"Compensation to municipalities"**, although rejected in article 24 of Law 9433, continues to be a political **instrument** of Politics, in article 5 of the mentioned Law. It is believed that this is an issue yet to be resolved at judicial level.

f) **The National System of Information about Water Resources** is the political instrument that is used as a basis for all previous ones , because it contains all information about hydrology (quantity and quality), water offer, uses, grants, users, legislation and the large issues related to water in the Country. Until now the existing system has been primarily concerned with hydrologic information. It already contains other information on a smaller scale, but total implementation is still in second place.

According to the National Policy of Water Resources, a part of the State Executive Powers and the Powers of the Federal District responsibilities include the granting of rights of use of water resources, and regulating and inspecting water uses. These responsibilities also include executing the technical control of water offer projects and the implementation and management of information systems on water resources, as well as promoting the integration of water resource management with environmental management.

The integration of local policies of basic sanitation, use, occupation and soil conservation and the environment with the federal and state policies of water resources is also part of the responsability of the Executive Powers of the Federal District and of the Municipalities.

### 4.4.2 Management Model

According to the previously mentioned Law 9433, modified by Law 9984 with the creation of the National Agency of Waters, the National System of Management of Water Resources is made up of:

- The National Council of Water Resources – CNRH;
- The Secretary of Water Resources – Executive Secretariat of CNRH;
- National Agency of Waters;
- Water Basin Committees;
- Agencies of the federal, state and municipal public governments whose responsibilities are related to the management of water resources; and
- Water Agencies.

The National Council of Water Resources is responsible for the promotion, deliberation and arbitration of large issues of the area. These include: planning alliances, legislation and policy alteration, institution of Water Basins Committees, the National Plan of Water resources and general criteria of granting and charging, as well as complementary guidelines for the implementation of the Policy and the application of instruments.

The Secretariat of Water Resources (SRH) of the Ministry of the Environment mainly deals with the proposal of the Policy of Water Resources, the elaboration of the National Plan of Water resources supported by ANA, support to the Committees of Federal River Basins and providing stimulus for research and training, in addition to being Executive Secretariat of CNRH.

The National Agency of Waters is responsible, among other activities, for the implementation of instruments of the National Policy of Water Resources. This encompasses the supervision, control and assessment of actions and activities resulting from the execution of federal legislation on water resources, elaboration of technical studies and proposals to the National Council of Water resources as well as for the participation in the elaboration of the National Plan of Water Resources.

The Water Basin Committees are responsible for the role of the true "water parliament" where users and the community discuss themes related to the subject as well as for the development of proposals and approval of the Basin Plan, in their area.

The Water Agencies are responsible for the implementation of the resolutions of Water Basin Committees, being structured as executive agencies. The creation of a Water Agency will be authorised by the National Council of Water Resources or by the State Councils of Water Resources, through requests from one or more Committees of Water Basin, and they should have economical feasibility assured by charging for the use of water resources.

This established model is also valid for the institutional organisation of the states with small variables of specific and regional character.

### 4.4.3. Regulation

After the promulgation of Law 9433, a series of regulations were issued in the area of the National Council of Water Resources. This council is making the implementation of the system and policy instruments more agile.

Below is a summary of the previously mentioned regulations. (**chart 7**).

**Chart 7 - Regulations on Water Resources**

| | |
|---|---|
| Decree 2,612<br>June 03 1998 | It regulates the National Water Resources Council (CNRH) |
| Ministerial Decision no. 407 (MMA)<br>November 23 1999 | It approves the Bylaws of the National Water Resources Council |
| Ministerial Decision no. 307 (MMA)<br>December 13 2000 | It designates the members and their deputies in the National Water Resources Council |
| Resolution no. 03 (CNRH)<br>June 10 1999 | Institution of a Work Group for the elaboration of proposals to create Permanent and Provisional Technical Chambers |
| Resolution no. 04 (CNRH)<br>June 10 1999 | Institution of Technical Chambers of the Water Resources National Plan and the Technical Chamber of Legal and Institutional Affairs |
| Resolution no. 05 (CNRH)<br>April 10 2000 | It provides the criteria for the institution, organisation and functioning of the Hydrographic Basins Committees |
| Resolution no. 7 (CNRH)<br>June 21 2000 | It institutes the Permanent Technical Chamber of Procedures, Grant Actions and Regulation Actions |
| Resolution no. 8 (CNRH)<br>June 21 2000 | It institutes the Permanent Chamber of Analysis and Projects |
| Resolution no. 9 (CNRH)<br>June 21 2000 | It institutes the Permanent Technical Chamber of Underground Water |
| Resolution no. 10 (CNRH)<br>June 21 2000 | It institutes the Permanent Technical Chamber of Transboundary Water Resources Management |
| Resolution no. 11 (CNRH)<br>June 21 2000 | It institutes the Permanent Technical Chamber of Science and Technology |
| Resolution no. 12 (CNRH)<br>July 19 2000 | It provides the classification of water bodies, according to prevailing uses |
| Resolution no. 13 (CNRH)<br>September 25 2000 | It establishes the guidelines for the implementation of the National System of Information on Water Resources |
| Resolution no. 14 (CNRH)<br>October 20 2000 | It establishes the guidelines for the indication of the representatives of Water Resources State Councils, Users and Civil Organisations |
| Resolution no. 15 (CNRH)<br>January 11 2001 | It establishes the guidelines for disciplining the integrated management of underground waters |
| Resolution no. 16 (CNRH)<br>May 8 2001 | It establishes the grant conception and general guidelines and procedures to be adopted when requesting and analysing the request of grant of right of water resources use |
| Resolution no. 17 (CNRH)<br>May 29 2001 | It establishes complementary guidelines for the elaboration of Water Resources Plans of Hydrographic Basins |
| Resolution no. 18 (CNRH)<br>December 20 2001 | It establishes the possibility of extension of the Provisional Board of Hydrographic Basins Committees |
| Resolution No. 19 (CNRH)<br>March 14 2002 | It approves the amount charged for the use of water resources from Paraíba do Sul River Hydrographic Basin |
| Resolution No. 20 (CNRH)<br>March 14 2002 | It establishes the composition of Permanent Technical Chambers and that they will be in force until July 2002 |
| Resolution No. 21 (CNRH)<br>March 14 2002 | It institutes the Permanent Technical Chamber of Charge for the Use of Water Resources |

In general, the instituted model is also followed in the states (State Councils, Water Basin Committees, Agencies), to manage the water resources owned by them. At the end of this chapter there is a summary of the present stage of state legislation. The summary includes their respective regulations, as well as suggestions made by institutions in charge of water resource management.

The solution for the water conflict is integrated and shared management of water use, control and conservation. This management should be carried out with the participation of all the involved sectors. This should take place in decision making as well as in implementation of scientific criteria and respect to the needs of all citizens. The old concept of water resource management as an overbearing sector cannot exist anymore.

## UNDERGROUND WATERS

The Federal Constitution of 1988 changed the text of the *Waters Code* of 1934 in may aspects**.** One of the most important changes was the extinction of the private domain of water, foreseen in some cases in the initial legal document.

Present aspects of use and conservation of underground water, such as the licensing and granting of wells, the payer-user and the payer-polluter, were already anticipated, (Art.97 until 101). However, they have never been regulated.

Therefore, according to the Magna Carta of 1988, all waters of Brazil became public domain. Another modification that the federal constitution of 1988 introduced was the establishment of only two domains for the bodies of water in Brazil:

**a)** **Union ownership of rivers or lakes that flow through more than one federal unit, or that serve as frontiers between such units, or between the Brazilian territory and the neighboring country, or come from them or flow to them;** and

**b)** **State ownership of superficial or underground waters, effluents, emergents and deposits, except, in this case, the ones deriving from Union projects.** Of course, this definition does not exempt the process as a whole. Initially, the real inability to dissociate waters in the water cycle should be taken into consideration.

Federal Law nº 9.433, of January 8th, 1997, instituted the National Policies of Water Resources, created the National System of Management of Water Resources, regulated paragraph XIX of art. 21 of the 1988 Federal Constitution and altered art. 1 of Law nº 8.001, of March 13, 1990, that modified Law nº 7.990, of December 28, 1989.

It is important to highlight that this law defines the basic principles practiced nowadays in almost all countries that made advances in water resource management, such as:

**a)** The adoption of the **hydrographic basin as a planning unit;**

**b)** **Multiple uses of water**, ending the traditional difference of treatment conferred by the central power to the hydroelectric sector;

**c)** Recognition of the **economical value of water,** strong encouragement of its rational use and basis for the institution of charging for its use;

**d)** **Decentralized and participatory management,** highlighting the Water Basin Committee, a political waters forum divided in three parts formed by representatives of organized civil society, users and representatives of the federal, state and municipal governments. Therefore, it is part of the Water Basin Committees' responsibility to establish plans and norms, based on their own criteria of opportunities and convenience, such as the economical, financing, hydrological, geological and environmental aspects of the granting of rights;

**e)** **Finally, it is established that, in a scarcity situation the priority should be given to human and animal supply, coordinating the National System of Management of Water Resources.**

Finally, Law Nº 9.984, of July 17th, 2000, created the National Agency of Waters – ANA (*Agência Nacional de Águas*), to implement the National Policy of Water Resources. Policy formulation is the responsibility of the National Council of Water Resources. The secretary is the National Secretary of Water Resources – SRH (*Secretaria Nacional de Recursos Hídricos*), of the Ministry of the Environment – MMA (*Ministério do Meio Ambiente*).

However, in this table, Law nº 9.433/97 talks about the integrated management of the water basin, the actions implanted until now have encompassed only the waters that flow through rivers and are accumulated in dams, swamps and other superficial water bodies.

Therefore, there is one legislation missing, one that considers the specific aspects of occurrence, uses and conservation of underground waters in each of the UGRHI – Unities of Management of Integrated Water Resources. It is also missing specific legislation that establishes the principles to be observed for the impounding of rain waters, and above all, of reuse of rain waters or waters treated and injected into the underground of each UGRHI, for example.

However, it is already clear that all the water basins – physical unities of planning – cannot be ruled by only one legislation that, by nature, cannot cope with the complexity of each separate system. Thus, each basin should apply laws in accordance with their regional peculiarities, according to Law 9433, encompassing all their different possible sources of water supply and the different functions – production, filter, transportation, stocking, regulation, marine interface control, for example – that could be performed by aquifers from each basin.

Words that were previously remote have been incorporated in the daily vocabulary of the decision maker, legislator and citizen in general. These words include impounding, use and conservation of superficial and underground water, environment quality, water basin, systemic management, water offer for the lowest cost, more efficient use of each available drop of water, dumping of domestic sewage treated in rivers and other superficial water bodies, reuse of water and privatization of public services of supply. Moreover, the charging for the use of water – user/polluter payer – tends to be seen as an instrument of management essential for the creation of balanced conditions between strengths of offer (availability) and demand (use). This situation consequently promotes domestic, industrial or agricultural use that is even more efficient for every available drop of water.

However, by persisting in the present form of disorganized extraction of underground water, the supply of potable water, in particular, becomes ever more critical. So, the use and protection of underground water should be included in the policies of water resources, on the federal level as well as on the states' or water basins (Rebouças, 1999).

### 4.4.4. Standardising

The extraction of underground water for human consumption, in particular, is duly standardized by the Brazilian Association of Technical Norms – ABNT (*Associação Brasileira de Normas Técnicas*), both on the project level, as well as in the construction of wells. Thus, the well project is an object of Technical Norm – NBR nº 12.212/92 that substituted NB 588/77 and technical norm NBR nº 1290/90 related to its construction (Rebouças, 1999).

The observation of such technical norms are proportionate to the minimal expected conditions of a project that should correspond to geology engineering (construction), hydraulic (efficiency) and sanitation (protection of the quality of produced water)criteria, in particular. In this fashion, the project of underground water impounding through well or wells system presupposes the knowledge of:

**a)** NBR 12211 – Conception studies of public systems of water supply – Procedure;
**b)** The outflow intended for the system;
**c)** The water study containing the basic geophysical and geological information from the aquifers, hydraulic characteristics and water quality; in areas where there is not enough hydrologic knowledge, a preliminary technical report should be elaborated with the available data;
**d)** Evaluation of the system risk;
**e)** Estimate of the number of wells constituting the system;
**f)** Topographic plant on an adequate scale, with location and register of projects and existing wells, and register of the levels of present draining and piezometric levels;
**g)** The water basin plant, in reduced scale, with location and register of existing wells;
**h)** Register of the maximum level of floods in the area of the system.

Thus, the well or the wells of a system of underground water extraction should be projected and constructed with equipment and compatible methods with the local geologic conditions. They should be covered and receive filters that guarantee the acquisition of hydraulic efficiency adequate to the production of the project flow. Finally, they should guarantee the sanitation protection that is crucial for the quality of the water extracted.

#### 4.4.5. Regulation

It is demonstrated that many Brazilian states have, nowadays, specific regulation about underground water (Costa, 2001). In fact, there is the Federal District (Law nº 55/89); Goiás (Law nº 13.583); Minas Gerais (Law nº 13.771/00); Pará (Law nº 6.105/98); Paraná (Administrative Rule nº 05/96) Pernambuco (Law Nº 11.427/97) and Normative Decree nº 20.423/98) and São Paulo (Law nº 6.134/88 and Normative Decree nº 32.955/91). Besides, many Federation Units have established norms and specific criteria for the request of perforation license and operation license of deep tubular wells in areas considered critical, such as the Metropolitan Region of São Paulo, Paraíba do Sul Valley, and Ribeirão Preto, in the State of São Paulo, Metropolitan Region of Recife (ABAS, 2001). Still in the State of São Paulo, three protection perimeters have been defined, and they should be established based on pertinent hydro geological studies (Iritani, 1998). The State of Pernambuco has defined sectors in the Metropolitan Region of Recife, where, nowadays it is prohibited to perforate wells (Costa, 2001).

### 4.5 Forests

The main legal instruments that regulate environment and forestry issues in the country are: the Forest Code (Law no. 4771, of September 15, 1965), the Fauna Protection Law (Law no. 5197, of January 3, 1967), the National Environment Policy (Law no. 6938, of august 31, 1981), and a number of Resolutions of the National Environment Council (CONAMA) and Normative Acts and Service Orders of the Ministry of Environment and IBAMA. The general principles related to environment protection are consolidated in Chapter VI, Article no. 225 of the Federal Constitution, proclaimed on October 5, 1988. These instruments are complemented by specific state legislation. The states have the legal capacity to legislate in a complementary and even in a concurrent way to the Union (in cases in which a general regulation does not exist).

#### 4.5.1. Forest Code

In July 1996, the Presidency of the Republic issued a provisional measure changing and including articles Law no. 477165, the Forest Code, with the objective of increasing protection of forests situated in rural properties in the Legal Amazon. According to the provisional measure in force the percentage of legal reserve varies according to the region of the country: 20%, in the South, Southeast and Northeast, 35% in the Cerrado and 80% in the Amazon Forest. With the permanent protection areas (APPs), the legal reserve has important ecological functions related not only to biodiversity protection but also to the well being of human populations. This includes microclimate maintenance, plague prevention and soil and water resource protection. In order for it to become a law, the National Congress instituted a joint parliamentary commission, with eight house representatives and eight senators.

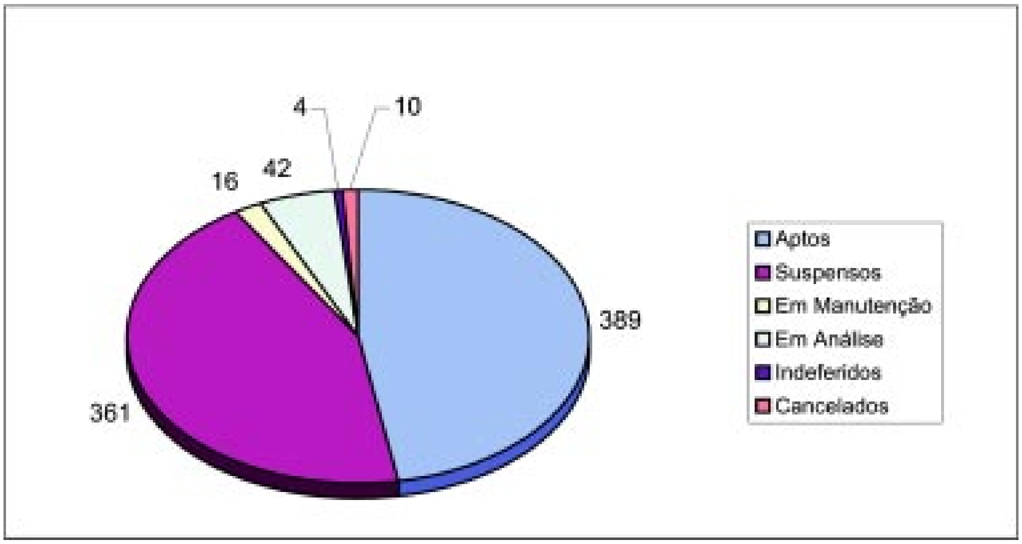
The proposal presented by the joint commission proposes a text promoting profound changes in the provisional measure issued by the federal government. As well as proposing a drastic reduction in the percentage to be protected by law in each rural property, the proposal gives amnesty to rural landowners that had not complied with the law in previous years. This enables the cultivation of exotic forests (eucalyptus and pine trees, specially) in native forest areas and makes it easier to deforest legal reserves and permanent protection areas, among other problems. If approved, the proposal will transform an environmental protection law into a law of incentives to the expansion of the ago-pastoral sector. The provisional measure will be reissued until the bill is approved in a joint Commission and in the National Congress and followed by a sanction by the President of the Republic.

The Agriculture Law (817191) establishes compulsory reforestation of Legal Reserve areas whose percentage has gone beyond the limits established by the Forest Code for each region. In some states (Paranoia and Goes, mainly) the Public Ministry has made rural landowners reforest the Legal Reserve, in the proportion of 1/30 a year, as established by law.

Law 9393/96 of the Rural Territory Tax exempts areas with forest cover from payment of tax property and provides tax reductions for areas with forest management plans. This stimulated landowners to maintain and preserve forests.

Also in regards to the legislation field it is important to highlight that states are editing their forest laws. Until now, 12 states have edited them: Minas Gerais (1991), Rio Grande do Sul (1992), Bahia (1994), Paraíba (1994), Pernambuco (1995), Rio Grande do Norte (1995), Ceará (1995), Goiás (1995), Paraná (1995), Alagoas (1996), Santa Catarina (1997) and Acre (2001). But even though there are forest laws, most of these states are not yet appropriately structured to fulfil their duties and responsibilities in the forest area – with the exception of Minas Gerais, Paraná, Rio de Janeiro, Goiás and Acre. These states already have specific institutions for forest resource management.

**Figura 1 e Tabela 1 - Situação da área sob PMFS na Amazônia após Vistoria (em hectares)**




Despite legislation having required forest management for the Amazon forests since 1965, this practice is recent in the region. The first management plans were registered in the Brazilian Forestry Development Institute (IBDF – *Instituto Brasileiro de Desenvolvimento Florestal*, predecessor of IBAMA) in 1987. Ten years later IBAMA had 2808 management plans registered in all 9 states of the Amazon. A first check revealed that most of these plans existed only on paper and not in practice.

IBAMA undertook the tremendous task of going through all management plans for the Amazon. In the first diagnosis, concluded in 1997, IBAMA cancelled around half of the total of the plans registered until then and suspended another 30% for later field investigation. The work has continued since then and from 1999 on the agency has systematically performed field studies in management plans in all Amazon through samples.

In 2001, 85 forest engineers were temporarily hired to carry out field investigations of management plans in the Amazon. The report is being concluded, but extracts from the 2000 reports, shown in **Figure 1** and **Table 1**, demonstrate the management plan situation in the region.

**Table 1 - Status of the area under the Simplified Forest Management Plan (PMFS) in the Amazon after inspection (em hectars)**

| State | Qualified | Suspended | Under Maintenance | Under Analysis | Denied | Cancelled | Total |
|---|---|---|---|---|---|---|---|
| Ha | 184,861 | 187,262 | 8,551 | 14,760 | 4,431 | 3,470 | 403,335 |
| Volume ($m^3$) | 4,134,519 | 3,666,499 | 289,815 | 110,044 | 91,697 | 23,248 | 8,315,822 |

Source: IBAMA/DIREF

Parallel to the investigation efforts, the Ministry of the Environment and IBAMA have carried out a wide revision of the legislation on forest management since 1998. The objective is to simplify procedures, reduce bureaucracy and facilitate the life of the landowner that wants to perform management. Additionally, the agency has been working in partnership with state environment agencies, so as to speed up field investigations and the overall process and also to facilitate the life of users.

Despite history demonstrating that the population has participated in forest activity in the Amazon for four centuries, it took a long time for forest management to reach the population. Indians and mixed-race individuals participated in drug exploitation in the interior. Jesuits mobilised Indians for cocoa extraction. In rubber extraction there were Indians at first and riverbank populations later on, the so-called savage and civilised rubber tappers. Indians and mixed-race individuals harvested guaraná, and rubber tappers and mixed-race individuals harvested nuts.

The reasons why forest management has taken a long time to reach communities cannot be attributed only to the research area, to researchers and institutions responsible for providing appropriate answers. For over a decade, there was strong doubt within social community organisations regarding the risk of promoting management, specially that of timber, on a community scale. In environmental agencies, responsible for the elaboration of rules and regulations and for compliance with them, there was resistance as to the implementation of forest management in an associative or community form. There were several difficulties and a great deal of bureaucracy until the first community management plans, registered by environmental agencies in the second half of the 1990s, were approved. Despite the fact that resistance not yet been removed, there has been great progress in the last five years. Non-governmental organisations and the PP-G7 programmeme have begun financing community forest management projects. Researchers have become more directly involved with this issue, mainly Universities (where there are Forest Engineering courses) and EMBRAPA, through its research units in Rio Branco, Acre, and in Belém, Pará. Environmental agencies have become more receptive to this issue, mainly IBAMA. Legislation has become broader. A specific regulating instruction for community forest management was issued for the first time in the end of 1998. For this to happen, a decree had to be modified, Decree 1282 of 1994. The revision of this Decree also enabled the simplification of management regulations for small and medium forest landowners through the edition of a specific IBAMA regulation entitled Simplified Management.

In recent years, mainly from the second half of the 1990s onwards, governmental efforts were undertaken to enable technical and economic management in some of the Amazon's National Forests. These efforts also encountered difficulties of a legal nature. Nevertheless, it is possible to observe a growing tendency in the consolidation and strengthening of a system of public forests used for production. This involves the Union, the states and even municipalities. These efforts combined with this tendency demonstrate the need for a legal instrument that regulates contracts for access by private agents to public forest resources. To complement these actions, the Ministry of the Environment and IBAMA have been striving to widen the area of National Forests that currently comprises 16.6 million hectares **(Table 2)**.

**Table 2 - Brazil's National Forests and Extrativist Reserves in 2002**

| Region | No. of national forests | Total area of national forests (ha) | No. Of Extrativist Reserves | Total area of extrativist reserves (ha) |
|---|---|---|---|---|
| South | 9 | 15,022.36 | – | – |
| Southeast | 8 | 13,721.70 | – | – |
| MidWest | 2 | 9,812.83 | – | – |
| Northeast | 6 | 62,601.54 | – | – |
| North | 35 | 16,444,949.99 | | 8,034,175.00 |
| Brazil | 60 | 16,546,108.42 | 36 | 8,034,175.00 |

Source: IBAMA/DIREF-CNPT

In this context, the Ministry of the Environment and IBAMA have been carrying out a series of studies and implementing actions regarding public forests since 1997. These studies and actions involve issues related to economy, management and exploitation – particularly that of National Forests – as well as those related to legal aspects of private access to natural resources of these forests. Currently, IBAMA and MMA are concluding a cycle of seminars in the five Brazilian regions to discuss a proposal for the regulation of forest concessions. Once consultation is concluded, the most appropriate legal form will be given to the proposal for the necessary formal procedures.

In April 2000 the National Forest programmeme (PNF – *programmea National de Florestas*) was officially launched as part of a group of priority programmes of the Federal Government. PNF permitted a budget guarantee for the forestry sector by the Ministry of Planning, Budget and Management, in the sphere of the Pluriannual Budget programmeme. PNF is programmemed to develop actions and offer responses in the areas of reforestation This is being done in support of the increase in the planted forest basis; recovery of degraded areas; increase of protected areas and use of wood resources of national forests; and monitoring and control of forest cover.

#### 4.5.2. National Forest programmeme

The National Forest programmeme was created by Decree 3420, of April 20, 2000. Its mission is to promote sustainable forestry development, conciliate exploitation with ecosystem protection, as well as to make the forestry policy compatible with other government public policies (Leitão *et al* 2002). One of the programmeme's objectives is to promote reforestation, recover permanent protection areas, repress illegal deforestation and predatory extraction of forestry resources, and prevent forest fires. Such activities contribute significantly for *in situ* conservation. The programmeme, however, is still very incipient.

In the area of international co-operation, Brazil has many agreements with the objective of protecting forests, particularly the Amazon and Atlantic tropical forests. Among these agreements, the most relevant are the Amazon Co-operation Treaty (TCA), the Objectives 2000 Agreement of the International Tropical Timber Organisation (ITTO) and the Pilot programmeme for the Protection of Tropical Forests (PP-G7). In relation to TCT, Brazil has outlined strategies and pursued collective actions with other Treaty signatory countries with the objective of

**IBAMA's Centre for Remote Sensoring monitors deforestation areas distinctly defined by period in the Amazon region, specially in the Deforestation Belt, which covers the States of Acre, Rondônia, Mato Grosso (North), Pará (South), Tocantins, Maranhão (West) and Amazonas (South). The databank is periodically updated with the geographic coordinates for every deforestated area studied in terms of area in hectares. The databank is developed by means of comparisons of images for a specific area that are obtained through the Landsat-TM satellite for consecutive years. This monitoring allows inspectors to act directly in the deforested areas, thus increasing inspection efficiency, the application of penalties and the evaluation of the real dimension and reach of the deforested areas. Information on images of deforested areas by state, municipality, size class, geographic coordinates with geo-references and statistics are available at http://www2.ibama.gov.br/desmata/index.htm**

monitoring and controlling forest use, the transportation of wood and forest resources in frontier areas and commercialisation of tropical timber, as well as technical and scientific exchanges.

In terms of PP-G7 many actions have been undertaken in the Amazon and Atlantic Forest, with emphasis on the Pro-Management programme, which supports the management of potential areas, community management, management in extraction reserves and increase of conservation unit areas. It is important to point out the Demonstrative Projects (PD-A), the Demonstrative Projects in indigenous lands (PD-I), Projects for protection and demarcation of indigenous lands (PPTAL), ecological corridors, natural resource policies, control and monitoring of deforestation and forest fires, as well as support to research centres established in the Amazon.

In the private sector, many companies committed to sustainable use of forests and the valorisation of its products have sought to certify its areas. The total certified area in Brazil reaches 1,152,243 hectares distributed as follows: Amazon – 353,313 ha; Atlantic Forest – 20,000 ha; planted forests – 778,930 ha (FSC, 2002, WWF, 2002).

As part of a strategy to complement management of the protection of tropical forests, Brazil prepared and submitted a project to undertake an inventory of the area of occurrence of mahogany (approximately 1.5 million of Km2) to the International Tropical Timber Organisation (ITTO). This project is currently under negotiation with that organisation.

### 4.5.3. Forest Challenges

Considering Brazil's forest characteristics as well as the types of uses of this resource and the sector policies proposed and being executed in the country, the following considerations are in order:

**a)** Data from the last world report by FAO (FAO 2000; FAO 2001) reveal that in the end of the 20th century the average forest area in the world was 0.6 ha per capita. Compared to this average, data from Brazil demonstrate that the forest area per inhabitant is superior in the North, Central West and Northeast regions (31.7; 9.0; and 1.5 ha/inhabitant respectively) and below the average in the South and Southeast regions, with 0.35 and 0.30 ha/inhabitant respectively. These numbers indicate that policy actions must concentrate on recovery of forest cover in the latter regions, and in the former on actions of command and control;

**b)** The average rate of deforestation in the Legal Amazon region for the period 1997/2000 was of over 1.8 million hectares a year, representing an estimated volume of biomass of 774 million m3, of which 54 million m3 are potentially commercial and 720 million are not commercial (considering 400m3/ha of not commercial volume and an extra 30m3 of commercial volume, by current average standards). The *vis a vis* with the volume of 300 million m3 of wood used by the productive sectors and that are responsible for the generation of a production value of over US$27 billion a year, demonstrates the non-existence of policies that permit the appropriate and adequate economic, social and environmental response of the volume not utilised (474 millions of m3). The use of at least 50% of this volume originated from areas of deforestation (human action for alternative use of soil) could contribute to enhancing the economy in the Amazon states while at the same time enabling a significant reduction in the costs of control and environmental recovery in these states;

**c)** Of the total volume of wood (300 million m3) used by the productive forest sector, 44% is destined for varied energy purposes (domestic consumption and grain drying mainly); the remaining 56% is used by companies in the production of cellulose and paper, wood – mechanically processed – and the iron sector. Special reference must be made to the paper and cellulose sectors that do not use wood from native forests in the production process;

**d)** The volume of wood from qualified forest management plans (approved by IBAMA) represents around 13% of the volume produced annually in the Amazon. This demonstrates, on the one hand, the need to increase and strengthen policies that promote forest management activities, and on the other hand, to improve monitoring and control instruments of conversion areas, as well as the increase of areas within conservation units of sustainable use (public forests). It is important to note, that if the current growth rates of the productive sector of forest base, around 50 million hectares of public forests would be needed to maintain this rate of production;

**e)** Not withstandy the increment in the use of raw-material from native forests, environmental restrictions and new technology continue to point to a reverse in this trend in the short term, with a consequent increase in the plantation areas. This fact will contribute not only to the reduction of pressure on native forests by the various production segments but will also increase the recovery of degraded areas by alternative use of soil;

**f)** Emphasis must be given to the action of Non-Governmental Organisations – NGOs in striving for increasing protected areas defined in the National System for Conservation Units (Law 998500). This is true for the main biomes, specially in the Amazon and Atlantic Forest. These actions have found resonance not only within organised civil society but also within the government itself and results will contribute to the improvement of the Brazilian position regarding the volume of protected areas and environmental quality in as well as biodiversity conservation. An important result achieved thanks to the efforts by NGOs in the last years is the recovery of degraded areas of the Atlantic Forest. This demonstrates a tendency towards the reversal of the process of change in the forest cover of this biome.

### 4.5.4. Recovery of Native Vegetation

In the 1970s, the expansion of commercial forests of exotic species in Brazil promoted enormous advances in forestry sciences, creating high-level research groups. From the 1980s onwards, a growing interest of these groups in native trees rapidly consolidated the technology for the dissemination and planting of some hundreds of Brazilian native vegetation species. Despite the number being small in relation to the total of species found in the country, Brazil currently has knowledge and autonomous technology that allows for the implementation of plantations for recovery of native species, mainly in the Atlantic Forest biome (Kageyama *et al.* 1992, National Council for Biosphere Reserve *Conselho Nacional da Reserva da Biosfera* 1997, Secretariat of the Environment of São Paulo *Secretaria do Meio Ambiente de São Paulo* 2000).

### Box 6 - Vegetation restoration

**The São Paulo Energy Company (CESP - *Companhianergética de São Paulo*) has been planting heterogeneous forest bodies since 1972 in its old construction sites and in the surrounding areas and islands of its hydroelectric power plant reservoirs. The first plantations emphasised landscape restoration and protection against erosion, and used mainly exotic species of aesthetical or economic value. Diversification of species, original native flora (and fauna) restoration and functional ecological groups were gradually introduced as a result of a closer co-operation with forest research institutions. In 1988, CESP established a co-operation agreement with the University of São Paulo's Luiz de Queiroz College of Agriculture (ESALQ/USP - Escola Superior de Agricultura Luiz de Queiroz) for the development of technologies to introduce mixed forests, based on the knowledge ~~of~~ of native tree species and the ecology of tropical forests. The resulting plantations, in addition to being ecologically closer to natural forests, reduced production costs by 63 percent. At the moment, costs are US$1,500 per hectare. CESP accumulates today one of the largest areas of native vegetation restoration in Brazil. That is, about 10,000 hectares, or 25 percent of its properties area can be restored.**

Sources: Silva L.O. 1992. Recomposição de matas nativas empreendidas pela CESP - Evolução do programa e concepções norteadoras. Revista do Instituto Florestal 4: 1054-1060; Noffs P.S. Galli L.F. & Gonçalves J.C. 1996. Recuperação de áreas degradadas da Mata Atlântica - Uma experiência da CESP. (Série Cadernos da Biosfera da Mata Atlântica, no 3) Conselho Nacional da Reserva da Biosfera da Mata Atlântica, São Paulo; "Revegetação em Áreas de Preservação Permanente no Entorno dos Reservatórios Hidrelétricos e de seus Tributários" página 11 do Boletim Informativo do IPEF de agosto de 1997.

However, there are important knowledge gaps, mainly regarding recovery in other biomes, production, storage and germination of seeds of native species; forest ecology, identification of species more apt for different recovery models, techniques of community extension for the involved populations, and monitoring of recovery projects (Kageyama *et al.* 1992, National Council for Biosphere *Reserve Conselho Nacional da Reserva da Biosfera*, 1997; Rodrigues e Leitão Filho, 2000; Secretariat of the Environment of São Paulo *Secretaria de Meio Ambiente de São Paulo* 2000, Rezende *et al.* 2001; Ima Vieira com. pess.). In addition to a lack of knowledge, seed production and native species seedlings are still restricted both in numbers of units and variety of species (Kageyama *et al.* 1992, National Council for Biosphere Reserve *Conselho Nacional da Reserva da Biosfera* 1997, Secretariat of the Environment of São Paulo *Secretaria do Meio Ambiente de São Paulo* 2000, Danilo Sette de Almeida, Henry Martos e Vanilde Zanette, com. Pess.).

Despite technical advances, the area that has been recovered in Brazil is in fact extremely small. There are no data available, but in the Atlantic Forest, the total area of recovery programmes, with native species, does not reach 20,000 hectares (Paulo Kagyama, com.pess.). This represents an insignificant fraction of the 92.5 million hectares already deforested in this biome. Recovery projects of big areas (100 ha or more) are very rare or non-existent in the remaining biomes, mainly the non-forestry ones (Paulo Kageyama & Bruno Walter com. pess.). The biggest ongoing programmeme in is the Atlantic Forest and totals today 10,000 hectares planted, after 30 years of activity. Its history represents an evolution of technology and concepts in the recovery of degraded areas in Brazil. Originally initiated with empirical plantation of species of economic value - exotic and native, today native vegetation recovery is undertaken based on scientific knowledge of natural forest ecology.

The main cause for the small recovery area in Brazil is the cost of this action, which can reach US$4,000.00 per hectare. There are already recovery models for the Atlantic Forest with an implementation cost of US$1,500.00 per hectare (IPEF, 1997), but this is still a very high investment for most Brazilian landowners. If we consider the cost of maize production, for example, it is around US$450.00 per hectare. A study in the Cerrado estimated that the total cost of recovery of riverbank forests can reach 9% of the annual income of properties, an impossible investment for most landowners, specially in an activity with long term benefits (Santos *et al.*, 2001). Even so, ecological benefits brought by vegetation include economic gains that should be deducted from recovery costs. One of the best examples of "environmental services" that are already recognised by society is the maintenance of water quality by riverbank forests.

Significant actions of recovery are also scarce because pertinent legislation is only very recent. Brazilian environment laws have a restrictive and punitive tradition and, only from the 1980s onwards there were laws and norms that made reference to reparation for environmental damage. The regulation of these instruments has not been concluded and their application is extremely deficient (Secretariat of the Environment of São Paulo, 2000).

Overall, the great programmes of management and recovery of areas in Brazil still have a very limited scope. The main reason for this is the lack of human and material resources, both for generating necessary knowledge and executing management actions. There is great need for more investment and for the consolidation of legal instruments and their application. There is also need for a more rational use of existing resources, and greater co-operation among specialists and managers is a priority as well.

## 4.6. Atmosphere

In Brazil the problem of emissions and the issue of atmospheric pollution, mainly in big cities, are quite serious. These problems are created by mobile sources (vehicles) and fixed sources (industries and energy transformation).

The transportation sector contributes significantly to the emission of atmospheric pollutants in the country. Additionally, this problem has increased significantly, mainly in metropolitan regions. Some of the main causes are:

- High participation of road transportation, both for cargo transportation and the transportation of passengers;
- Little incentive for the use of collective transportation;
- The decrease of the use of vehicles powered by alcohol; and
- The increase in the number of vehicles.

Regarding fixed sources, the main problem comes from the burning of fossil fuels in industries. This results in the emission of particulate material and $CO_2$, among others.

In relation to the emission of atmospheric pollutants from energy conversion processes, resolution 08/ 90 of CONAMA, mentioned earlier, establishes emission standards. Despite the relatively small number of power plants, the problems related to this activity are not insignificant, mainly in the North and South regions. In the North of the country there is a predominance of thermoelectric power by diesel and other combustion oils, whereas in the South there is a concentration of coal-based thermoelectric industries.

Additionally, it is important to observe a tendency towards increased in the participation of thermoelectric generation from the burning of fossil fuel, mainly natural gas. This occurs not only due to the increase in energy consumption in the country, but also due to changes in the national energy grid. This contributes greatly to the aggravation of problems such as the greenhouse effect.

The main actions developed in the country to minimise the problems previously mentioned are presented in the following items.

### 4.6.1. The National Alcohol Programme (PROALCOOL)

The main objective of the National Alcohol programmeme (PROÁLCOOL) was not atmospheric pollutant emission reduction. However, the programmeme was one of the country's first initiatives against the problem of atmospheric pollution. Launched in 1975, PROÁLCOOL is the greatest programmeme of commercial application of biomass for the production and use of energy in the world. Its success demonstrates the technical feasibility of widespread production of alcohol from sugar cane and its use as fuel in vehicles. Since 1979, 5.4 million cars powered by alcohol were produced in Brazil. In 1998, these cars consumed 7.6 GL (billions of litres) of alcohol per year and 5.3 GL of the fuel were used in the production of gasool (a mixture of 22% of alcohol with 78% of gas) for the rest of the cars in the country.

With a significant reduction in oil prices during the 80s, the main role of PROÁLCOOL became its contribution to the reduction of the air pollution in the big cities and of the greenhouse effect.

In 1999, the cost of alcohol production was still higher than the derivatives from oil, as this oil was imported at the price of almost US$20 per gallon. This is approximately equivalent to half of its international price in 1980, when the second phase of PROÁLCOOL was launched. This demonstrates the main cause of financial difficulties currently encountered by the programmeme. Results from recent years demonstrate that for the feasibility of production, the price of oil must be at least US$30 per gallon so that alcohol becomes an effective economic alternative (LA ROVERE, 2000). This is true even in the region of São Paulo, where distilleries are very efficient.

In the long run, the possibilities for the economic feasibility of PROÁLCOOL are much better, considering the double impact of a potential increase in oil prices and potential gains in productivity in the production of alcohol and its by-products (specially through the introduction of technological innovations of fermentation and the use of the remaining pulp for generation of exceeding energy, to be inserted in the national grid). This is specially true considering the macroeconomic impact of PROÁLCOOL. As well as having prevented a withdrawal of dividends of the country around US$18 billions from 1978 and 1990, (in 1990 dollars), the programmeme was responsible for the creation of 720 direct jobs and more 200.000 indirect placements in rural areas (LA ROVERE, 2000). This was in a country where rural exodus to cities is the cause for serious social and environment erosion.

Emissions of greenhouse gases avoided by sugar cane alcohol and the remaining pulp. In Brazil, were well evaluated by MACEDO (1997). Carbon liberated into the atmosphere when the pulp and alcohol are consumed for fuel is compensated for in an equivalent quantity of carbon absorbed by sugar cane during its growth. Results summarised by MACEDO (1992) are presented in **Table 3**, below, using 1990-91 as a base period.

**Table 3 - Brazil: net emissions of CO2 derived from the production and use of sugarcane – 1990-91**

| | $MtCO_2$ /year |
|---|---|
| Substitution of alcohol for gasoline | - 27.17 |
| Substitution of bagasse for fuel oil in Other Industries | - 11.88 |
| Use of fossil fuel in the sugarcane industry | + 4.40 |
| Net Uptake | - 34.65 |

Source: MACEDO – 1992.

This total of 34.65 $MtCO_2$, during the year 1990-91 corresponds to 17% of total carbon emissions from energy consumption in Brazil in 1990. Considering only gas substitution, the use of alcohol avoided the liberation into the atmosphere of an average of 21.49 $MtCO_2$ a year from 1980 to 1990. Today, however, the survival of PROÁLCOOL depends a lot in an adequate flow of foreign investments, considering its global environmental benefits.

### 4.6.2. Program for the Control of Emissions by Automotive Vehicles (PROCONVE)

Actions in the country with the specific objective of reducing emissions from automotive vehicles date from 1976. That year, the National Transit Council (CONTRAN), through Resolution No. 507, established a control of car emissions of gases and vapour. In the following year, by means of Resolution No. 510, also of CONTRAN, standards for the control of fumes by diesel vehicles were defined. Over the years adequate conditions were created for effective actions. These aimed at monitoring and controlling emissions resulting from automotive vehicles, which included the construction of laboratories and the elaboration of technical norms. To ensure this the programmeme for the Control of Emissions by Automotive Vehicles (PROCONVE) was created in 1986.

PROCONVE was created through CONAMA Resolution No. 18, of July 6th 1986. In 1993, by means of Law No. 8723 of October 29th of 1993, its legal base was strengthened. The national co-ordination of the programmeme was under the responsibility of IBAMA with technical support from CETESB. Throughout the years, the programmeme has undergone a series of updates, as well as an increase in scope.

PROCONVE was developed with the reference of international experience in the areas. The programme, since its creation, established deadlines and legal standards of admissible emissions for the different categories of vehicles and motors, national and imported. The programmeme established certification for prototypes and for production vehicles and special authorisation by the federal environment agency for use of alternative fuels. The programmeme also established punitive actions of collecting and the repair of vehicles that were found in conditions that did not meet the production or project standards[1]. Finally, the programmeme determined the prohibition of commercialisation of models of vehicles not certified according to its criteria.

It is important to highlight that PROCONVE constituted one of the most effective instruments for the control of atmospheric pollution from mobile sources in Brazil. PROCONVE is being considered one of the most successful programmes in the world.

The vehicle manufacturers have been meeting the requirements determined by the programmeme and, since its inception to 1999, the average reduction obtained in emission of exhaust gases of light passenger vehicles in RMSP was around 15.8% for CO, 15.2% for HC and 21.4% for NOx[2]. However, the greatest reductions in emissions are still to come due to the obsolescence of older vehicles (pre-PROCONVE), with the possibility of reductions in emissions reaching in 2010, 51.2% for CO, 45.3% for HC and 46.3% for NOx[2] (data referent to the Metropolitan region of São Paulo (evaluation of PROCONVE – programmeme for Control of Air Pollution by Automotive Vehicles, 2002 – available in **www.lima.cooppe.ufrj.br/proconve**). It was considered that there would be technological advances in light vehicles that occur independently from the programme.

[1] A identificação dos veículos em desconformidade com a produção ou com o projeto é possível através dos programas de inspeção e manutenção veicular. Estes programas,a serem realizados em âmbito estadual, mas oriundos de ações do PROCONVE, permitem evitar a circulação de veículos usados que não apresentem os sistemas de controle de emissões originalmente instalados e com níveis de emissão excessivos. Assim, representariam uma importante iniciativa para controlar as emissões de veículos usados. Atualmente somente o Estado do Rio de Janeiro possui um programa deste tipo (detalhes do programa do Rio de Janeiro podem ser vistos no estudo Programa de Inspeção e Manutenção dos Veículos em Uso no Rio de Janeiro disponível em www.lima.coppe.ufrj.br/proconve

[2] Essas reduções se referem à Região Metropolitana de São Paulo (Avaliação do PROCONVE - Programa de Controle da Poluição do Ar por Veículos Automotores, 2002 – disponível em www.lima.coppe.ufrj.br/proconve). Considerou-se que ocorreria um avanço tecnológico nos veículos leves, independente do Programa.

It is important to note that PROCONVE also contributed to the technological development of the automotive sector in the country. As well as the use of new technology in vehicles, with the objective of meeting the established targets, manufacturers had to equip themselves for the development of new models. Additionally, the Brazilian refineries need to adjust the market fuel offered to keep up with the adopted specifications. A reduction in the level of sulfur from diesel oil and the creation of a “metropolitan diesel” for use by urban buses of big cities and the reduction of levels of sulfur and the total elimination of tetraethyl lead from gas, for example, were important contributions for the reduction of vehicle emissions.

### 4.6.3. Energy Conservation: Actions of PROCEL

PROCEL was created in 1985 to reduce waste in electric energy both on the demand and supply sides. ELETROBRÁS is the executive secretariat of PROCEL and is responsible for the co-ordination of efforts of government agencies, industries, consumers, producers, research institutions and other agents of the electric energy system.

In the beginning, PROCEL suffered from insufficient resource allocations. After 1994, the funds increased substantially thanks to the use of the Global Reverse Reserve (RGR), an important fund administered by the energy sector. Since then, PROCEL has achieved significant results, including support for various field actions for energy conservation in the country, as shown in **Table 4** below.

As mentioned, energy conservation measures of PROCEL are guided by the demand and supply sides. Projects based on demand are related to energy use by final consumers. When electricity is consumed by electrical equipment such as domestic appliances, PROCEL concentrates its efforts in improving the electric efficiency of such appliances. PROCEL initiatives include:

**Table 4 - Annual results achieved by PROCEL – 1986-1997**

| | 1986-94 | 1995 | 1996 | 1997 |
|---|---|---|---|---|
| Approved Investments (R$ millions) [a] | 33.5 | 30[b] | 50[b] | 122[b] |
| Current Investments (R$ millions) [a] | 31.5 | 15.8 | 19.6 | 40.6 |
| Energy savings and Additional Power Generation from actions taken over the course of the year (GWh/year) | 1274 | 572 | 1970 | 1758 |
| Equivalent Power Generation Plant (MW) [c] | 300 | 135 | 430 | 415 |
| Reduction in peak power (MW) | 219 | 103 | 293 | 976 |
| Investments saved (R$ millions) | 600 | 270 | 860 | 830 |

Notes: (a) Wages of ELETROBRÁS/PROCEL personnel not included; (b) RGR Resources included: R$20 million in 1995, R$40 million in 1996 and R$90 million in 1997; (c) Obtained from Energy Savings and Additional Power Generation taking into account a typical charge factor of 56% for water plants and including 15% of average losses in transmission and distribution for saved energy.
Source: LA ROVERE & AMERICANO - 1999

**a)** labelling programmeme to inform consumers about the average consumption of energy of domestic appliances;
**b)** concession of efficiency seals for domestic appliances, with the objective of influencing consumer choice;
**c)** support of equipment substitution with more efficient options in some pilot projects;
**d)** pilot project for the design of more efficient buildings;
**e)** pilot project to substitute incandescent lamps with fluorescent ones in the residential sector (low income families);
**f)** support to efficient illumination projects;
**g)** program of energy efficiency for public buildings;
**h)** adoption of differentiated electricity prices according to the time of consumption, in some pilot projects;
**i)** pilot project for the installation of demand limits and to stimulate the use of electric showers during off peak hours;
**j)** projects for adjustments in public lighting; and
**k)** marketing campaigns to modify consumer habits.

Projects on the supply side are concentrated in reducing energy losses in generation, transmission and distribution. These include:

**a)** installation of measuring devices to reduce commercial losses due to illegal consumption; and
**b)** additional generating capacity to increase available energy to the network through improvements in generation plants.

In addition to these direct measures on the demand and supply sides, PROCEL invested in general infrastructure improvements, in research and development of new technologies and in education programmes (including training courses and seminars).

Furthermore, PROCEL was also a base for electric sector reform, mainly through the law that instituted a National Policy for Energy Conservation. In the restructured electric sector, PROCEL provides technical support to the National Electric Energy Agency (ANEEL).

With the expansion of PROCEL, together with a significant increase in thermal generation estimatedeen for the next two decades, it is estimated that emissions spared by PROCEL by 2020 will amount to 98 Mt of CO2 equivalents. In terms of accumulated value throughout the period from 1990- 2020, if the objectives of PROCEL are met, a reduction of 32% in electric sector emissions will be calculated without PROCEL (Table 3).

For the efficient use of energy, another programmeme that deserves attention is the National programmeme for Rationalisation of the Use of Oil Derivatives and Natural Gas (CONPET). Created by Presidential Decree in July 18th 1991, the programmeme is co-ordinated by a group composed of representatives of agencies of the federal government and of representatives of the private sector. All technical and administrative support is provided by PETROBRÁS through the programme's Executive Secretariat, an agency created in its administrative structure specially for this purpose.

Effective results of CONPET are difficult to quantify. However, its activities are divided into six lines of intervention; institutional, transport, industrial, residential and commercial, agriculture and ranching, and energy generation sectors.

**Table 5 - Summary of greenhouse gas emissions in the Brazilian Power Generation Industry and results by PROCEL in terms of spared emissions, 1990-2020, in millions of tons of $CO_2$ equivalents ($Co_2$, $N_2O$ and $CH_4$)**

| Year | Power Sector Emissions (In millions of $CO^2$equivalent tonnes) (E) | Spared emissions in the Power Sector (In millions of $CO^2$equivalent tonnes) (EE) | Spared Emissions (% as compared to the base year) (EE*100/(E+EE)) |
|---|---|---|---|
| 1990 | 9.6 | 0.04 | 0.41 |
| 1991 | 11 | 0.08 | 0.72 |
| 1992 | 12 | 0.09 | 0.74 |
| 1993 | 12 | 0.18 | 1.5 |
| 1994 | 11 | 0.32 | 2.8 |
| 1995 | 13 | 0.57 | 4.2 |
| 1996 | 15 | 1.1 | 6.8 |
| 1997 | 17 | 1.2 | 6.6 |
| 1998 | 14 | 4.1 | 23 |
| 1999 | 19 | 5.6 | 23 |
| 2000 | 28 | 5.4 | 16 |
| 2001 | 31 | 6.2 | 17 |
| 2002 | 35 | 6.4 | 15 |
| 2003 | 36 | 8.3 | 19 |
| 2004 | 38 | 9.8 | 21 |
| 2005 | 39 | 11 | 22 |
| 2006 | 40 | 16 | 28 |
| 2007 | 42 | 21 | 33 |
| 2008 | 50 | 24 | 32 |
| 2009 | 59 | 27 | 31 |
| 2010 | 67 | 31 | 32 |
| 2011 | 75 | 35 | 32 |
| 2012 | 84 | 41 | 33 |
| 2013 | 94 | 47 | 33 |
| 2014 | 104 | 54 | 34 |
| 2015 | 115 | 63 | 35 |
| 2016 | 127 | 69 | 35 |
| 2017 | 139 | 75 | 35 |
| 2018 | 153 | 82 | 35 |
| 2019 | 167 | 90 | 35 |
| 2010 | 183 | 98 | 35 |
| Total | 1739 | 830 | 32 |

Source: LA ROVERE & AMERICANO - 1999

### 4.6.4. Specific Actions to Combat Atmospheric Pollution in Urban Centres

The first specific action at national level to try and control emissions in the atmosphere occurred with the edition of Act No. 0231, of April 27th, 1976, of the Ministry of the Interior. With this Act, maximum concentrations allowed are established for specific atmospheric pollutants, so as no to affect human health.

In 1989, through Resolution 05/89, the National programmeme to Control Air Quality was instituted (PRONAR). PRONAR had the main objectives of monitoring and limiting the emission levels of pollutants by sources of atmospheric pollution. The basic instruments for the achievement of such objectives included the establishment of maximum of emissions, the adoption of national standards of air quality, the management of licensing of sources of air pollution, the establishment of a national inventory of sources and air pollutants, inter-sector alliances and the development of human and laboratory resources.

In the following year, in 1990, Resolutions Nº 03/90 and 08/90 of CONAMA were edited. Resolution Nº 03/90 came to substitute Act 0231 of 1976, fixing new standards of air quality. Resolution Nº 08/90 established limits for emission of pollutants in the air coming from fixed sources.

Currently, it is the responsibility of states to execute air quality monitoring programmes. Despite positive aspects, this decentralisation has led to a lack of uniformity in terms of efforts and results. In most states there are monitoring air quality stations, manual or automatic. The existence of these stations demonstrates the consolidation of efforts for the evaluation and monitoring of the problem. However, despite there being active states, for example, São Paulo, not all states have effective programmes to combat causes and effects of atmospheric pollution.

Moreover, despite existing initiatives, the levels of atmospheric pollution in large Brazilian urban centres are still troublesome. Studies undertaken by the World Bank cited by MCT (2001), presented data on air quality in some cities. Results demonstrate that pollution levels, in many cases, are well above internationally accepted standards. The average annual standards of concentration of suspended particulate material in São Paulo and Rio de Janeiro are superior to the levels verified in other big cities around the world such as Seoul, Los Angeles, Buenos Aires, New York, Tokyo and London.

**Figure 2 - Air quality in selected cities**

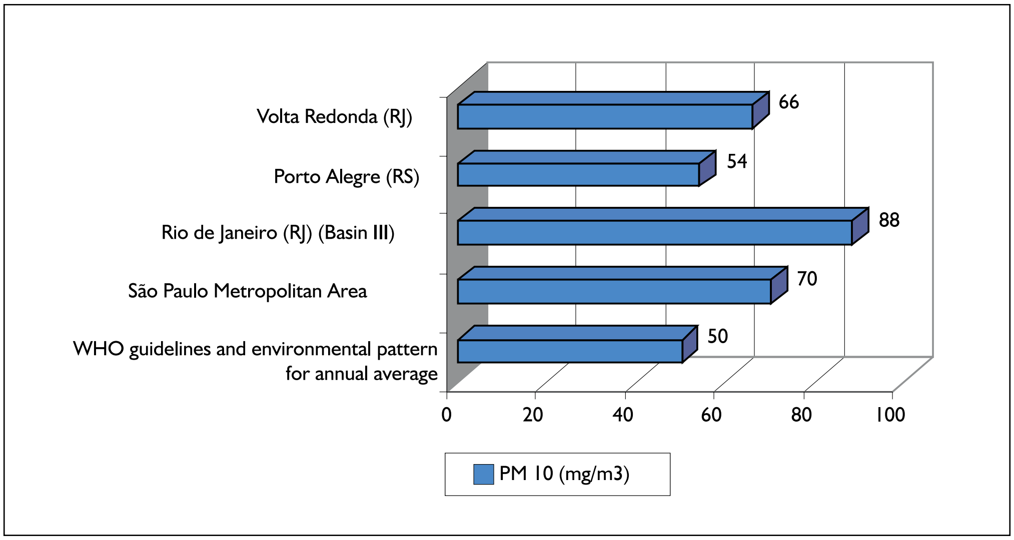



Figure 2 presents a comparison of average values observed of particulate material emissions in monitoring stations in some cities of the country and the directives of the World Health Organisation (WHO).
As it can be observed, in Rio de Janeiro and in the Metropolitan Area of São Paulo the emission of particulate material is still above required limits.

Also, it is important to cite a study undertaken by CETESB in the state of São Paulo (CETESB, 2001), demonstrating that in the State Metropolitan Region in 2000, the concentration of various pollutants was above the Primary Standards of Air Quality established by CONAMA Resolution Nº 03/90. Such pollutants include:

- **Total Particles in Suspension**: daily (240?g/m³) and annual (80?g/m³) standards of air quality were exceeded;
- **Inhaled particles**: daily standards of air quality (150?g/m³) and annual (50?g/m³) were exceeded;
- **Smoke**: daily standard of air quality (150?g/m³) was exceeded;
- **Carbon monoxide**: standard of air quality for 8 hours (9 ppm) was exceeded;
- **Ozone:** hour standard of air quality (160?g/m³) was exceeded;
- **Nitrogen dioxide**: hour standard of air quality (320?g/m³) was exceeded.

Examples of successful programmes, however, demonstrate that it is possible to solve many problems associated to local effects of atmospheric pollution. The successes obtained in the city of Cubatão and efforts in the state of São Paulo and Rio de Janeiro, as demonstrated in the following table, lead to the conclusion that solutions must be sought urgently.

## Box 7 - The cases of Rio de Janeiro and São Paulo

In São Paulo, CETESB prioritises the great pollution sources, identified by the Sources Directory. The operational aspects of such control are carried out by: (i) the environmental agencies' periodical control actions, during which they can verify whether CETESB's requirements have been met, as well as assess the implantation and effectiveness of environmental pollution control systems; and (ii) the pollution sources' self-monitoring schemes. As far as assessing the quality of the air, CETESB has an automated monitoring network, with a daily bulletin also available on the Internet, as well as a manual network. In order to control pollution caused by moving sources, CETESB has several programmes such as the Diesel Vehicles Heat Density Control Programme, the Vehicle Inspection Programme and a Vehicular Restriction Programme.

Since 1976, the black smoke emitted by diesel vehicles has been controlled on the streets under CETESB's supervision. This programme includes training and guiding actions, as well as applying fines to those drivers whose vehicle emissions exceed the maximum legal levels.

The Vehicular Restriction Programme was first put into practice in 1996, enabling a significant reduction in the emission of polluting gases in São Paulo's metropolitan area, where an estimated 90% of all air polluting agents come from automotive vehicles (Ministry of the Environment, 2002).

This programme restricts use of some vehicles on certain days of the week according to their plate numbers. Rather than simply prohibiting vehicles from operate on a given day, it also included a number of environmental awareness activities aimed at elementary and secondary school students, as well as the participation of different segments of society in the search for solutions.

According to the Ministry of the Environment (2002), the main results obtained from the Vehicular Restriction Programme are:

- Acceptable pollution levels in most of the days the programme was on;
- Reduced traffic jams and increased average speed in the city;
- A 17% reduction in the number of accidents without victims in the city;
- A 28% reduction in the number of broken-down vehicles;
- Saving 40 million litres of fuel; and
- Average reduction of 30 minutes in ordinary routes.

Still in São Paulo, the so-called Winter Operation includes a number of preventive actions such as the use of low-sulphur fuels and the interruption or substitution of certain production processes with the objective of reducing air pollution. The Winter Operation is put into practice between May and September, a period when the weather conditions are most unfavourable to disperse the polluting agents, and it includes actions aimed at both moving and fixed sources.

### 4.7 Coastal and Sea Areas

One of the government programmemes related to fisheries resources is called "REVIZEE PROGRAMMEME". It is co-ordinated by the Ministry of the Environment and was approved by the Interministerial Commission for the Resources of the Sea (*Comissão Interministerial para os Recursos do Mar* - CIRM) in 1994. This programmeme is the result of a commitment taken by Brazil when ratifying, in 1988, the United Nations Convention on Law Sea (*Convenção das Nações Unidas sobre o Direito do Mar* - CNUDM) regulating all uses of all maritime and oceanic areas covering more than 70% of the surface of the earth.

The main objective of the REVIZEE programmeme is to survey the sustainable potential of the capture of living resources in ZEE, seeking to reach the following goals:

- to register living resources in ZEE and the consequent environmental characteristics;
- to determine their biomasses; and
- to establish the potentials of sustainable capture.

The closing of the activities of REVIZEE's fisheries prospecting is expected for December 2002, while the final report should be concluded in December 2004.

According to the coast diagnosis accomplished by the Tropical Database group (*Base de Dados Tropical* - BDT), the conservation effort achieved to protect the sea and estuary species can be described as follows:

- Fisheries management of the main fishing;
- Creation of Conservation Units, mainly referring to islands and their surroundings, swamps, estuaries and other regions of proven ecological value, restricting the use of such areas;
- Creation of Extractive Reserves;
- Improvement of the legislation.

In spite of the existing norms for fisheries management, decreasing results have been observed in the outcome of fisheries, both in industrial and small scale fishing.

The term "Fisheries Management" should conceptually be understood as a harmonious group of measures seeking to expand or to restrict a fisheries activity. This should be done so as to obtain sustainability in the use of the resource, equilibrium of the ecosystem where such activity occurs, preservation guaranty of the genetic bank of the species or exploited species and economic profitability of business enterprises.

The uncertainty and the risk inherent to the process of fisheries management (due to fishing peculiarities, environmental variations, including climatic changes, and the opposition of biological and economical processes), leads the modern process of fisheries management to adopt a precautionary focus, which recognises that the diversity of ecological and socio-economic situations demands the adoption of different strategies (IBAMA, 1997).

Finally, it is fundamentally important to stimulate the creation of programmemes and projects of total fishing quality, covering the management system, catchment, improvement and commercialisation, thus establishing a certification system, preferably non-governmental.

#### 4.7.1. Tourism

Tourism can become a powerful development factor in certain areas. This is true as long as the existing human resources are capable of assuring its implementation and related activities at all levels.

When Brazil gives priority to the tourism industry, the country will be following two tendencies iat global plan. There are increase in travel and international tourism, and expansion for specialised tourism. These will take place in the spirit of a growing interest for nature and preference for well preserved areas.

Therefore, sustainable tourism depends on the mobilisation ability and the activities taken on the communities. This ability is necessary so as to limit the tourist flow at an adequate level in relation to the visited areas in social and environmental terms.

The Brazilian Company of Tourism, nowadays denominated Brazilian Institute of Tourism (*Instituto Brasileiro de Turismo* - EMBRATUR) should create more fiscal incentives and funds to motivate and stimulate tourist activity and the expansion of the corresponding infrastructure.

The National programme of Tourism Municipalisation (*Programa Nacional de Municipalização do Turismo* - PNMT) should stimulate sustainable tourist development of the municipal districts, based on the economical, social, environmental, cultural and political sustainability adopting the following procedures:

**a)** Decentralise planning actions, co-ordination, execution, monitoring and evaluation, motivating the organised sections of the municipal district to participate in the formulation and in the co-administration of the Sustainable Development Plan of Municipal Tourism.

**b)** Make available, to the Brazilian municipal districts with tourism potential, technical, organisational and management conditions for the development of tourist activity. By April 2001, 1,476 municipal districts had been involved in the programmeme.

On the other hand, the Action programmeme for the Integrated Development of Tourism (*Programa de Ação para o Desenvolvimento Integrado do Turismo* – PRODETUR/NE), is a global programmeme of regional tourism development. It is structured to finance the implementation of a supporting infrastructure to tourism that includes nine states of the North-east region and should also be extended to the South and North regions.

With regards to Ecotourism, a National Policy is being implemented through joint work between EMBRATUR and MMA/IBAMA (Ministry of the Environment/IBAMA). This Policy has the objective of harmonising ecotourism activities with the conservation of natural areas.

## 4.8. Fishing

The first aspect to be considered next is related to the adopted model of development.

The attempt to modernise fishing initiated at the end of the 1960s and continued until the beginning of the 1980s. It was linked to the actual economic model, which concentrated funds was, export-orientated, oversized, technologically intensive and ecologically predatory. State funds, through fiscal incentives and public crediting, played an enormous and important part in this process. The application of this model in the Brazilian fisheries area soon faced serious problems related to the sustainability of the exploited resources. The ambitious rationality put into practice in this model can be compared with the one pointed out by Habermas (1987) as "Instrumental Reason". It was immediatist and led to unlimited exploration, with known disastrous results, as demonstrated by statistical data of production already discussed. The knowledge used in this great task can be classified as "mimetic", due to the acritical level faced on its introduction, assimilated and applied by the different planners.

The proposed model for Brazilian fisheries activity can be classified as "late productivity", because at the beginning of the seventies, the Rome Club was already criticising this model. The same was happening to the international ecological and environmental movement.

In reality, the apogee and decline of national fishing was verified during the 1970s and 1980s (CNIO, op. cit.). The same happened with the main management support instruments, such as incentives or subsidies, research, statistics, as well as legal aspects.

As was discussed earlier the use of this model resulted in the compromise of about 80% of the main marine fisheries resources and significant impacts on those from continental waters, at the end of the 1980s. The research went through serious difficulties from the second half of the eighties to the beginning of the nineties. Also, in the beginning of the mid eighties, the statistical data network began to be dismounted, leading to the inexistence of consolidated data on the total production of national fishing between 1990 and 1994. The recovery of such data was only possible in 1995 through estimates. The fishing regulation, specially in the eighties, was quite disrespected by both the users and the managers of the resources. Monitoring was largely insufficient and inefficient. Management at that time was then responsible for the postponing of the crisis or collapse of the main fisheries (Dias-Neto & Dornelles, op. cit.).

The disastrous result of the policies implemented by that model consequently led to widespread dissatisfaction. This significantly contributed to the extinction, in 1988, of the Superintendence of Fishing Development (*Superintendência do Desenvolvimento da Pesca* - SUDEPE), an agency linked to the Ministry of Agriculture.

The nineties began with a new milestone. The fishing activity began to be managed by the Brazilian Institute of the Environment and Renewable Natural Resources (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* - IBAMA), linked to the Ministry of the Environment (*Ministério do Meio Ambiente* -MMA). This agency started to consider fisheries resources as part of environmental resources. It then decided, at that time, to implement plans and programmemes that sought the recovery of the fisheries resources in a situation of overfishing or threat of exhaustion (Dias-Neto, 1999b), as well as the economic recovery of its fisheries. Thus, mainly from 1991 to 1995, the negotiation, definition and implementing of strong measures seeking the recovery of resources occurred. Good results were obtained by this process. Sardine fishing recovered production from 32,000 tonnes, in 1990, to 117,642 tonnes in 1997. The catch of the "piramutaba" fish recovered from 7,070 tonnes in 1992, to 21,558 tonnes in 1997. Among others, the red porgy catch reached 6,085 tonnes in 1997, recovering from 1,612 tonnes in 1990 (Dias-Neto, 1999a).

In spite of these positive results, the process deteriorated during the period. The users of environmental resources were accustomed to a less committed attitude to sustainable use and more paternalistic use and they did not like the changes. Strong impacts were caused because there were no more benefits from incentives and subsidies. This dissatisfaction rebounded in the government and was aggravated by the competition that started to exist among the several jurisdictions of the Executive Power who began to fight for the management of the fisheries resources (Dias-Neto, 1999b).

All was very well explored by the immediatists or defenders of the use of resources at any cost which, added to the misinformation of part of the society, mainly of the deciding parties, favoured the appearance and consolidation of lobbies that led the government to make a series of decisions. These decisions were partly unnecessary, even conflicting and absurd, like the division of management competencies of some fisheries resources between two Ministries (Agriculture and Environment), at the end of 1998 and beginning of 1999, which was considered by some segments as a rollback (Dias-Neto, 1999b).

These decisions happened in the administrative, legal and managerial area and can be looked upon as a result of ignorance or lack of commitment with the sustainability in the use of resources on intermadiate and long term. This propitiated a total reversion of the positive results being reached with great difficulties, as in the case of the sardines. It also favoured the compromising of others, as in the case of the shrimp of the north coast, until then considered the only positive managerial example of a fishery in Brazil.

Thus, the nineties closed the decade with the total reversion of some positive results that were attained in the first half of the decade, when an institutional framework of responsibilities was implemented and called “official anarchy” (Dias-Neto, 1999b). A conflict of paradigms in the management of the use of resources was also strengthened, inside and outside the State. This happened among those nostalgic for development policies and those defenders of projects based on principles and environmental bases, focused on sustainable use.

Therefore, the results of such period indicate high losses, specially and once again regarding the sustainability in the use of resources, where the small fishermen were certainly the most affected. In the past two years, continuity has been provided to the confused process of the division of responsibilities of the Executive Power in relation to the management of fisheries activity.

## 4.9. Environmental Disasters

In the past few years, specially starting from the 1990s, Brazil has been experiencing significant progresses in the reduction of disasters:

a) **National Doctrine of Civil Defense (*Doutrina Nacional de Defesa Civil*) -** The main conquest was the approval of the National Policy of Civil Defense on Dec. 12, 1994, by Resolution no. 2 from the National Council of Civil Defence (*Conselho Nacional de Defesa Civil*). This instrument allowed the general orientation of government performance on civil defense actions, establishing guidelines for all federal agencies. The policy helped to change the paradigm of post-disaster performance, with reduction through preventive and preparatory actions, and consolidation of the National Doctrine of Civil Defence.

b) **New Paradigm -** Since the approval of the National Policy of Civil Defence, priority has been given to the continuous action of states and municipal districts for prevention and preparation. Considering the objective “to eliminate disaster” as unattainable, the action “to reduce disasters” was internationally elected, as a group of preventive and preparatory actions (to minimise causes) and in the case of disaster occurrence, response and reconstruction actions (to minimise effects/consequences).

c) **Strengthening of the National System of Civil Defence (*Sistema Nacional de Defesa Civil* - SINDEC) -** legal instrument that establishes the responsibilities of each agency composing the System, at three government levels. It is composed of a deliberating organism, represented by all sectorial areas of the government, to approve guidelines and actions among the governmental agencies.

d) **Regulation of the decree covering emergency and public disasters situations -** the identification of the disaster occurrence is based on preponderant and aggravating technical criteria.

**e) Creation of CEPED agencies –** Academic Study Centres and Researches on Disasters (*Centros Universitários de Estudos e Pesquisas sobre Desastres* - CEPED) installed in Brazilian Universities. Presently, the CEPED of Campina Grande in the State of Paraíba is reactivated and another one was created in the Federal University of Santa Catarina (UFSC). The later has been developing projects with the Civil Defence State Management (*Diretoria Estadual de Defesa Civil* - DEDEC) of the State of Santa Catarina.

**f) Priority given to COMDEC agencies –** Civil Defence Municipal Co-ordination (*Coordenadoria Municipal de Defesa Civil* -COMDEC), is the main civil defence agency, and is responsible for co-ordination at the site of the disaster and the first to act under circumstances of disasters - prevention, preparation, solutions and reconstruction.

**g) Partnership with technical agencies to do follow-up** - Agreements with federal and state technical institutions to inspect works and services and motivate agreements with states and municipal districts. This measure has been assuring the fulfilment of the expected results both in quantity and in quality.

**h) Legislation on dangerous products** as well as inspection of the procedures in several transport areas, in the scope of MERCOSUR .

**i) Legal Aspects** - Legislation has been progressing, through constitutional texts, both at federal and state levels, as well as the infra-constitutional legislation. Much is still needed for the multi-sector approach demanded by the management of disasters.

**j) Voluntary work** - Participation of volunteers and companies (in preventive and emergency actions of civil defence), motivated by campaigns developed during the International Volunteer Year in 2001.

### 4.9.1. Information on the NATIONAL SYSTEM OF CIVIL DEFENSE (*Sistema Nacional de Defesa Civil* - SINDEC)

Decree no. 895, of August 16, 1993, regarding the organisation of the National System of Civil Defence - SINDEC as well as offering other provisions, has established, in clause 4°, that SINDEC should have the following structure:

**a) Superior Agency** - National Council of Civil Defence (*Conselho Nacional de Defesa Civil* - CONDEC) constituted by representatives of the ministries, of the three Armed Forces and of the Secretariat of the Presidency.

**b) Central Agency** – National Secretary of Civil Defence (*Secretaria de Defesa Civil* - SEDEC) subordinate to the Ministry of National Integration (*Ministério da Integração Nacional*).

**c) Regional Agencies** - Regional Co-ordination of Civil Defence

**d) State Agencies, of the Federal and Municipal districts** - Co-ordination of Civil Defence (*Coordenadorias de Defesa Civil* – CEDEC), Municipal Co-ordination of Civil Defence (*Coordenadorias Municipais de Defesa Civil* - COMDEC) and Community Centre of Civil Defence (*Núcleo Comunitário de Defesa Civil* - NUDEC).

**e) Sectorial Agencies** - Agencies and Entities of Public Management - Federal, State and Municipal belonging to SINDEC.

**f) Support Agency** - Agencies and Public and Private Entities, at the three government levels, supporting and promoting SINDEC.

### 4.9.2. The National Policy of Civil Defense

The above-mentioned Decree no. 895, in its clause 6, established that the National Council of Civil Defence would have the following abilities:

**a)** approve policies and guidelines of governmental action of civil defence; and

**b)** approve the criteria for the declaration, homologation and recognition of Emergency and Public Disasters Situations.

While performing these functions, CONDEC, through Resolution no. 02, of Dec. 12, 1994, approved the National Policy of Civil Defence that was homologated by the President and published in the Federal Official Gazette no. 01, on Jan. 2, 1995.

In the same resolution CONDEC approved the General Classification of Disasters (**Appendix I**) and the Code of Disasters, Threats and Risks (*Codificação de Desastres, Ameaças e Riscos* -CODAR) (**Appendix II**) adopted in Brazil, both included in the referred manual.

It is important to mention that:

**a)** Brazil was the first country in the world to approve a National Policy of Civil Defence.

**b)** This policy is compatible with the Brazilian reality and has been showing development in the Brazilian Doctrine of Civil Defence.

### 4.9.3. The Brazilian System of Information on Disasters - SINDESB

In addition to performing their responsibilities, CONDEC, through Resolution no. 03, of July 2, 1999, approved the *Manual for the Decree on Emergency and Public Disasters Situations*, which made official the institution of the Brazilian System of Information on Disasters (*Sistema Brasileiro de Informações sobre Desastres* – SINDESB) as well as two standardised forms of information on disasters, both included in this Manual:

- Preliminary Notification on Disasters -NOPRED - (**Appendix III**)
- Evaluation of Damages -AVADAN – (**Appendix IV**)

Presently, SINDESB is in an implementing phase. Considering the great geographical extension of this country, the full implementation of the Information System is not an easy task. For this reason the National Secretary of Civil Defence would very much like to receive international support to accelerate the implementation of the Information System all over the national territory.

## 4.10. Urban and Industrial Areas

Brazil is presently a country whose population lives mainly in urban areas. Therefore, urbanisation becomes an irreversible process and is intrinsically associated to the model of development in force. The pressure exerted by the concentration of population and activities on the space and base of natural resources; the condition of the urban environment, expressed in the quality of the waters, air and soil; and the impacts of this process, above all in the health condition and in the quality of life of the population, demand answers that include both the protection and recovery of the natural environment as well as the reduction of deep social inequalities in the production and consumption of goods and environmental services.

Among the answers presented here some instruments and institutions created with the objective of reinforcing the management of the urban environmental component are highlighted. This is the case of the recently approved "City Acts" and the implementation of the National Agency of Waters under the Ministry of the Environment, already mentioned in previous sections of this chapter. Another highlight concerns the investments and programmes that have been applied in essential areas, such as basic sanitation, popular housing and urban transport, all formulated under the inclusion perspective of the environment issue.

The City Acts approved by Law nº 10.257, of July 10, 2001, regulate clauses 182 and 183 of the federal constitution of 1988 that deal with urban policy. These Acts, when regulating constitutional demands, gather norms related to the action of public power in the protection of the use of urban property on behalf of public interest. These norms relate to citizens' safety and well-being as well as environmental equilibrium. At this moment, the City Acts represent hope for positive change in the urban scene. This is because it reinforces the performance of local public power with powerful instruments that, if used with responsibility, will allow consequent actions for the solution or minimisation of the serious problems observed in the Brazilian cities. These problems include distant suburbs without services or essential equipment, growing slums, invasions, shanty towns and swamps. They also include speculative use of lands, accumulation and growing urban verticalisation, water, soil and air pollution .[3]

The National Agency for the Waters (*Agência Nacional de Águas* - ANA), created by Law nº 9.984, of July 17, 2000, is responsible for the execution of the National Policy Water Resources, as well as the co-ordination of the National Management System of Water Resources. Among other attributes it is also responsible for the control and the granting of use of the water in federal rivers. It performs within an institutional perspective that favours the decentralisation of management, reinforcing regional instances.

[3] Ver Oliveira 2001 Estatuto da Cidade; para compreender...

Again, institutionally, a Secretary for Environment Quality in Human Settlements was created in 1999, introducing the concept of the Brown Calendar into the Ministry of the Environment. The objective of this calendar is to harmoniously equalise the environment issue with the economic and social problems of the country. At the same time, the objective is to prevent and correct the causes of contamination and degradation of the urban environment.

The Ministry of the Environment, based on a survey of requests regarding cities sent to the Ministry, and seeking to guide and optimise its specific performance in 1999, concluded that most of the concentration of urban problems was in the area of solid residues management, specially concerning the final destination.

#### 4.10.1. Solid Residues

Thus, a new culture related to the management of solid residues has been consolidating. This culture focuses on the social and environmental sustainability of projects financed with federal resources. The concept of integrated management was adopted in the whole financing programmeme covering solid residues. A plan of integrated management was demanded from the municipal districts. Conditions for the approval of the application of resources to the commitment by the municipal district were the eradication of child labour in dumps and the elaboration of a social project for the inclusion of garbage collectors in a programmeme of selective collection.

The results of the National Research of Basic Sanitation (*Pesquisa Nacional de Saneamento Básico* – PNSB 2000) reveal that the performance of urban clean up demonstrated improvement throughout Brazil over the last decade. This was true from collection to the final destination of solid residues. This improved performance can be attributed to several factors. The decisive ones are highlighted bellow:

**a)** Increase of consciousness of the issue on behalf of the population and organized sections of society;
**b)** Improvement of municipal management, in response to pressure from the population, the Public Prosecution Service and agencies of environment control of the states and the Union; and
**c)** Availability of financial resources through federal and state programmemes.

In spite of all positive forces, the desirable quality has not been reached yet, particularly in reference to the final destination of garbage.

The programmemes described hereafter partly demonstrate recent initiatives for the improvement of garbage management, contributing to minimize the problems related to the inadequate disposition of the residues.

**a) Programmes and Government Investments**
The Ministry of the Environment has been reinforcing a rationalisation strategy for the application of federal resources in solid residues, and has been developing programmemes and offering investments to solve the garbage problems.

**b) Programme Brazil Plays Clean**
This deals with the management of solid residues in cities. Some of its objectives are to reduce garbage growth and to improve and increase its collection guaranteeing some adequate and final disposal. Another objective is to promote recycling and reuse with proper environmental treatment.

**c) National programmeme Garbage and Citizenship**
The primary objective is to remove all children who work or live in dumps, placing them in an educational and healthy social context. Other objectives are to encourage and develop programmemes of selective collection and to eradicate the dumps by recovering their degraded areas. More than 30 governmental and non-governmental organisations participate in the National Forum programmeme, a UNICEF initiative. The programmeme basically believes that the municipal districts should solve their solid residues problems through participating in strategies involving all local participants that actually live with the situation.

**d) Financing of Solid Residues**
Resources applied on the integrated management of solid residues are indicators of this performance. In the year 2000, R$13,800,000 were destined to projects of integrated management of urban solid residues, favouring 45 municipal agencies in several areas of the country. Another R$21,900,000 originating from the fines applied to Petrobrás for the oil spill in Guanabara Bay in 2000. These are being

applied in the management of solid residues of 13 municipal districts that integrate the Basin of Guanabara Bay organized as a consortium (CONIMA - BOX on garbage and Conima). In 2001, another 114 projects of integrated management of urban solid residues in the Brazilian municipal districts were given assistance, totalling R$32,000,000 of investments in the area.

The eradication of dumps is a serious sanitary, environmental and social problem. Projects towards this objective are outstandingly demonstrated in demands sent to the Federal Government, through the Ministry of the Environment. This year, they amounted to R$514,000,000 in investments, including requests sent to The National Fund of the Environment (*Fundo Nacional do Meio Ambiente* – FNMA).

#### 4.10.2. Urban Environment Management

**a) Urban Environment Management Project**
This project is being executed with technical co-operation from the German Government, through the GTZ Agency. This agency operates in the field of training and education of human resources for the elaboration of projects and the integrated management of solid residues, environment sanitation, use of the soil and urban public transport. In the first phase of the project (2000-2003) GTZ contributed with about five million marks (approximately 3.5 million dollars).

**b) Urban Environmental Management Project in the Amazon**
This project is being executed with the technical and financial support of the Dutch Government (Holland) and is directed to the development of actions, with local and regional focus, directed to the improvement of the quality of life of the population, sustainable development and reduction of negative impacts on the environment. Pilot projects of processes for the management of residues are being developed in nine Amazonian municipal districts, where processes and adequate forms are being tested to face the serious environmental and public health problems resulting from the produced garbage.

Studies have been accomplished involving several organisations (MMA/SQA/GAU, GTZ, FNMA, CEF, FUNASA and CETEC-MG). These studies have made an effort to estimate the necessary amount of resources to eliminate the deficit in garbage collection, recovery of degraded areas and installation of sanitary embankments in the entire national territory.

In the wider scope of sanitation, the federal government has been promoting financing programmemes directed to solving problems of the urban environment agenda.

**c) Pro-sanitation**
This is a programmeme linked to the Special Secretariat of Urban Development of the Presidency (*Secretaria Especial de Desenvolvimento Urbano da Presidência da República* – SEDU/PR) searching to promote improvement in the conditions of health and quality of life of the population. It is composed of sanitary actions, seeking to increase the coverage of services of water supply, sanitation drainage, urban drainage and management of solid residues, including institutional development actions.

**d) Prosanear**
Also linked to SEDU/PR with community participation, this programmeme seeks to promote integrated sanitation actions in areas with urban characteristics and occupied by low income populations (groups of families with income of up to three minimum wages), through appropriate technical solutions and at low cost, implementation, operation and maintenance of the systems.

**e) Programme of Sanitary Social Action - PASS**
This is a programmeme linked to SEDU/PR, searching to implement services of environmental sanitation. The programmeme gives emphasis to the improvement of health and life conditions of communities located in the main slums of the country, preferentially in the small and medium sized municipal districts, selected by the programmemes Reduction of Mortality in Childhood (*Programa de Redução da Mortalidade na Infância* - PRMI) and Solidarity Community (*Programa Comunidade Solidária* - PCS).

Additionally, the PASS programmeme - Touristic Cities (*Programa PASS – Cidades Turísticas*) is focused on the improvement of the touristic and potentially touristic municipal districts that integrate the National programme of Tourism Municipalization (*Programa Nacional de Municipalização do Turismo* - PNMT). This programmeme is intended to reduce tourist dissatisfaction by 50 per cent, by cleaning urban areas in the cities and incorporating a list of defined actions.

**f) Programme of Urban infrastructure (GO-INFRA – *programmea de Infra-estrutura urbana*)**

This is a programmeme linked to SEDU/PR for the reduction of displacement costs, of environmental pollution and of traffic accidents through actions giving priority to public investments in urban public transport and in road safety. By giving support to the actions undertaken by the Inhabit-Brazil and PASS programmemes, it also aims to reduce risk and insalubrities in inhabited areas with low income populations, located across the entire national territory. Among the affected financing interventions are those related to improvements in the urban infrastructure in degraded, unhealthy or risky areas.

**g) Programme to Housing in Brazil (*Programa Habitar Brasil*)**

This programme's principal objective is to ameliorate the quality of life of low income families, predominantly those which income equal or inferior to three monthly minimum wages, living in subnormal agglomerates located in state capitals or municipal districts belonging to metropolitan areas or in urban agglomerations. Linked to SEDU/PR, it depends on the financing of the Inter-American Development Bank (IDB), and directs its resources mainly to the institutional development of municipal districts for the execution of projects and infrastructure services, besides motivating community development actions.

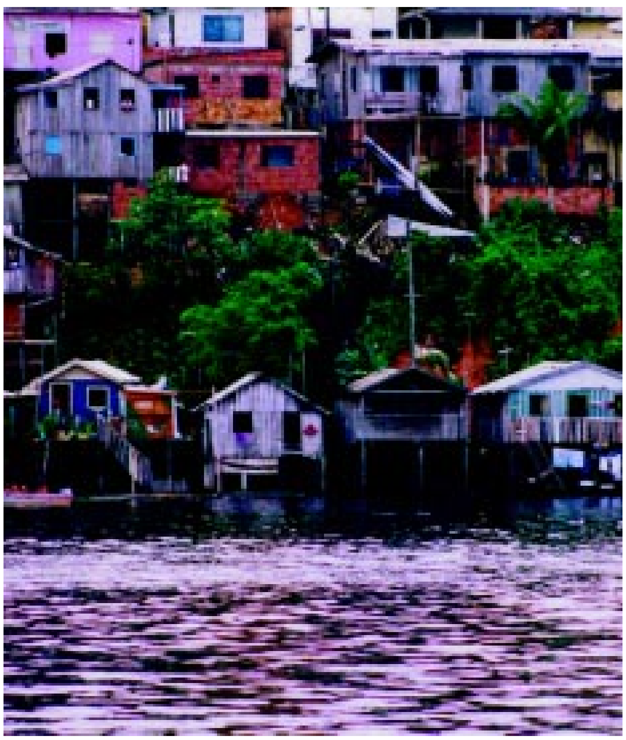
**h) National Fund of the Environment (*Fundo Nacional do Meio Ambiente* - FNMA)**

Created in 1989 (Law nº 7.797/89) it is an important decentralisation instrument of environmental policy in the country. It has a wide reach and flexibility to include municipal projects, linking plans of public management, NGOs and society. The law on environmental crimes established that a percentage of the collection of resources coming from fines and infractions would go to the FNMA.

**i) Progress in Urban Environmental Management**

Still referring to sanitation, significant progress has been observed more recently in the Brazilian cities (including understanding what sanitation really is). It is interesting to note that if sanitation progress of the seventies was linked, above all, to the technological aspects more directly linked to the execution of projects, the present alternative technological proposals and, mainly, the innovative initiatives in the field of service management become the most important issues of the area. An aspect of great importance in the change of direction was the assimilation of a new vision on public policy, which is based on the decentralization of responsibilities and procedures.

The new vision that appeared on the sanitation issue was demonstrated through the National Consultation on the Management of Sanitation and of the Environment. This Consultation renewed the methodology of the consultation of society sectors. This was accomplished by the Brazilian Institute of Municipal Management (*Instituto Brasileiro de Administração Municipal* - IBAM) in 1995 (sponsored by CEF/PMSS-IPEA/BIRD). It includes the capitals of nine metropolitan areas and five medium-sized cities of *the country (Volta Redonda, Florianópolis, Campo Grande* and others). The results demonstrated consensus of positions concerning the need for municipal districts to participate more intensely in the conduction of the sanitation policy, the decentralization of urban environmental management and the inclusion of the urban environmental theme in



the agendas on investments and government actions as well as of the guidelines of non-governmental organisations.

Another prominent conclusion from the National Consultation incorporates the environmental dimension in the forming and implementation of public policies made concrete through the adoption of the unit of hydrographical basins as a stage for the planning and management of conflicts around the multiple uses of the water. In this case, the concept is magnified to demonstrate that the inclusion of the pollutant and degrading effects of human life is an important variable to be considered when one decides about the location of pollutant economic activities, the use of water resources as sources of provisioning or effluent receptive bodies. This also includes the technology to be adopted in the implementing of sanitation projects and the people to be assisted.

#### 4.10.3. Combat against Deficits and Wastes

Costs are very high when it comes to correcting the effects of environmental degradation on the health of people and the survival and integrity of environmental resources. These resources are essential to human life. In this sense, the programmes of environmental sanitation currently in action or executed in the last decade in several metropolitan areas of the country, as is the case, for instance, of the Depollution programme of the Water Basin of Guanabara Bay, in Rio de Janeiro, and of the programme of Environmental Sanitation of the Water Basin of Guarapiranga, in São Paulo, involve answers representing investments in the amount of hundreds of million of dollars and reaching equally numerous populations.

While facing the housing deficit most efforts are still accomplished by the population. This occurs through countless private or collective enterprises. Construction is undertaken by the residents themselves with the assistance of working groups. This takes place without any public financial assistance. In the period 1964-1986, about 27 percent of the new construction received some type of official housing financing. However, research done by the *João Pinheiro Foundation* (2001) estimated a drastic reduction in this rate during the nineties (something around 11 percent). This rate, in spite of being low, in view of the Brazilian reality, approaches the patterns of some European social democracies.[4]

In the fight against the waste of natural resources and energy in the Brazilian cities, some programmes are being performed. It is important to mention the Network of Efficient Cities in Electric Power (*Rede Cidades Eficientes em Energia Elétrica*). This network is of national importance and seeks to facilitate the exchange of information on efficient management forms, technologies, experiences and projects of energy efficiency among the Brazilian municipal districts and other countries that develop initiatives in the combat against electric power waste. The Network of Efficient Cities in Electric power is linked to PROCEL – National programme of Conservation of the Electric Power, in partnership with Eletrobrás and the Brazilian Institute of Municipal Management - IBAM – searching to promote the reduction of consumption and electric power expenses in the Brazilian municipal districts. There is also a search to concentrate efforts to accomplish projects and implement measures against electrical power waste, besides creating and strengthening municipal competence in the management of the electrical power.

[4] Ver Fundação João Pinheiro 2001 - Déficit habitacional no Brasil 2000

Urban environmental management also demonstrated progress in the participation of social organisations, particularly through committees, co-operatives and community councils. The issues of water resources, solid residues and areas of environmental protection have been treated with great importance by such movements. The committees of hydrographical basins join distinct social participants and lead to the enlargement of the local scale to the supralocal and to the management of multiple interests in the use of the water.

These initiatives have been experiencing recognition from the population as well as from the public agents, through consultation of management processes or during the execution of projects.

In turn, the formation and organisation of co-operatives of garbage scavengers are multiplying in the Brazilian cities. These co-operatives, besides stimulating joint enterprise, contribute to the reduction of generated garbage volume and social waste and to the increase of recycling and reuse of solid residues.

The managing councils of natural resources and ecosystems are usually composed in a non-heirarchical fashion. They open the way to incorporating the community contributions in several modalities. The public and private partnerships are included in this list and have been making possible the improvement and conservation of the natural and cultural patrimony.

### 4.10.4. Company and Environment

Referring to business actions and the large environmental responsibility in the private sector, a growing adoption of clean production technologies has been observed. These minimise the generation of residues and of emissions and released thrown in the atmosphere. Also, the social responsibility of the private agents is a present demand in the current development process. The increase in environmental demands from the world-wide consumer market has been forcing national companies to adopt attitudes following the rules of the dispute for a place in the international trade arena.

The industrial consumption of water and the impact of contamination of water resources were significant in the 1980's. They demonstrate positive alterations in the need for reduction of production costs and energy consumption, as well as the execution of legal demands and the adaptation to market requirements.

The implementing of an Environmental Management System within the companies represents the adoption of an instrument capable of generating a quality differential in the internal and external markets, following the improvement in quality and in performance of activities.

When referring to environmental certification, the number of companies in Brazil with ISO 14000 certifications grew from two, in 1995, to three hundred and thirty in 2000. This number may still be considered to be low if compared to the number of companies, potentially pollutant or not, existing in the country.

**Chart 8 - ISO 14,000 Certifications in Brazil – 1995-2000**

| Dec 1995 | Dec 1996 | Dec 1997 | Dec 1998 | Dec 1999 | Dec 2000 |
|---|---|---|---|---|---|
| 2 | 6 | 63 | 88 | 165 | 330 |

Source: The iso survey of ISO 9000 and 14000 certifications tenth cycle - 2001

## 4.11. Health and the Environment

In order for the Ministry of Health to establish an environmental health policy it is fundamental that *FUNASA* develop solid links with the other MH agencies in charge of developing environmental health actions and activities. Thus, *FUNASA* submitted a draft proposal to set up a Permanent Environmental Health Commission at the Ministry of Health. This Commission, created on December 11, 2001 through Ministerial Decree no. 2253/GM, is formed by *FUNASA*, *ANVISA*, *FIOCRUZ*, the MH Health Policies Secretariat, the MH Executive Secretariat and the Minister of Health's Office.

### 4.11.1. Institutional Links for Health Management

In addition to intraministerial links, the Ministry of Health's links with other ministries are very important in order to ensure that *SINVAS* is well structured and operational. The most relevant of these ministries are the Ministry of the Environment, the Ministry of Labour, the Ministry of Foreign Affairs, the Ministry of Education, the Ministry of Planning, besides other Federal Government agencies and organisations (CGVAM, 2001).

Working towards this goal, the Ministry of Health signed a Technical Co-operation Agreement with the Ministry of the Environment with a view towards developing a set of integrated environmental health policies and actions and strengthening initiatives to increase these actions' institutional, political and socio-environmental impacts. The Health and Environment Co-operation Agreement, signed by the Ministry of Health and the Ministry of the Environment on November 7, 2001, aims at setting up a federal government environmental health agenda so as to

identify priority co-operation areas to be part of the pluriannual action plan.

Social participation in *SINVAS* will take place through the National Health Council (*CNS - Conselho Nacional de Saúde*), the National Environmental Council (*CONAMA - Conselho Nacional do Meio Ambiente*), and other alliance mechanisms such as the private sector, non-governmental organisations (NGOs), unions, etc.

In addition, the *Working Group on International Health and Environment Issues* was created on June 21, 2001, through Ministerial Decree 922 issued by the Ministry of Health. This working group aims at discussing and incorporating health and environmental issues dealt with in international agreements, treaties, conventions, protocols and other international law documents into the Brazilian legal system. Through this forum, *FUNASA* has been able to contribute to the Ministry of Health's participation in the process of assessing the implementation of Agenda 21, and in the preparations for the Rio + 10 Summit, to take place in Johannesburg, South Africa, in September 2002.

The Ministry of Health acts as vice-president to the Chemical Safety Action Plan Co-ordinating Commission (*COPASQ - Comissão Coordenadora do Plano de Ação para a Segurança Química*), which also includes *FUNASA*, *ANVISA* and *FIOCRUZ*. A set of 16 priorities was agreed on, and their related actions are carried out and followed up on by their respective co-ordinating institutions. *COPASQ* was established by the Ministry of the Environment in April 2001 to meet the commitments made by the Brazilian Government to implement the principles, guidelines and priorities described in Chapter 19 of Agenda 21 and consubstantiated in the "Bahia Statement" and the "Priority Action Lines for Beyond 2001" during the 3rd Section of the Intergovernmental Forum on Chemical Safety – IFCS, which took place in Bahia in October of 2000. FUNASA co-ordinates Priority no. 10, which determines the presentation of a "Report on Risk Reduction Initiatives for Chemicals of Major Concern".

In order to ensure the quality of the water distributed to the populations who have access to treated water, the Ministry of Health has started, through the National Health Foundation - *FUNASA*, the implantation of the Information System for Health Surveillance related to Water Quality for Human Consumption (*SISAGUA - Sistema de Informação para a Vigilância à Saúde relacionada à Qualidade da Água para Consumo Humano*). With the legal support of Ministerial Decree no. 1469/2000, the Brazilian government has been given access to an information system able to indicate the main risk zones in the country (according to control and surveillance data), which will enable it to monitor and plan the interventions to enlarge and improve the quality of the water distributed to the population (CGVAM, 2001).

Despite being FUNASA's direct responsibility, SINVAS's implantation demands the various agencies within the Ministry of Health that develop environmental health action to form alliances and co-operate, including:

**a)** National Health Surveillance Agency (*ANVISA - Agência Nacional de Vigilância Sanitária*) – This agency is in charge of controlling health products and services, as well as work places and other environments that present a potential threat to public health. In regard to health services residues, *ANVISA* has been promoting a Public Consultation (no. 48 of July 4 2000) with the objective of establishing technical rules for general guidelines on how to deal with such residues. The main aspects of this proposal include the obligatory management by the generating sources and the minimisation and segregation of the residues. The said proposal also includes the application of technological alternatives to treat and dispose of the residues, so as to contribute to the promotion of public and environmental health (MH, *ANVISA*, 2001);

**b)** Oswaldo Cruz Foundation (*FIOCRUZ – Fundação Oswaldo Cruz*) – This foundation is responsible for several science and technology programmemes and projects, as well as the development of environmental health human resources;

**c)** Secretariat for Health Policies (*SPS - Secretaria de Políticas de Saúde*) – This secretariat is subordinate to the Ministry of Health. Its Science & Technology Department has been co-ordinating the "*Cidade dos Meninos*" programmeme, its Strategic programmeming Actions Department co-ordinates the Workers' Health Technical Group, and it is also responsible for the Health Promotion Co-ordination and for a programmeme of community health agents (PACS) and a Family Health programmeme (PSF);

**d)** **International Issues Department (*AISA - Assessoria de Assuntos Internacionais*)** – This department of the Ministry of Health co-ordinates and links the activities related to the implementation of environmental health international agreements; and

**e)** Other forums and organisations within the Ministry of Health that develop environmental health related actions.

Some universities have been acting as FUNASA's Environmental Surveillance Collaborating Centres, such as the Rio de Janeiro Federal University, which developed a series of courses on Environmental Epidemiology and Hazardous Residues Risk Evaluation through its Collective Health Study Centre and also collaborated towards the implantation of the Basic Course on Health Environmental Surveillance (*CBVA - Curso Básico de Vigilância Ambiental em Saúde*)

### 4.11.2. Society's Participation

After the 1992 UN Conference on Environment and Development (RIO 92), the Pan-American Health Organisation – PAHO held the 1995 Pan-American Conference on Health and Environment in Sustainable Human Development with the purpose of defining and adopting a set of health and environment policies and strategies, as well as establishing a Regional Action Plan on sustainable development to interact with the various national plans to be created by the other American countries and presented during the conference.

In order to implement the National Action Plan on Health and Environment in Sustainable Development, a decentralised consultation process involving the technical-scientific community and organised civil society in Brazil resulted in a set of guidelines for health, environment, sanitation and water resources policies and actions, as well as requisites for integrated actions involving other sectors of society.

Based on these guidelines, Brazilian society has been working through civil society organisations, specially environmental organisations, trade unions and professional associations, as well as participating in local, regional and federal health and environmental councils, independently or jointly with the government, in an attempt to raise issues, plan demonstrations and carry out actions to protect health and the environment, thus defining goals and attaching meaning to the proposals and initiatives at local, national and global levels.

The government, on the other hand, has been trying to establish policies and plan and implement activities and actions that may fulfil the expectations and provisions of international agreements at different levels, including health and environment ones. These agreements protect all sorts of interests, principles and projects, and may lack the necessary coherence to reach the fairest goals and save lives and suffering. However, considering the issues addressed herein, it is important to remember that many governmental initiatives at federal, state and municipal levels have been implemented and their positive effects are already visible, despite their recent implementation.

These efforts are expected to develop and intensify in the future, given the importance of this issue for the improvement of present and future populations' living conditions and welfare, as well as the need to promote methods of production, circulation and consumption that ensure sustainability and equity in our society.

## 5. Challenges

The government's programmemes and projects implemented over the past 40 years aimed at the transformation of the production structure and at national integration have produced radical changes in the socio-economic scenario of some regions and substantially accelerated the occupation of their territory. Some of the results of this process have been particularly important. This is specially true for those that resulted in better transport and communications networks, thanks to the opening of inter- and intra-regional roads that led to a significant change in the existing land articulating patterns.

On the other hand, the same process has simultaneously generated serious social and economic contradictions characterised by conflicts involving the regions' traditional populations. These conflicts were aggravated by the fast and improper exploitation of natural resources, causing severe damages to the regional flora and fauna, and reached alarming levels due to the ever more frequent deforestation actions and clearing and burning forest clearing.

The growing cumulative concentration of all sorts of environmental uses and abuses in a certain area inevitably leads to the gradual loss of its resilience capacity and generate a number of previously non-existing vulnerabilities.

The growth of certain sectors of the economy directly related to agriculture and mining followed the model described above. The production and consumption methods adopted then and their interrelations with that area's specific environmental, economic, social, cultural and ecological dimensions resulted, in the end, in the progressive deterioration of living conditions. Consequently, quality of life of both the traditional population and immigrant groups is detrimentally affected as well. Some corrections became necessary and determined the introduction of significant changes in land occupation patterns, affecting agroforestry activities and urban occupation as well as their present forms. Even though this process of change has already started in various areas of action, it is far from over.

The Brazilian Government is aware of these contradictions and is committed to a comprehensive long-term approach to development. It understands that it is vital to apply some corrections in the current occupation/ exploitation process, and that these corrections will determine the creation of a new regional development model that incorporates adequate environmentally sustainable principles and processes.

The realisation that it is necessary to modify the traditional approach to land management, with the consequent shift of focus regarding the supremacy of economic goals at any cost is a reflex, on the national level, of deeper changes that are affecting our social and economic structures and the trade relations that characterise their dynamics. These changes were followed to a certain degree by international pressure in order to guarantee that the corresponding adjustments were made. Although incipient at the beginning if compared to First World countries, the role played by Brazilian society has grown significantly over the past few years, and is now able to exercise sufficient pressure on governmental institutions, forcing the implementation of the above-mentioned corrections.

As already mentioned at the beginning of this chapter, the 1988 Federal Constitution assigns to the Union the power to "prepare and carry out national and regional plans for ordaining the territory and for economic and social development" and to the Union, the States, the Municipalities and the Federal District together to "protect the environment and fight pollution in any of its forms", and to "preserve the forests, fauna, and flora". Ordaining the territory is to be understood as "the territorial expression of the economic, social, cultural and ecological policies of any society. It is at the same time a scientific matter, an administrative technique and an interdisciplinary and global practice tending to promote balanced regional development and the physical organisation of the space according to a set of guiding principles (IBGE, 1990, p.4).

The implementation of the previously mentioned guiding principles and the constitutional attributions requires the creation of an instrument able to guide governmental policies and the proper planning of the corresponding growth strategies. This instrument shall be based on sustainability criteria directed towards compatible economic interests, better quality of life and preservation of the environment.

In this context, the National Ecological & Economic Zoning programmeme (*ZEE – programmea de Zoneamento Ecológico e Econômico*) represents a clear expression of the Brazilian Government's efforts to create the necessary tools and database, and to establish a land development planning, monitoring and control process that will

**BOX 7 - The Amazon Vigilance System (SIVAM) as a Political Response for the Brazilian Amazon**

**The Amazon Vigilance System (SIVAM) appeared as a response from the Brazilian government to avoid activities that cause degradation in the Brazilian Amazon. This is done through the search for broad and integrated knowledge about this highly visible region. It also allows for the effective control of criminal actions that imperam the Amazon region. At the same time there is an effort towards making the various agencies in the region work together in a co-ordinated and optimised fashion. Finally, SIVAM has been establishing a new order in the region. This translates into practice in a network for the collection and processing of information that is treated in an adequate and integrated fashion. This network makes up a large knowledge base where all governmental agencies acting in Amazônia participate.**

**The System counts on an infrastructure of technical methods that include: remote sensoring, environmental and meteorological monitoring, the use of communications, radar tracking, computer resources and telecommunications methods.**

**The SIVAM infrastructure depends on a General Coordination Centre (CCG) and three Regional Vigilance Centres (CRV) located in: Manaus (inaugurated in July/2002), Porto Velho (to be inaugurated in October/2002) and Belém (to be inaugurated in January/2003). They are integrated, functional and operational. The System also depends on Remote Agencies that are linked to the CRVs via satellite. They are responsible for the collection and transmission of information to the corresponding CRVs. Various Vigilance Units (UV) make up part of this infrastructure.**

**Once implanted, the operations of the infrastructure will be accomplished through the Amazon Protection System (SIPAM).**

**In terms of the environmental area, SIVAM will count on the Environmental Cell project which is anticipated for action in the Environmental Vigilance area through four groups of applications:**

1) **Group of Ecosystem Functions;**
2) **Group of Water Functions;**
3) **Group of Atmospheric Monitoring;**
4) **Group of Sustainable Development Support.**

**A wide variety of federal agencies will participate in the project. These include:**

- **National Meteorology Institute (INMET);**
- **Brazilian Geography and Statistics Institute (IBGE);**
- **Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA);**
- **National Institute of Space Research (INPE);**
- **National Indian Foundation (FUNAI);**
- **Federal Police Department (DPF);**
- **Special Units of the Navy, Army, and Air Force, including Pelotões Especiais de Fronteira;**
- **National Institute for Agrarian Reform (INCRA).**

**With the inauguration of CRV/Manaus, the System enters a pre-operations phase, where the cartographic products and reports will be tested and adjusted in addition to the other products that will be made available to the various partners. The technical teams will be trained and qualified in the various technologies of the System. Definitive operations will occur in approximately one year.**

progressive lead Brazil towards the necessary changes. The *ZEE* programmeme is the government's main strategy to ordain the territory and contribute to the "adequacy of land organisation and use with a view towards an integrated, harmonious and sustainable development of the country's different regions." As a strategic instrument to achieve the said goal, both to define zones of occupation and use for selected activities and to prohibit their use altogether, the *ZEE* programmeme defines the analysis and prospective view of land occupation, enables the formulation of scenarios for land use, and seeks alternatives for its implantation. It represents the development of land use evaluation that may effectively incorporate the integration of economic, social and environmental domains into the decision making process.

The implantation of such a programmeme including all available natural resources, as well as the "socio-economic resources deriving from land appropriation, and the legal, institutional and financial aspects" requires institutional alliances among a wide variety of sectors of the same hierarchy at different levels of government. In view of the complexity of this process, the fragile application of the *ZEE* programmeme often tends to enable a reductionist and opportunistic view which, on the other hand, stresses even more the need to face the challenge of integration and compatibility of the various segments involved.

With the best institutional reforms carried out over the past two decades, the country is now facing the imperative need to make better use of its federal structure (supposedly through the due municipal integration) associated to instruments enabling greater social participation. This goal is to be attained by creating certain organisations, systems and programmemes meant to link public policies and institutions at the three levels of government, such as new management systems and boards, sectorial councils and, more recently, regulatory agencies.

With the above-mentioned management systems, the treatment given to public policies took on an interdisciplinary and intersectorial approach, at least in regard to political, administrative, economic and social aspects. However, one must not fail to consider the effect of these new institutional arrangements on the land and its natural resources, such as the need for new land planning units that enable the crossing of biomes, ecosystems or water basins.

There are also a number of important impacts resulting from current and scheduled investments that may contribute to redesigning the country's land configuration and redefining the city system. In this context, the international changes (e.g. globalisation of the economy and a greater concern about the planet's environmental conditions) have also affected the federation balance itself. This is true because they imply new specialisation in production methods, the creation of great preservation areas and new links between regional and foreign economies, with considerable reduction in national governments' macroeconomic regulatory powers. The principal characteristic of the recent investments in the country is their being so selective. This benefits areas with better infrastructure and increases the tendency for population concentration. This concentration will consequently lead to a greater demand for natural resources in certain areas and the worsening of the already serious social, economic and environmental problems.

The lack of more participatory policies that could integrate actions of various organisations has disoriented the directly interested social groups and even the public agencies in their search for solutions to satisfy common interests and respect the regional limits of sustainability. In addition, there are no adequate databanks that associate socio-economic data to the use of natural resources according to the environmental planning units. The association of these two factors leads to equivocal diagnoses and concurrent and conflicting actions.

chapter 4

# Environmental management

# environmental management

## Overview

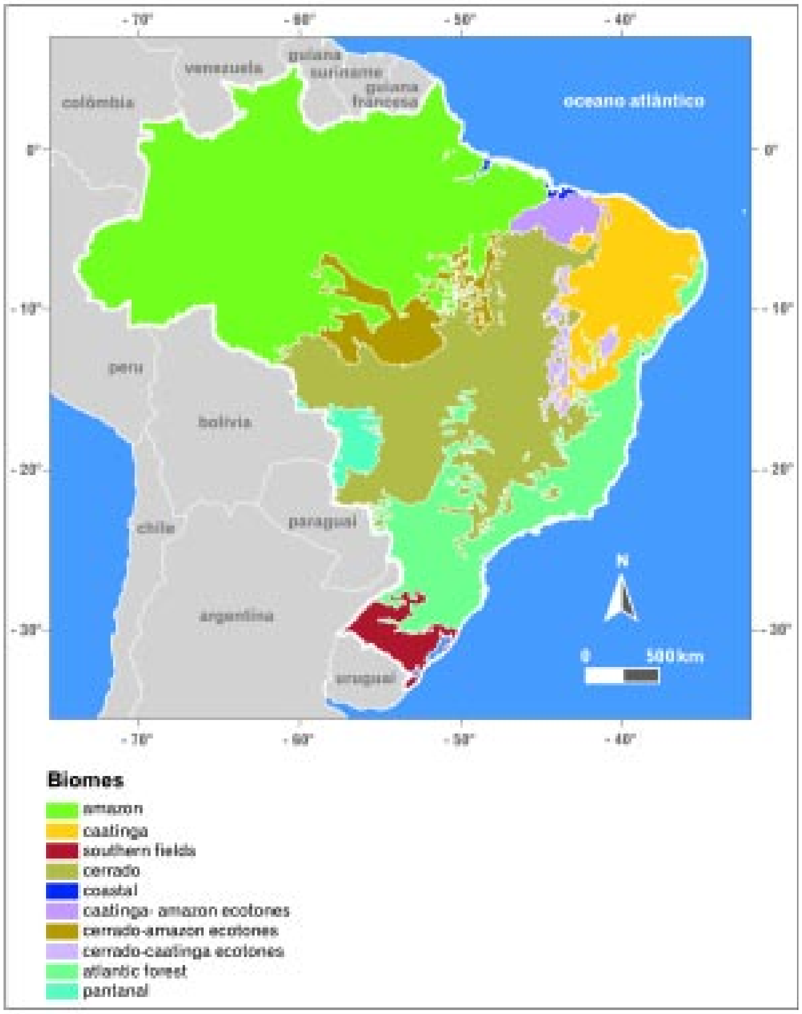
Construction of outlook settings is a major task in becoming familiar with the dimensions involved in the environmental matter and for the contribution to the search for positive solutions. The SPIR (State, Pressure, Impact and Response) methodology is adequate to describe the actions that different social agents impose on environmental conditions, as well as to guide managers in decision making. There is pressure from the very beginning when critical situations are identified in various stages and when responses are expected from the government, society, and companies to prevent and diminish the damages caused to the environment and to recovery degraded areas. This is demonstrated not only through public policy and actions but also mainly through the implementation of environmental management strategy searching for commitment on the preservation of ecosystems and life quality improvement of the population.

The main biomes were defined as spatial units for diagnosis and prospective analysis. Main vectors and their impact causing results were identified for this purpose, forming intentional and desirable scenarios. The impacts - and level, once identified begin to make sense when compared to biomes, at local and regional scales. To permit the integration of ecological and socio-economic conditions, an option for the use of physiographic zones was made, which are municipal groups with similar environmental characteristics, as base territorial units for the biome definition.

Such an option is justifiable for various reasons:

1) a clear environmental component of such spatial classification;
2) its messo-regional dimensions, that provide a establisment of inter-census comparisons, surpassing the frequent problem of successive municipal divisions, making the construction of historic series on detailed levels of spatial deaggregation difficult. The map on main biome and urban-industry areas of Brazil, established from physical-graphic zone aggregation, may be found in **Figure 1. (Maps of Biomes).**

Picture 1 - Biome Map



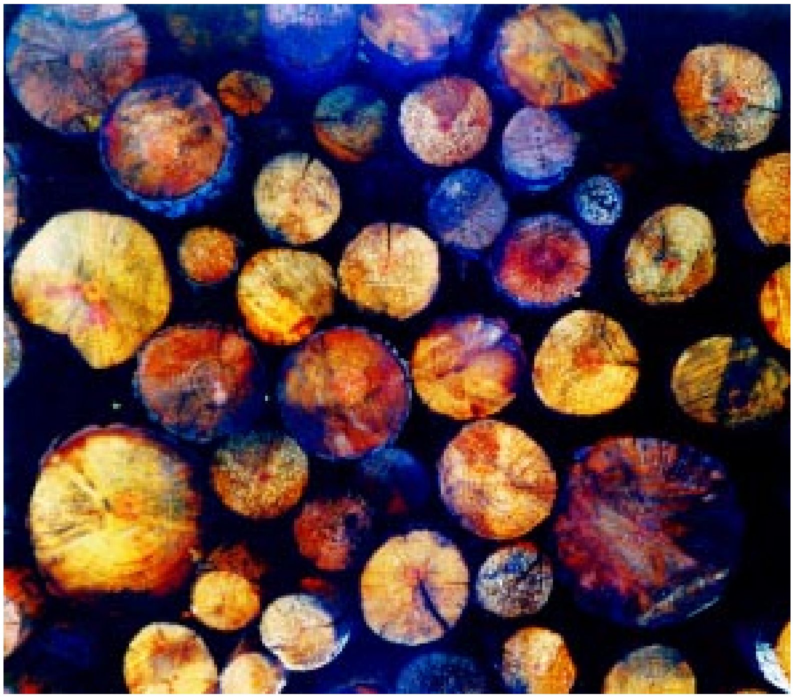

Source : IBAMA

In order to construct strategic scenarios on environmental management in Brazil, we should start from the present situation analysis and recent impact changes on the main biomes, observed as big territorial units with similar characteristics, from the environmental point of view. However, these represent a different area selection from the one used in major statistical data and political-administrative units that construct a basis for policy action and population industrial representation. Assuming that implemented actions should consider these differences, different social participants should be reached as well as resources used in the process of environmental management strategy.

A thematic view was considered and developed by GEO-Brazil, forming an Evaluation Base, trying to synthesise -, each biome is contribution in spatial terms. This includes the urban-industrial areas in order to understand a tendency behaviour and a desirable idea of subjects included in GEO Brazil. According to this conception, two evaluation bases were formed. One includes Pressure and Impact relation, and permits establishing tendencies. The other one is based on the pro-active policies of the present situation. These occur through interactions between impact and response, pointing out the desirable scenario.

## 1. The Continuation of Environmental Pressure: Establishing Trends

Projection of evolution tendencies should begin from global adjustments among several social components, changing the relations between the State and companies. These elements have contradictory points of view that are evident today in the conflicts of interest in the Kyoto Protocol regarding global warming. Controversy exists regarding the conservation of the present biomass supply or in the increase of reforesting areas that serve to absorb carbon from atmosphere. This controversy has a direct influence on the present and suggested use of the huge surfaces of the planet.



These adjustments, not always co-operative and many times conflicting, are part of the context definition of transnational mechanisms for environmental control. Vegetation surface is - both, a carbon reservoir on the earth's surface and a key element in the control of its exchange in the atmosphere. These interrelationships represent an important challenge on conducting and implementing strategic environmental management concepts.

### 1.1 Brazil in the Context of Global Environmental Changes

Brazil occupies an important position on the global scene, as far as global environmental changes are concerned. First, due to territorial and demographic proportions, Brazil is among the ten largest nations in the planet. Secondly, the immense presence of rainforests and fresh water mass, largely untouched, gives Brazil an important participation role in terms of the remaining natural planet cover. Thirdly, the extreme imbalance in social and land income distribution reduces social alternatives and contributes to large spatial movement of the Brazilian population. This is one of the main factors explaining the rapid and extensive changes to land surface and use.

Larger participation in the international market and a significant reduction in the State's business role caused the substitution of a national developing project with global macro-economic stability, limiting substantially planned territorial intervention. This made the process even more selective and more dependent on the private sector and the international financial system.

Large dependence on foreign financial resources results in vulnerability to speculative international actions and maintenance of high interest rates, reducing the pace of economic growth and the reach of social policies. This position has become particularly critical with the recent North American orientation, imposing barriers on Brazilian import products. Maintaining this opinion opposes the International Trade Organisation policy and may provoke the recurrence of protectionism in other regions, causing unpredictable effects on international trade.

Internally, currency stabilisation in the second half of 1990 is constituted an important macro-economic policy matter. This stabilisation increased social system vulnerability, mainly regarding employment matters, and made sectorial and/or integrated political policy introduction and investments more difficult. Territory, on the other hand, is a dynamic subject and reflects observed tendencies, modifying them or re-directing them in some regions.

On the supra-regional scale, where there are integration and counter movements, or in Mercosul or ALCA proposals, or in negotiations with the European Union, there are more impediments to integration than there are dynamics of impulse or fluidity. As a matter of fact, as far as Mercosul problems are concerned, Argentinean crises influence investments with potential integration postponed term. Co-operation possibilities with the European Union may suffer reversals. This would make the consolidation of trade agreements between these two economic blocs more difficult. Regarding ALCA, differences between countries invited as members increase the existing problems even more, destroying potential labour production chains and income generators in various regions. Increases of protectionist policies, as mentioned, also influence the negotiation dynamics.

International restrictions provoked by lack of confidence in emerging markets and high internal income taxes have been causing difficulties in the production of chain investments that could improve economic growth indicators. Associated to these factors, the recent energy crisis imposed modernisation investment restrictions on industrial units. Needless to say, this factor did not contribute to the reduction of atmospheric pollution in big urban industrial concentrations, nor did it help reduce the energetic intensity of the GDP.

Still as an effect of the external situation, the State reform policies have take on considerable importance in the political and economic agendas for the last ten years. The opening of the internal market for direct investments has maintained focus on national private investment programs. Although the majority of public services have been transferred into the private sector (telecommunications, electrical energy). This moment of active transition has not solved the necessity of investments for the expansion of infrastructure networks, specially in rural areas.

## 1.2 The Recent Spatial Dynamic and its Impact on the Biome

In the context of the described situation, dynamic factors increased the evolutionary tendency in Brazilian territorial occupation and use in the recent (1970-1995) period. These factors were stressed in almost all thematic studies realised by GEO Brazil. They are:

**a)** urban population growth and concentration; and

**b)** the expansion of land use for agriculture and cattle raising.

Population land distribution shows us an extremely high concentration on the Coastal Zone and the Atlantic Forest (Figure 2- Population Density Map). This is a biome that has been suffering human occupation pressure since the beginning of colonisation and it is where most demographic concentrations occur. Important internal differences, reflecting medium and short term tendencies and pressures and environmental impacts include:

**a)** the large urban area in the State of São Paulo, consisting of three metropolitan areas: São Paulo, Campinas and Baixada Santista, virtually joined on their borders;

**b)** expansion of constantly growing coastal urbanisation, continuously from Rio de Janeiro up to Macaé, where the off-shore petroleum extraction support base (Bacia de Campos) is located – the main Brazilian production area of fossil hydrocarbonates (petroleum and natural gas);

**c)** increase of urban accumulation between Curitiba (PR) and Porto Alegre (RS), passing through the valley of

Itajaí, and Florianópolis (SC), industrial investment alternatives searching to escape from the economic imbalance agglomeration of the São Paulo metropolis;

**d)** metropolitan area of Porto Alegre, although with a reduced growth rate - mainly due to emigration of the agricultural Gaucho population for soybean cultivation in areas of the Cerrado, also receiving growing impact from the metal-mechanical industrial complex, and Mercosul;

**e)** three Northeastern metropolitan areas, Salvador, Recife and Fortaleza, main demographic concentration and urban expansion centres of the Northeast.

This expansion process has provoked an increase in the metropolitan peripheries as well as in the small and medium towns that are achieving an important role in urban-industrial dynamics. The immediate impacts are demonstrated in:

**a)** increase of river, lake, and lagoon pollution, due to the lack of water and sewerage infrastructure in urban centres of all dimensions;

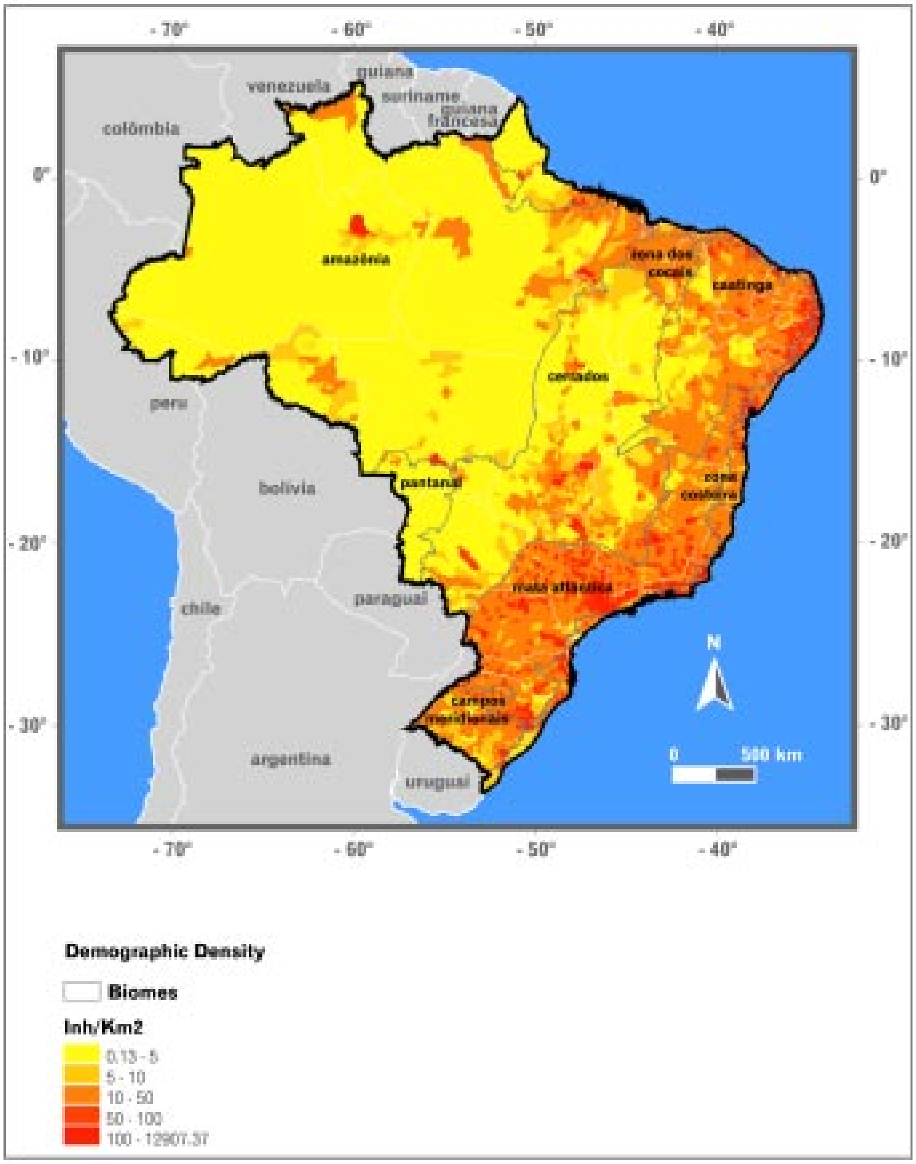
**b)** increased pressure on the remaining vegetation in the Atlantic Forest, where water springs and upstream for city freshwater supplies are found; and

**c)** increasing of river, lake, lagoon and delta sedimentary bases, affecting drinking water availability due to the reduction of vegetation surface cover.

On the short and medium term, this situation will demand investments in water and sewerage treatment. There is a delicate balance in this situation that presently lacks financial resources.

In the Coastal Zone, expansion of urban centres, without a necessary network on sewerage collecting and treatment, have resulted in a considerable increase of waste nutrients and other waste material from sewerage, including pathogenic organisms in the last three decades. Water quality deterioration, due to lack of necessary sanitation conditions, occurs in local towns with constantly increasing population. There is also a significant population growth and growth in the number of tourists that visit historic sites, just recently valued for such activity. There is also petroleum activity. These elements have caused the following: a considerable increase in water consumption, high fishing resource exploitation, with an overload of species that give support to traditional fishing activity without necessary investments in rational technical equipment and constant oil spill accidents in ports. These activities contribute equally to the deterioration of water quality and reduction in the reproduction of species that support fishing activities in the mangrove areas that are part of this biome. The pipeline duct and intensification of heavy vehicles traffic associated with petroleum extraction, together

**Picture 2 - Demographic density map**




Source : IBGE

with nuclear plant construction on the Southern Coastline of Rio de Janeiro, as well as investments of Sepetiba Port construction - in the same of Sepetiba Bay, transformed this part of the coastline into a major environmental risk area in Brazil.

In the Southern-Southeastern part of the Atlantic Forest biome, the recent and increasing activity of agribusiness is found. Production of soybean, sugarcane, oranges, coffee, maize, and the poultry and swine industries, figure among the most expressive activities in the urban-industrial expansion process, due to changes caused in the agricultural landscape. This is true because of the extreme dependence on chemical, mechanical and genetic products, as well as the industrial destination of the major part of such production. These agribusiness "giants" figure among the biggest "consumers" of natural resources of the ecosystem of both regions often causing environmental damage of huge proportions. (MMA - Ministry of Environment, Agenda 21, Sustainable Agriculture).

Resulting from population concentration, and industrial and agro-industrial activities in the region, water pollution directly affects population health, causing diseases such as diarrhoea, hepatitis, typhoid fever, mycoses, ear infections, conjunctivitis, allergies and intestinal parasites. Children, old people and low immunity patients are the most vulnerable to developing diseases or infections after having used the contaminated water, for example. Although there has been a 32% decrease between 1995 and 1999 (DATASUS, 2002) of hospitalised children - up to one year old from diarrhea in the public health system, we must take into consideration access restrictions to public health institutions for the populations in risky areas. Releasing untreated sewage directly into rivers, sea, lakes and swamps, polluting and contaminating the water resource system highly increases the risk of infectious-contagious diseases.

In the Amazon Biome, expansion of urban areas is still affecting only the regional capitals, with the towns of Belém and Manaus as metropolitan agglomerations largely expanding between 1991 and 2000. This shows how the process of metropolisation has surpassed the limits of resources. Besides these metropolises, special stress should be given to expansion of the urban area of Imperatriz, located in the state of Maranhão. This area plays an important role in Oriental Amazon polarisation. This is the area where the logistic network is intensifying, increasing

the changing process in soil use and use of green cover on the borders of the meridian Amazon. In addition, we should consider the number of medium and small capacity towns that have grown constantly in recent years. This expansion is not followed by infrastructural growth of water and sewerage systems. Also, the relatively high percentage of social contact rates without the necessary infrastructure increased considerably the possibility of diffusion of various pathogenic agents. These are mainly those transmitted from person to person such as flu agents, Hansen's Disease, tuberculosis and meningitis. These are reasons of the major causes of badly defined death cases, approximately 27% (DATASUS, 2002). This is also one of the indicators that existing medical assistance is insufficient for an extensive number of regions.

Internal occupation differences put pressure on the vegetation cover, contributing to deforestation. An increasing tendency towards cattle raising establishments is observed in the expansion of occupied areas, specially in the States of Rondônia and Pará, part of the belt that in encroaching on the Amazon area.

Deforestation and cattle raising for big landowners are instruments of judicial property claims. For small producers, cattle raising is the immediate alternative for the appreciation of degraded soil that is incapable of recycling soil nutrients after the first year of harvesting. The substitution of forests with forage means increasing phosphorous production in soil and causes larger erosion. This is due to the fact that water drainage in forage is ten times bigger than in forests. This facilitates more intense floods during rainy seasons and reducing river flows during dry seasons.

The search for wood, another factor of considerable pressure on vegetation cover, is constantly increasing, specially in the internal market. Major log producers still continue to exist in States of Pará and Mato Grosso, followed by Rondônia, and major consumption of this production – 37.4 %, is absorbed by the Southeast region, mainly by the State of São Paulo (20.1%). The external market absorbs 14 % of the production (Egler,2001).

The introduction of investments in agriculture in the Amazon is a historical innovation, having survived the extraction activity. The trademark crops of this new model are soybean, rice and maize. Until the mid-nineties, these crops represented a small share but in 1999 they represented occupation in new and significant portions of the Legal Amazon.

In the Cerrado biome, expansion tendencies of the urbanisation process were demonstrated in the formation of the new and dynamic urban territorial complex of Goiânia, Anápolis and Brasília. Goiânia, founded in 1942, and Brasília, in 1960, are recent events in the history and geography of Brazil. However, in conjunction, they have more than three million inhabitants and a strong tendency to maintain this quick pace of expansion. Located in areas of soft topography, with no notable obstacles to the expansion of urban constructions, its spatial standard tends towards the proliferation of peripheral centres. These are mainly populated with low-income populations that expand rapidly into the Cerrado. As in the Amazon, some states in this location maintain the tendency to extend the occupied area to agriculture and cattle breeding establishments, specially in the State of Mato Grosso, where a soybean complex has been developed.

Intense occupations of this biome have caused environmental problems on a larger scale due to rapid expansion of the agriculture-pasture economy. Among these impacts, we can stress the following: erosion and soil compaction, water contamination and biota contamination by chemical fertilisers, deforestation, reduction of availability of subterranean water resources due to inadequate irrigation of cultivated areas, reduction in vegetation and animal diversity and soil degradation.

TThe use of improved processes for other surroundings, like “central pivot” irrigation, demands energy and water use intensity that are not available in the Cerrado reserves today. Used in a controlled manner, this type of irrigation provokes large losses of water accumulated in waterbeds, thus compromising the future water supply. This includes water for human consumption. Lowland irrigation that is affected by gravity, although it has fewer negative affects than the “central pivot” method, also presents problems when used without planning. This can jeopardise river and valley ecosystems. The drainage system used in this kind of irrigation may provoke a lowering of the waterbed, destroying riverside forests and areas with buriti palms, causing future destruction of lowlands. This phenomenon is easily found in the Cerrado area.

Deforestation and clearing and burning are used in the formation of huge pasture areas for cattle breeding. The installation of such pasture areas, with a single crop, Xuawa considerable consumption of different products, like correctives, fertilisers, herbicides, pesticides and extensive use of heavy machinery. A depletion of the ecosystem is observed immediately, with a loss of native vegetation species that creates conditions for the appearance of plagues, insects and damaging weeds.

In the Caatinga area, approximately 60 % of the area is covered with native vegetation, in major or minor stages of alteration. Such degradation – in over 50% of the "natural" area – is provoked by intense collection of timber resources, excessive land clearing and occasionally by fires. The disappearance of vegetation during the dry season - opposite to what occurs in the Cerrado - where fires do not exist, improves natural pastures. The use and occupation of land is essentially agricultural, with short cycle crops and cattle breeding. Medium and long cycle crops are also found in the area but they have a minor territorial significance. Fruit and grain production are emphasised in irrigated areas. Space occupied by mining practice and regional infrastructure represent an extremely small part of the territory.

Modern agricultural activities in expansion in the semi-arid area, have not yet acquired the density, nor the extension to involve workers that are out of jobs due to the progressive disappearance of activities such as cattle breeding and cotton farming. Fruit growing is beginning to appear within private or public irrigation projects, and constitutes an economic alternative of high importance. Generally, however, it is still limited to small extensions of irrigated soil in humid valleys of the semi-arid region. These demand capital and qualified labour. Both activities are extremely rare among workers from areas linked to cattle breeding and cotton farming. Cattle breeding, due to its technical matter, is strictly reduced to properties with more than 200 ha, preferentially with more than 500 ha, and they continue to be poorly technically equipped.

Environmental degradation in the semi-arid area has been happening for a long time. This is due to the large and continuous reduction of flora cover and the consequent soil erosion. Erosion is most visible with extremely clear signs of where the semi-arid area has lost the minimum capacity to retain water in the soil and subsoil. As a consequence, exaggerated superficial rain runoff repeats every season. This cycle worsens every season and affects the erosion process of the fine layers of soil that still exist. Small and intermittent rivers and streams are fed for several months after the heavy rains. They are fed for several months by watertables, and, if not recharged by rainwater, they cease to exist

There is relatively high population density in the Northern semi-arid region, largely occupied by subsistence agriculture and in even larger areas, by cattle breeding and sheep and goat raising. There is no soil and water conservation plan and this creates a picture of non-sustainability. According to the map of areas critical to biodiversity, the Caatinga biome appears with an alteration level of 45% in relation to the total area of the biome. The future situation tends to worsen, because effects of the programmes in place have not included, in an efficient way, soil conservation, water conservation, or the biological importance of various habitats, mainly in areas involving the Drought Polygon.

Interpreting the flora of the Amazon, the Central and the Caatinga regions that are located in the area called Zona dos Cocais, provides space for a complex mosaic of ecosystems in transition. The climate and the resulting flora oscillate between tropical hot sub-humid – characteristic of the Cerrado border with the pre-Amazon – to semi-arid, characteristic of the Caatinga. The natural original vegetation is Dense Ombrofile Forest, in the middle valley of the Itapecuru and it contacts the Seasonal Forests from the Central area, between the Cerrado and the West Seasonal Forest. There are also contact areas between Cerrado and Caatinga to the east. Remaining native vegetation, significantly changed, covers approximately 60% of the area. Use and occupation of soil is mainly extraction, pastures and agriculture. Agriculture is the last one being represented by short and medium cycle species. The introduction of rice and soybean crops in the region – and the consequent urban increase that support it - are having an important effect on this biome. Low coverage rates of main water and sewerage pipeline – in urban as well as rural areas – and use of chemical products, cause pollution of waterbed resources and reduction of environmental health in this zone. We can also mention that the ratio protected area/considered area by the biome is the lowest in the country (0.1%).

In the Pantanal Complex, native vegetation still covers more than 97% of the area, partially modified by clearance and agronomic agreements, improving native pasture conditions. Use and occupation of this land is almost exclusively for breeding, re-breeding and cattle fattening. There is also fishing, the capture (not always legal) of wild animals, tourist and leisure activities, and mining. Mining activities are exclusively present in Corumbá and Poconé. Production systems of different areas of the Pantanal have important relationships with the neighbouring areas. In contrast, the use and occupation of soil in the surrounding areas have had a negative effect on the Pantanal ecosystem. (MMA - Ministry of Environment, 1995.)

As cattle breeding has adapted to the environment, the uncontrolled increase of cattle and its constant handling have caused flood periods. These alter – altering with extremely rigid dry periods, causing an intense deforestation in the riverbeds that nourish Pantanal rivers. On the other hand, fishing and predatory hunting have brought about species imbalance. Examples include the accentuated reduction of jacarés (Brazilian species of alligators), and the consequent increase of piranhas and the fall of viscosity in lakes and rivers. This causes weakening of the sustainable economic base of big fishing colonies. In the remaining areas of the Pantanal, soybean monoculture exportation has expanded, as has sugarcane used for the production of biological combustibles. This has caused indirect negative socio-economic effects, characteristic to this type of agriculture exploitation.

## 1.3 Short and Moderate Term Tendencies

Recent periods showed a considerable transformation in the territorial dynamic of social formation in Brazil. Short and long term tendencies for the whole territory refer to:

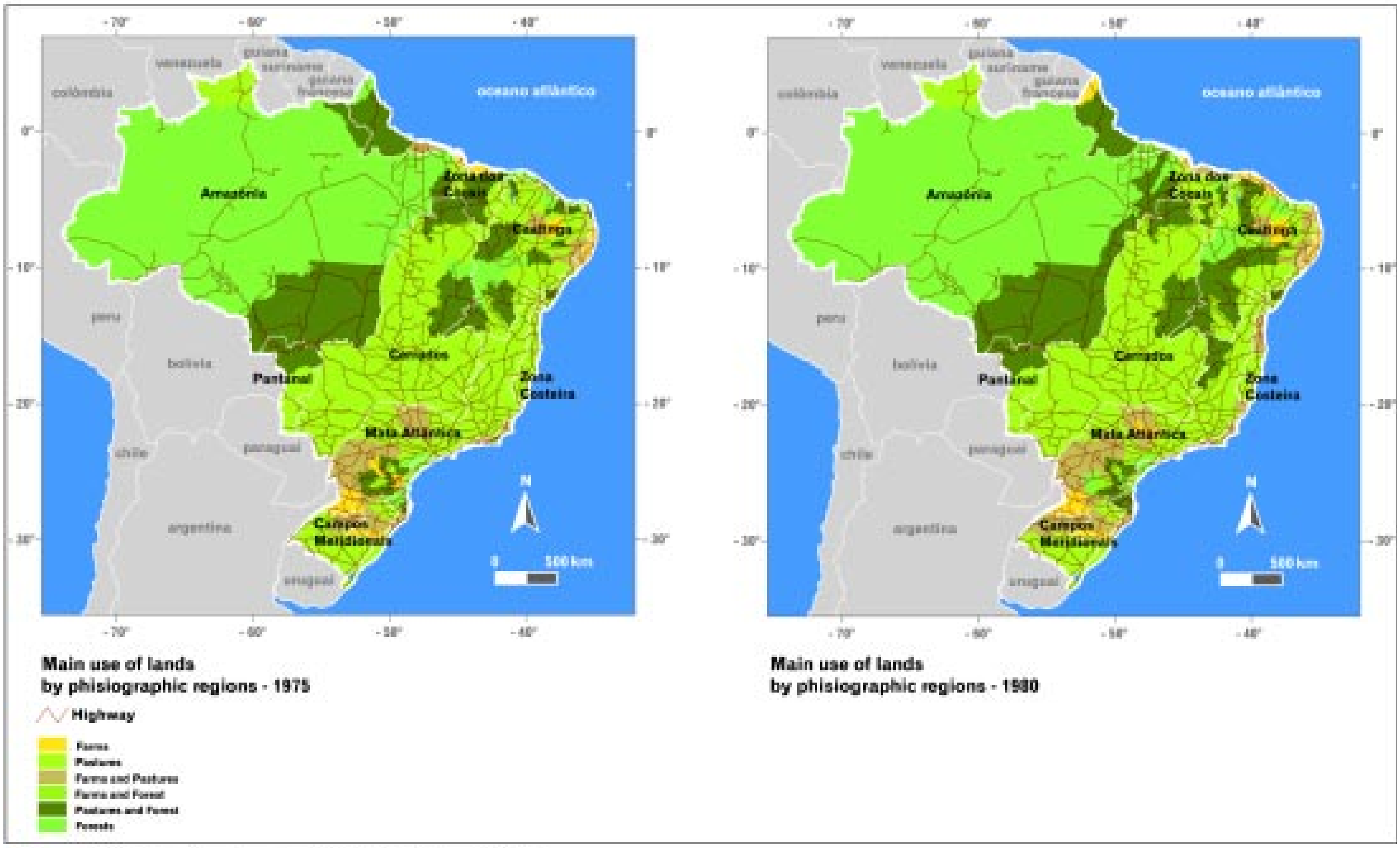
- maintaining of population growing rates;
- maintaining of space concentration levels;
- maintenance of disparity in income between urban and rural areas, in spite of relative elevation of income level in some rural areas and economic growth in the suburban area;
- difference of city increase and expansion rate of covering water and sewerage infrastructure system;
- financial program implementation difficulties with positive effects on environment;
- substantial increase of public charges, making difficult equipment maintenance in low income areas, specially in city peripheries;
- absence of political policy for the reuse of the temporary labour force caused by investment reduction of large projects;
- absence of political policies for the complementary re-distribution of inflation control.

Historically, the expansion of cattle breeding in Brazil was responsible for large changes in coverage and use of soil (Figure 3 – Maps on Soil Use). Pioneers thoroughly described in scientific Brazilian literature were the main agents in increasing deforested areas for agricultural and pasture use in Brazil. Based on the advance of small agriculture farmers seeking naturally fertilised forest soil, pioneers played the main role in the process of industrialisation. Industrialisation guaranteed the offer of wage goods, specially food, necessary to maintain low rates of the real wages of urban workers. Today, however, a major part of products that are part of the Brazilian basic food requirements originate from agro-industrial companies. This is occurring at the same time that the land acquisition process has brought the closing of the limits of access to resources.

On one side, the total area of agriculture and cattle breeding establishments decreased, the area that suffered changes in original soil cover continued to grow. This occurred at a much lower speed from the one observed in the past (Chart 1). This movement caused inversion of the historical tendency of the increase of establishments and occupied areas. This was true except for the area from the Amazon Belt and the one integrating the Amazon and the Cerrado biomes.

Two processes help to explain the influence this turnover in spatial agricultural dynamics. The first one is related to the expansion of urban, periurban and rururban areas, directed

**Picture 3 - Main use of lands by phisiographic regions map**




Source : IBGE agricultural census of 1975,1980,1985 and 1995/96

not only at construction, but also at different uses associated with city expansion. These include recreational and leisure areas, for example. (Map 4 - Urban agglomeration and rural population). The second one is a result of rentability gain in the main Brazilian crops as a consequence of technical progress incorporation in cultivation. The five main agricultural products used in Brazil are: maize, soybean, rice, sugarcane and coffee and the total harvested area has diminished from 33,083 to 29,100 thousand hectares between 1985 and 1995/96.

Brazilian grain has increased in production, regardless of each product's peculiarities, specially in grain cultivation. This means that maize, soybean and rice have all increased. As far as maize is concerned, production has grown to 43.5% between the two census counts, while the harvested area was reduced to 11.9%. Soybean production increased to 29.4%, and held in 1995/96 almost the same area harvested in 1985. For rice, an internal market product, although produced quantity has suffered a decline of approximately 10%, the harvested area has lowered to two thirds of that seen in 1985.

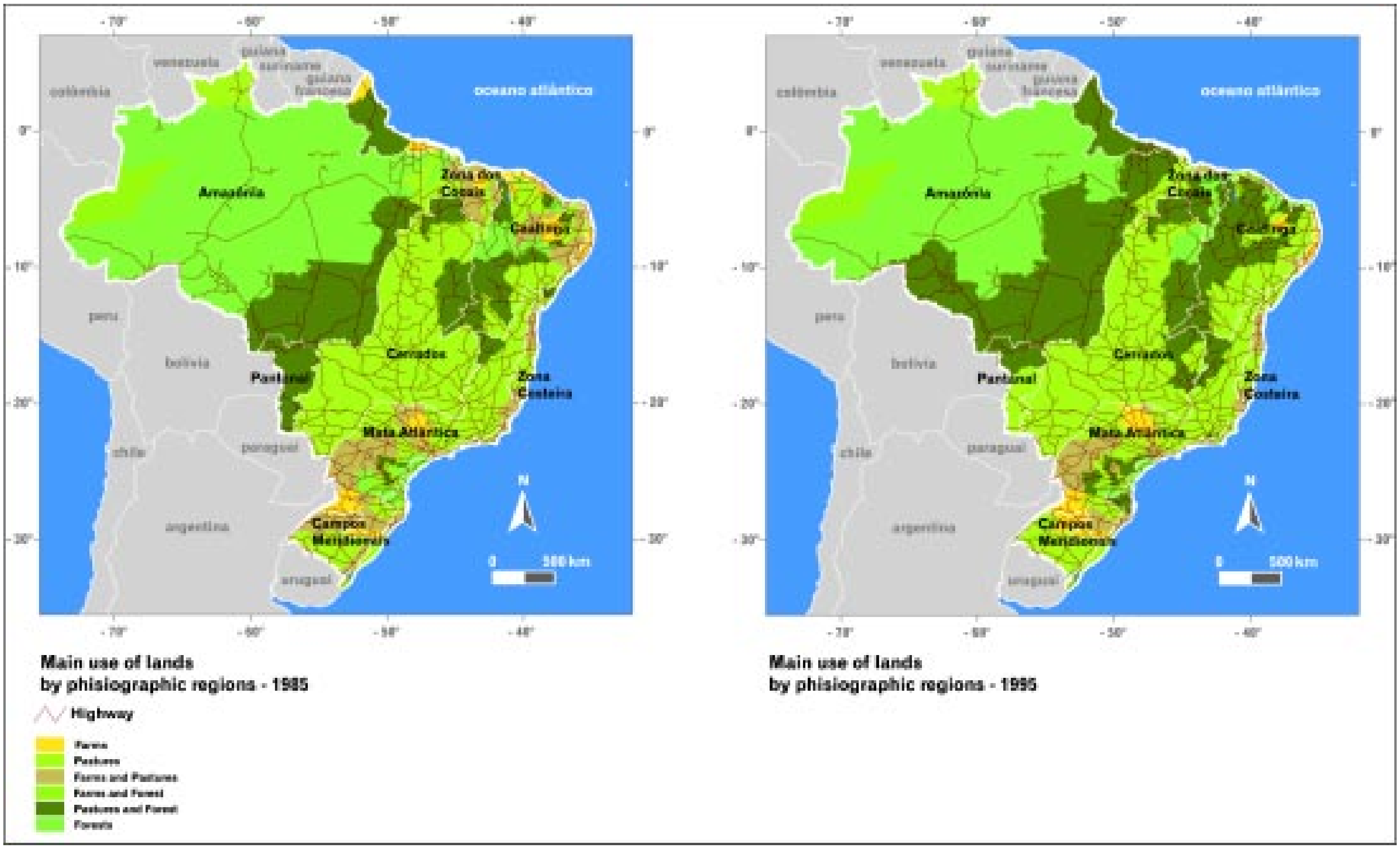
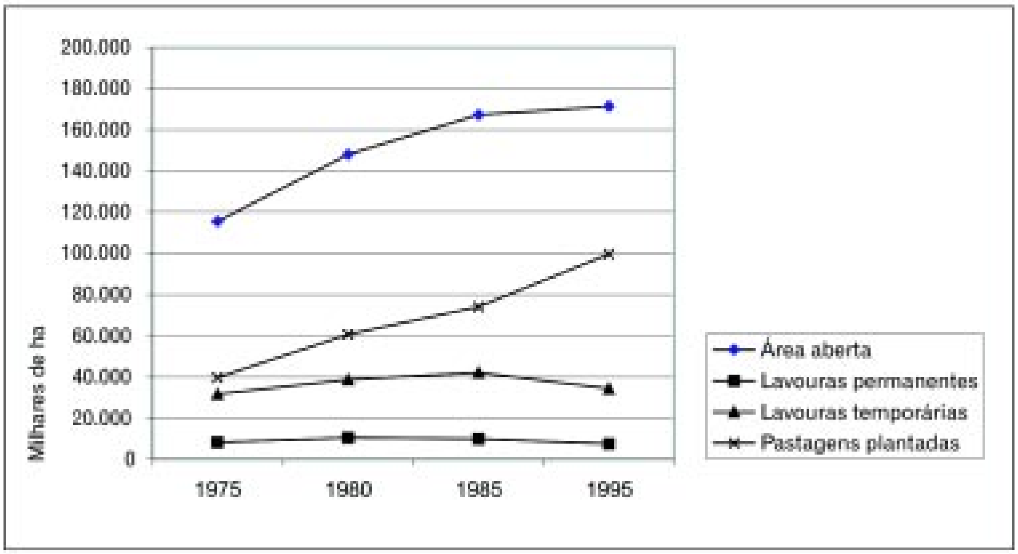



**Gráfico 1- Evolução dos tipos de uso da terra**




Fonte: Censos Agropecuários de 1975, 1980, 1985 e 1995/96

**Figura 4 - Mapa de aglomerados urbanos e população rural**


**Aglomerados Urbanos e População Rural 2000**

Aglomerados urbanos

> 100 hab/km²

Fonte: IBGE - Censo agropecuário de 1975 - 1995

The resulting impact of such dynamic is included in Source-Pressure-Impacts. The critical level of urban-industrial areas may be found here, specially regarding atmospheric pollution problems. These include water resources, subsoil, surface and water tables. This pollution originates from different sources, but results in life deteriorating conditions. Deteriorating life conditions are increasing due to critical inefficiency and unequal distribution of urban equipment and public services.

In the Amazon and the Cerrado biomes, pressure on vegetation cover tends to increase. This is mainly due to the increase of cattle breeding activities and exportation agricultural activities. In the Cerrado area, water resources are already found in a critical level. The tendency is to worsen, considering the continuation of the present occupational pattern and the pressure on environmental conditions.

In Caatinga there are permanent social-spatial inequalities as far as urban and rural infrastructure equipment is concerned. These cause significant effects on the living conditions of the population. High levels of environmental illness tend to increase. When we speak about agriculture activities and cattle breeding, pressure on biodiversity, water resources, soil and subsoil continue to be affected by the reduced technological level used in such activities. While there have been slight improvements in some production areas, there are improvements that bring new problems, for example, the salinisation of soil provoked by irrigation.

In the Zona dos Cocais, big projects in urban-industrial areas caused changes. Although they had a short reach, they had considerably high environmental costs. Traditional extraction systems can not compete on the regional and national markets and run the risk of disappearing with huge losses in terms of sociodiversity.

In the Southern Fields area, problems caused by inadequate use of soil and intense use of fertilisers and biological insecticides have provoked desertification. Pressure tends to increase on water resources, soil and subsoil if these elements remain. To prevent this process, necessary measures should be taken in the long term bases.

The Coastal Zone suffers pressure from activities in the area such as extraction and transport of petroleum and gas, or marine trade. These occur in urban and periurban area activities and in the occupation of areas along the coast. They include deforesting mangrove areas and rocky coastlines. This compromises water bodies beds by insufficient treatment of chemical and organic effluents.

## Chart 1 - Trend Scenario - Pressurre-Impact Matrix for the State of the Environment in Brazil

| Themes | Pressures | Impacts | Urban Industrial Areas | Amazon | Cerrados | Caatingas | Cocais Zones | Pantanal | Atlantic Forest | Southern Fields | Coastal Zone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Biomes | | | | | | | |
| Atmosphere | Deforestations and burns; Industrial Emissions, Transports and Energy | Greenhouse gases | Very high | Very high | High | Low | Low | Medium | Low | Very low | Very low |
| | | Atmospheric pollution | Very high | Low | High | Medium | Medium | Medium | Low | Very low | High |
| | | Acid rain | High | Low | Low | Low | Low | Very low | High | High | High |
| Water Resources | Consumptive and non-Consumptive use; Insufficient Treatment of Chemical and organic Effluents | Shortage of potable Water | Very high | Very low | Medium | Very high | Low | Very low | Medium | High | High |
| | | Contamination and Pollution | Very high | Medium | Medium | Medium | Medium | Low | High | High | High |
| | | Aggradation | High | Low | Very high | Medium | Medium | Medium | High | High | Very high |
| Underground Waters | Consumptive and non-Consumptive use; insufficient treatment of chemical and organic Effluents | Reduced aquifers | Very high | Very low | Very high | Very high | Low | Low | High | High | High |
| | | Contamination and Pollution | Very high | Low | Very high | Very high | Low | Low | Very high | Very high | Very high |
| | | Differential repression | Very high | Very low | Medium | Very low | Very low | Very low | Medium | Very low | Very high |
| Forests | Expansion of Agriculture and ranching; Timber exploitation And firewood and vegetal Coal production | Deforestation | Low | Very high | Very high | High | High | High | Low | Low | Medium |
| | | Reduced Biomass | Low | Very high | Very high | High | Medium | Low | Medium | Low | Low |
| | | Degradation of biota | Low | Medium | High | Medium | Medium | Medium | Medium | Low | High |
| Biodiversity | Expansion of Agriculture and ranching; Predatory hunting and Collection; Vegetal extractivism | Extinction of species | Low | Very high | Very high | High | High | High | Very high | Low | High |
| | | Loss of natural Riches | Low | Very high | Very high | High | High | High | Medium | High | High |
| | | Fragmentation of habitat | Low | Medium | High | Medium | Medium | Medium | Medium | Low | High |
| Sea Resources | Oil and gas extraction; Sea trade, Insufficient treatment Of chemical and And organic effluents, Urban expansion | Reduced Produtivity | High | Very low | Very low | Very low | Very low | Very low | Medium | Very low | Very high |
| | | Contamination and Pollution | High | Low | Very low | Very low | Low | Low | High | Low | Very high |
| | | Ballast water | Low | High | Low | Low | Low | Medium | High | Low | Very high |
| Fishery | Insufficient Treatment of Chemical and organic effluents, overfishing And predatory fishing | Excessive catch | Low | Low | Very low | Very low | Very low | High | Low | Very low | Very high |
| | | Extinction of species | Low | Medium | Low | Low | Low | High | Low | Very low | Very high |
| Soils | Primitive irrigation And cultivation; Overpasturing; Insufficient Treatment of Chemical and organic effluents; Intensive Use of Fertilisers and Agrochemicals, burns | Erosion | Low | High | Very high | High | Low | Medium | High | Very high | Medium |
| | | Contamination | High | Medium | Very high | Very high | Medium | Medium | High | High | Medium |
| | | Salinisation | Very low | Very low | Very high | Very high | Very low | Very low | Very low | Very low | Very low |
| | | Desertification | Very low | Low | Medium | Medium | Very low | Very low | Very low | Very high | Very low |
| Underground | Insufficient Treatment of Chemical and organic Effluents, intensive Use of Fertilisers and Agrochemicals, mineral extraction; inadequate Disposal of Residues | Contamination | Very high | High | High | High | Low | Medium | Very high | Medium | Medium |
| | | Degradation | Medium | High | High | High | Low | Low | Very high | Very high | Medium |
| | | Subsidence | Very high | Low | Low | Low | Low | Low | High | Very low | High |
| Quality of Life | Uncertainty of Compensatory Policies; Insufficient Treatment of Chemical and organic Effluents, Industrial Emissions, Transports | Social inequalities | Very high | High | High | Very high | High | Medium | High | Medium | Medium |
| | | Social divide | Very high | High | High | Very high | High | Medium | Medium | Low | Medium |
| | | Loss of Sociodiversity | Low | Very high | Medium | High | Medium | Low | Low | Low | Low |
| Health | Proliferation of Vectors, insufficient Treatment of Chemical and organic Effluents, Industrial Emissions, Transports | Pulmonary diseases | Very high | Low | Low | Low | Low | Low | Medium | Very low | Very low |
| | | Infectious and Parasitic diseases | High | Very high | Very high | High | High | Low | Medium | Low | Medium |
| | | Circulatory diseases | High | Low | Low | Low | Low | Low | Medium | Low | Low |
| Disasters | Uncertainty of Preventive policies | Forest fires | Low | Very high | Very high | Low | Low | Low | High | Very low | Very low |
| | | Floods and Landslides | High | Low | High | Medium | Medium | High | Very high | High | Low |
| | | Droughts | Medium | Low | High | Very high | Low | Low | Medium | High | Medium |

**Captions**

Very high | High | Medium | Low | Very low

Territorial practices that stimulate these tendencies are in a transitional phase. The results, are yet undefined in the long term. However they can be synthesised from two directions. On one side, there is an urban-industrial spread, in almost all the biomes. On the other side, there is an increasing movement towards claiming new land for agriculture and cattle breeding. This is mainly due to considerable production increase and advances in both activities. These are the undefined issues of a transitional period. They make it difficult to construct reliable forecasts. However, they open up a wide range of opportunities for conscientious actions and institutional solutions.

## 2. The Scope of InstitutionalResponses: the Desired Scenario

The starting point for the desired scenario is the institutional changes that can provide for alterations in the previously identified tendencies. In this regard, such scenario seeks to incorporate the economic, social, environmental and spatial dimensions of sustainable development.

### 2.1 Possibilities for Sustainable Management

The federal constitution of 1988 incorporated a specific chapter about the environment. The physical-biotic formations like the Amazon Forest, Atlantic Forest, Pantanal and Coastal Zone have constitutionally been granted the status of national heritage. As such, they must therefore be used according to the law providing that the conditions for preservation of the environment are fully met (Article 23, section VII and Article 225, first paragraph, section VII and second paragraph of the federal constitution).

The constitutional reference represents the recognition of these spatial units for sustainable management purposes. The notion of national heritage, in contrast, has two functions from the point of view of time management: a synchronic function, in which it entails mobilisation of resources and strategic options for sustainable development, and a diachronic function, in which it refers to the attribution of future purposes.

Thus, the spatial formations become fractions of the national territory that belong to a differentiated category, as they constitutionally imply three factors: safety, transmission and institutional character. The first factor, safety, encompasses conservation of intradiversity and physical-biotic interformations as a necessary condition to ensure the quality of the environment and the natural resources within it. The transmission factor, which is closely related to the term heritage, means that in the future there will be natural resources and the possibility to renovate the methods for their use for heritage to be shared by. The institutional factor creates the possibility for the responsibility of the federal, state and municipal powers. Therefore, the conventions and rules in that regard must regulate and stand for sustainable management.

The alteration of the current tendencies requires deeper changes than the ones identified above. Structural reforms are all crucial to the attainment of that scenario. They change the highly concentrated income patterns, improve access to infrastructure of public goods and services, broaden the channels for participation of the civil society organisations, ensure that these organisations are legitimately represented and improve the rights for participation in management processes at local and regional levels.

### 2.2 Institutional Feed Backs

From an institutional perspective, the foundation of the Interministerial Committee for Sustainable Development (CIDES – *Comitê Interministerial de Desenvolvimento Sustentável*) was an important step towards improved co-ordination of policies, plans and sectorial and territorial programmes as well as tax and credit incentive programmes. The potential of the Committee lies in its capacity to co-ordinate information from different sectors, so as to harmonise guidelines, goals, objectives and actions in an integrated and structured manner. Additionally, insofar as its crosscutting institutional character is concerned, it reinforces actions aimed at responding to emergency situations: disasters, external events, etc.

With regard to the plan for financing medium and large-scale investments, the Green Protocol (*Protocolo Verde*) is another initiative by the Brazilian government in terms of public policies for sustainable development. It contains guidelines, strategies and operational mechanisms to incorporate the environment variable into the management process and the process of granting official credits and tax incentives to production activities. This mechanism may mean an important change in industrial pollution levels and in the use of natural resources, as it favours those investments with reduced environmental impacts or those that entail mitigation measures since project inception.

Concerning the dramatic deforestation of the Amazon region and the Cerrado and threats to the remaining Atlantic forest, the modernisation of the Forest Code is an important response to the pressures that have been identified. In 1996, the percentage of a property allowed for deforestation was adjusted for the Amazon region. Through Provisional Measure no. 1,511, the fraction allowed to be deforested was reduced from 50% to 20% of the total area of any property; the remaining 80% of the property must retain the original forest coverage. Currently there has been pressure for the percentage to be increased. The mobilisation on the part of social participants is expected to be carried on so as to keep this change from happening.

One additional response to the constant pressure for allowing further deforestation is the formalisation per use under three different categories of the Forest Code:

- permanent preservation forests;
- forests for limited use; and
- forests for unlimited use.

In the first category the forest areas are untouchable regarding the direct use of any of their resources, unless otherwise decided by the applicable public authorities due to social interest reasons. In the second category the use of resources is subject to restrictions provided for in federal legislation (for each region) and for state and municipal legislation by regions, locations and species. In the third category the owner is allowed to use the resources without restraint, yet deforestation is still pending upon IBAMA's formal authorisation. Such categorisation should limit timber exploitation if the necessary measures for monitoring are taken.

The perspectives for the Coastal Zone are based on the implementation, maintenance and development of Conservation Units. In recent years, though, an increasing number of such units are being created to the benefit of coastal environments. Brazil has a broad system with different categories of management at federal, state and municipal government levels. It includes oceanic or coastal islands and the protected continental areas. The specific objective is the conservation and protection of beaches, sandbanks, coral reefs, marine vegetation, bays and estuaries, lagoons with marine influence and/or protection of ecosystems that are directly influenced by the sea, such as the mangrove and sand bar areas. There are 290 conservation units located along the Coastal Zone, which cover around 21,028,332 hectares that are protected under the legislation, including indigenous reserves, with 588,199 hectares divided into 34 units. The conservation units are not distributed uniformly along the coast and actually few units can be considered marine units. It is expected that these units be gradually integrated to the local and regional dynamics.

At the sectorial level, the Agriculture Policy Law (8171/91) obliges the recovery of areas pertaining to the Legal Reserve whose percentage have exceeded the limits that were established by the Forest Code for each relevant region. In some states (Paraná and Goiás, mostly) the office of the public prosecutor has demanded that rural owners recover the Legal Reserve at a 1/30 rate per year, in accordance with the Law. Law 9393/96, pertaining to the Rural Territorial Tax, exempts properties with forest coverage and grants tax reductions to areas that have forest management plans, thus stimulating their owners to keep and conserve the forests.

Agriculture Zoning, introduced in 1996, modernised the instruments of the policies for grain production in Brazil. It has also become an instrument for organisation of areas aimed at agriculture as it assigned priority level to lands with better environment potential. It did so reducing the pressures for land use and offering a response to the country's historical process of land occupation that disregarded the potentials and limitations of the lands. However, it is necessary to enhance the co-ordination with other environment policies that deal with land occupation and organisation of the national territory so that a dynamic mechanism for the conservation of natural resources is achieved.

In order to make it possible for the environmental health policy of the Ministry of Health to be created and in order to create a solid co-ordination between the National Health Foundation (FUNASA - *Fundação Nacional de Saúde*) and other departments of the Ministry of Health that are developing actions and activities on environmental health, FUNASA submitted a proposal to the Ministry of Health to introduce a Permanent Commission for Environmental Health within the Ministry of Health. On December 11, 2001 decision no. 2253/GM established the committee and its competencies. The committee is composed of FUNASA, the National Sanitation Monitoring Agency (ANVISA - *Agência Nacional de Vigilância Sanitária*), the Oswaldo Cruz Foundation (FIOCRUZ - *Fundação Oswaldo Cruz*), Secretariat for Health Policies of the Ministry of Health, the Executive Secretariat of the Ministry of Health and the Minister of Health's Office.

The Ministry of Health signed a technical co-operation agreement with the Ministry of the Environment aiming at developing policies and integrated actions for environmental health. It will catalyse initiatives to increase the institutional, political and socio-environmental impact of these actions. The co-operation agreement for Health and Environment, signed by the ministers of health and environment on November 7, 2001, aims to build an agenda for environmental health in the federal government in order to identify priority areas for co-operation that will be part of a pluriannual action plan. Besides the intraministerial co-ordination, the operation and structuring of SINVAS requires co-ordination of the Ministry of Health with other ministries, mainly the Ministry of the Environment, Ministry of Labour, Ministry of Foreign Relations, Ministry of Education and the Ministry of Planning, among other departments and agencies of the federal government (CGVAM, 2001). The structuring of environmental health monitoring within SUS has led to the development of sub-areas of action that will be gradually implemented focusing on mechanisms for monitoring health areas related to water use for human consumption, air, soil, contaminants, accidents with dangerous substances, natural disasters, vectors, reservoirs and poisoning of animals.

SINVAS will participate through the National Council of Health (CNS – *Conselho Nacional de Saúde*), the National Council of the Environment (CONAMA – *Conselho Nacional do Meio Ambiente*) and other co-ordination mechanisms with society, private sector, non-governmental organisations (NGOs) and unions, among others.

Still in the sanitation area, recently there have been significant breakthroughs in Brazilian cities (including the understanding of the concept of sanitation itself). It is worth mentioning that while the advances in sanitation of the 1970s were above all of a technological nature directly related to constructions, today they are about alternative technological proposals and, mainly, innovative initiatives in service management. There is a strategy to rationalise the utilisation of federal resources for solid residues that has been reinforced under the Ministry of Environment and which has developed programmes and provided investments to solve the problems of garbage disposal.

## 2.3. Challenges to Development Sustainability

There had been few effective actions until the 1990s with a view to solving the fragmentation of policies. This was true for all types of policies, both environmental and other kinds. This occurred despite the identification and diagnosis of segmented policies during the last three decades as a relevant issue for the effective implementation of environmental policies. In fact, the diverse laws, agencies, plans and programmes and other mechanisms introduced during that period contributed only to increase segmentation. Nevertheless, this current trend is being overcome by the efforts toward strategic environmental management (Egler, P. C. 2002).

Important responses from some sectors have already started to change the situation described above or, at least, to contribute to a change in the behaviour of some factors that cause impact. Hence, the responses of the public sector are based on the understanding of environment as a strategic element, whose actions are to be supported in previous negotiations in order to set guidelines that are operated on the medium and long term. In such a context of uncertainties, sustainable management take on a Strategic Environment Assessment, that is to say a process of environmental assessment on policy, plans and programmes on three different levels:

**a)** sector plans and programmes assessment (e.g. energy and transport);

**b)** plans and programmes assessment related to the use of territory, encompassing all activities to be implemented within a particular area; and

**c)** policies or actions that are not necessarily implemented by means of projects, but may have significant environmental impacts (e.g. incentive or credit policies) (Egler, P. C. G. 2002). Thus, the treatment of biomes is a breakthrough in the Brazilian institutional framework, considering both the integrative capacity and the potential for the promotion of sustainable development.

The new model of regional development management, based upon Agencies such as the Amazonian Development Agency (ADA – *Agência de Desenvolvimento da Amazônia*) and the Northeast Development Agency (ADENE – *Agência de Desenvolvimento do Nordeste*), has not yet effectively demonstrated whether it is a feasible institutional alternative in terms of the reduction in the State's fiscal and financial capacity. This is true despite the fact that it seeks improved flexibility and autonomy in the use of public funds.

There are at least two challenges to an environmental strategy aimed at sustainable development. The first refers to interagency co-operation and their respective capacities to create investment opportunities for attracting private funds, so as to comply with sustainable principles. It is time for society to demand more of governmental agencies but these agencies do not have the necessary allocation of human and financial resources or infrastructure. A combination of responsibilities and resources is required to enhance the agencies' capacities to respond as expected. The second challenge relates to the participation of wider sectors of civil society in decision-making and to the composition of forums that allow discussions among different sectors. Hence, some measures can be proposed:

**a)** Change the hierarchical and sectorial organisation to the benefit of acting in line with objectives of environmental quality that favour an improved management of shared resources;

**b)** Co-ordinate sector programmes with the proposal for sustainable development;

**c)** Strengthen the mechanisms for negotiated decisions and joint actions (obligation) of managers and social participants with diverse interests;

**d)** Establish and maintain an information system that is able to impede situations of inverted risk, i.e. situations in which each participant's perception is that the use of criteria (or indicators) scientifically (or not) formulated is of higher priority than environmental risks.

Concerning the different sectors at issue, some measures need to be more focused, for example:

**a)** Fishery handling of the main species captured;

**b)** Introduction of Conservation Units, predominantly per island and surrounding area, mangroves, estuaries and other regions of proven ecological value, which restrict the use of such areas;

**c)** Creation of Extractivist Reserves;

**d)** Introduction of management councils for sustainable use within the Conservation Units;

**e)** Definition of long term actions for the conservation of biodiversity, complying with the priority areas and conservation strategies established, which are provided for in the National Biodiversity Programme (PRONABIO – *Programa Nacional de Biodiversidade*);

**f)** Strengthen the institutional framework for patents to undertake advanced research;

**g)** Training in human resources for the elaboration of projects and integrated management of solid residues, environmental sanitation, land use and public urban transportation.

The logical Impact-Response framework (Chart 2 – Desired Scenario) presented hereinafter considers the group of sectorial measures already adopted as well as those that are deemed imperative for strategic environmental management. Sectorial policies would entail a change in the pace and intensity of the deterioration of different biomes, as long as they are transversally co-ordinated and combined into more representative categories related to differentiation within and between biomes. The time required for changes to occur varies. Some impacts can be reversed in a short period of time, while others demand much more time. Thus, within a 15-year time frame some impacts could already have stopped changing the state of the environment, whereas some effects brought about by mitigation measures adopted today would be just starting to be noticed.

Urban-industrial areas would still be under pressure regarding water supply as a result of the time necessary for the recovery of sources that supply cities with water, mostly those that depend on the recovery of the biomes of Caatingas and Cerrados. Losses in biodiversity and the fragmentation of habitats in biomes like the Amazon and Cerrados due to the reduction of vegetation coverage are still critical given the time necessary for the vegetation to recover, the critical situation of some larger areas and competition with other uses.

In the Pantanal, control over the utilisation of fishing resources and wild animals is a problem that still remains rather critical, even though it has been minimised, because of the biome's fragility and pressures from tourism activities along the borders. In the Atlantic Forest, although investments in recovery and preservation of significant portions can already be observed, soil and sub-soil contamination

has a long term impact and the condition remains critical. In the Southern Fields biome the least significant changes refer to water resources, soil and subsoil. Along the Coastal Zone, to which future investments for exploitation of resources of the continental platform are directed, biodiversity and rational use of resources are critical aspects and, consequently, explain the relatively poor improvement in that area.

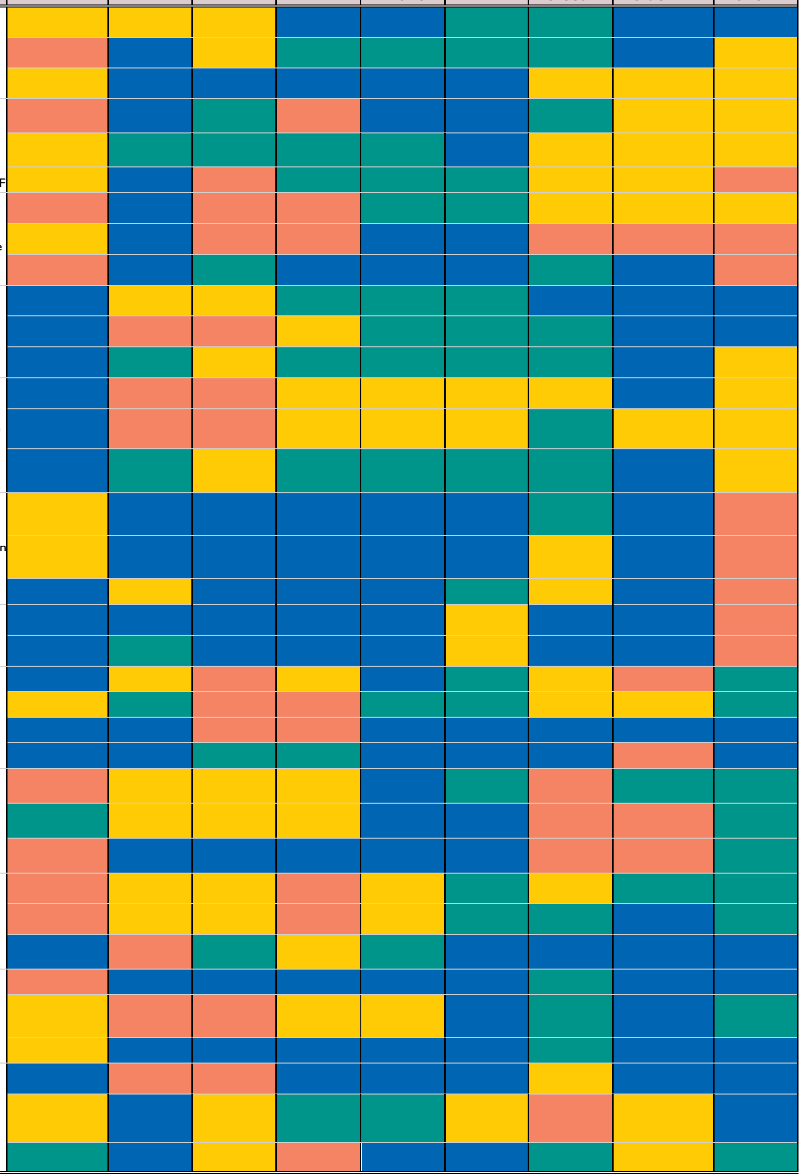
## Final Considerations

The scenarios presented above are images of a possible future that will result from decisions made today. Therefore, these trend scenarios were based on the continuation of resource concentration movements and on the fragmentation of institutional policies, that is to say, the perpetuation of the *status quo*. The expected scenario sought a new configuration with wide distribution of information and equal participation of different social sectors in strategic environmental management. In this regard, the necessary conditions for its achievement are a broader array of alternatives, increased participation and joint citizen-specialist action. The search for rational utilisation of resources and reduction of socio-economic inequalities in the country are objectives that have to be attained first so these conditions will become viable.

## Desired Scenario - Impact-Response Matrix for the State of the Environment in Brazil

| Themes | Impacts | Responses |
|---|---|---|
| Atmosphere | Greenhouse Gases | Kyoto Protocol Montreal Protocol; PROCONVE, PROCEL; PRONAR, PBCO, PROZON |
| | Atmospheric Pollution | |
| | Acid Rain | |
| Water Resources | Shortage of potable Water | Law on Waters, PQA; PROAGUA; National Information System on Sanitation; Brazil Plays Clean Program, PNF |
| | Contamination and Pollution | |
| | Aggradation | |
| Underground Waters | Reduced aquifers | Law on Waters, Brazil Plays Clean Programme |
| | Contamination and Pollution | |
| | Differential repression | |
| Forests | Deforestation | Forest Code; Agricultural Law; SNUC, PNF, Programme to Combat Deforestation and Forest Fires, |
| | Reduced Biomass | |
| | Degraded biota | |
| Biodiversity | Extinction of species | SNUC, PRONABIO; CEPF, Pilot Programme for the Protection of Tropical Forests |
| | Loss of natural Riches | |
| | Fragmentation of habitat | |
| Sea Resources | Reduced Productivity | Coastal Management Programme, REVIZEE; Emergency Action Plan; Oil spilling control In Waters under National jurisdiction |
| | Contamination and Pollution | |
| | Ballast water | |
| Fishery | Excessive catch | Coastal Management Programme, REVIZEE |
| | Extinction of species | |
| Soils | Erosion | Soil Conservation Nacional Programme; National Programme To Combat Desertification; Programme for a Streamlined Use of Agrochemicals |
| | Contamination | |
| | Salinisation | |
| | Desertification | |
| Underground | Contamination | Mining Code; Mining Reserves; Recovery Plan for Degraded Areas; Oil Spilling control in Waters under National jurisdiction |
| | Degradation | |
| | Subsidence | |
| Quality of Life | Social inequalities | PRONAF, PRONEA, HABITAR-Brasil; PRO-Sanitation; PROSANEAR, PASS; PRO-INFRA; Prog Brazil Plays Clean; National Prog. on Concious Littering |
| | Social divide | |
| | Loss of Sociodiversity | |
| Health | Pulmonary diseases | SINVAS; Permanent Committee on Environmental Health, COPASQ, SISAGUA |
| | Infectious and Parasitic diseases | |
| | Circulatory diseases | |
| Disasters | Forest fires | National Civil Defence System National Civil Defence Policy; Criteria to define Emergency and calamity Situations; CEPED |
| | Floods and Landslides | |
| | Droughts | |

Urban Industrial Areas | Biomes: Amazon | Cerrados | Caatingas | Cocais Zone | Pantanal | Atlantic Forest | Southern Fields | Coastal Zone



**Captions**

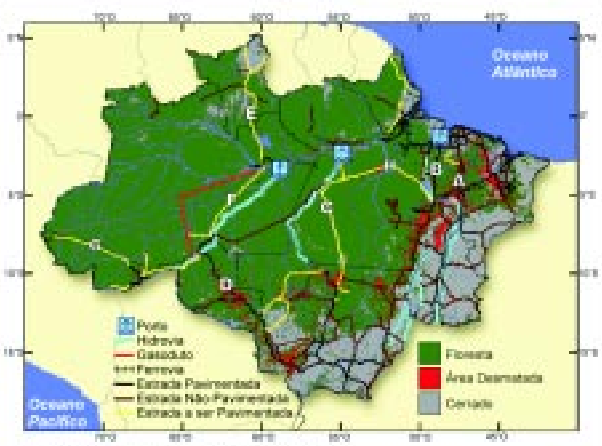
Very high | High | Medium | Low | Very low

**Box 1 - Amazonia Scene**

## Investments foreseen for Amazonia

The scenario for investments in Amazonia in the 2000-2007 period proposed by the federal government through the Move Forward Brazil Programme suggests continuity of the proposal to develop the region that has been implemented since the last decades. The main policy that remains is that of large infrastructure projects which are not committed to social and rural development policies that could improve the livelihood of local populations (Carvalho et al., 2002).

**Figure 6 - Infrastructure for the Legal Amazon according to the *Avança Brasil* Programme.**




**Rodovias pavimentadas existentes:**
A: BR-010 Belém-Brasília
B: PA-150
C: BR-163 de Cuiabá até a fronteira entre Mato Grosso e Pará
D: BR-364 Cuiabá - Porto Velho
E: BR-174 Manaus - Boa Vista (pavimentada em 1997)

**Rodovias a serem pavimentadas através do Avança Brasil:**
C: BR-163 de Santarém até a fronteira entre Pará - Mato Grosso
D: BR-364 de Porto Velho a Rio Branco e em direção a Cruzeiro do Sul (na fronteira com Peru)
F: BR-319 entre Porto Velho e Manaus
G: BR-317 de Rio Branco para Assis Brasil (na fronteira com Peru)
H: BR-230 Rodovia Transamazônica desde Marabá até Itaituba
I: BR-156 de Macapá até a fronteira com a Guiana

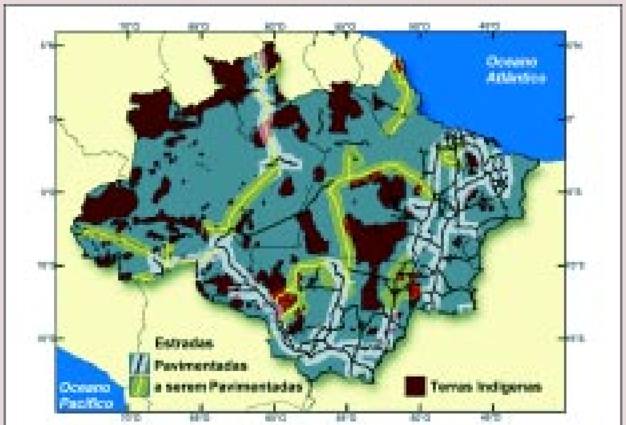
**Nota:** As estradas em amarelo serão pavimentadas através do programa Avança Brasil, coincidindo com áreas de florestas que tem escapado do desmatamento em larga escala e do fogo devido a inacessibilidade. As principais rodovias a serem asfaltadas são C, D, F, G,H e I. Cerrado refere-se ao ecossistema de savana existente no centro do Brasil.

Source: Amazon Environmental Research Institute - IPAM and Woods Hole Research Center.

Out of the total investments envisaged for the Legal Amazonia 82% will be applied in intersection regions of the Madeira-Amazonas and Araguaia-Tocantins rivers. These regions have large-scale projects such as the Belo Monte hydroelectric power plant, with capacity to generate 11,000 MW and which will demand almost 50% of the resources allocated to the Madeira-Amazonas area.

The planned projects for transportation include: two main hydro-ways, Madeira-Amazonas (operating) and Araguaia-Tocantins; extension of the paved highway network of Amazonia from 11,900 km to 18,145 km (highways Cuiabá-Santarém and Porto-Velho-Manaus, among others); the construction of nearly 1,600 Km of railways and at least five ports. These projects are justifiable because they can stimulate grain production in the southern part of Legal Amazonia as well as integrate the region with the rest of Brazil and Latin America. The reduction in production and transportation costs will stimulate the expansion of development frontiers and the introduction of centres to produce large cultures (soy and corn), cattle ranching, timber industry and agriculture.

**Figure 7 - Indigenous lands likely to be affected by the highway recovery and pavement, foreseen in the *Avança Brasil* Programme.**




As terras indígenas diretamente impactadas serão: São Marcos, Yanomami, Serra da Moça, Truaru, Sucuba, Raimundão, Canauanim, Tabalascada, Malacacheta, Wai-Wai, Waimiri-Atroari, Gavião, Paquiçamba, Arara, Koatinemo, Trincheira/Bacajá, Rio Jumas, Cachoeira Seca do Iriri, Kararaô, Parakanã, Mãe Maria, Apurinã do Ig. Tauamirim, Lago Capanã, Ariramba, Ariramba, Lago Jauari, Ariramba, Baú, Nove de Janeiro, Menkragnoti e Panará.

Source: Nepstad, et al., 2000; Capobianco et al., 2001

**Table 1 - Deforestation expected along the 50 km bands on each side of the highways still to be paved in the Amazon**

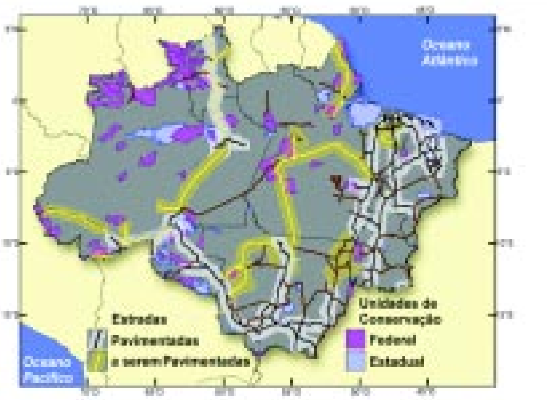
**able 4 - Forecast deforestation along the 50 km strips on each side of the roads to be paved in the Amazon**

| Road | Length (km) | Forecast Deforestation (25 -35 years)[1] | |
|---|---|---|---|
| | | Minimum (km²) | Maxim (km ²) |
| Cuiabá -Santarém (from Santarém to the boundary with the State of Mato Grosso BR - 163 | 1,147 | 22,000 | 49,000 |
| Humaitá -Manaus, BR – 319 | 663 | 14,000 | 28,000 |
| Transamazônica (from Marabá to Rurópolis) BR – 230 | 795 | 12,000 | 31,000 |
| Manaus – Boa Vista [2], BR – 174 | 981 | 16,000 | 33,000 |
| Porto Velho – Rio Branco, BR -364 | 613 | 16,000 | 35,000 |
| Others | 2,046 | 40,000 | 94,000 |
| **Total** | **6,245** | **120,000** | **270,000** |

Forecast deforestation calculated using minimum (29%) and maximum deforestation (58%) historically registered along the three main roads already paved in the mazon.
This section has already been paved in 1997/98.
ource: Nepstad and others - 2001

1 Expected deforestation estimated by using the minimum (29%) and maximum (58%) deforestations historically registered along the main paved roads of the Amazon.
2 This part was paved in 1997/98.
Source: Nepstad et al - 2001

**Figure 8 - Conservation Units likely to be affected by the highway recovery and pavement, foreseen in the *Avança Brasil* Programme.**




Das 81 UCs federais, 18 (22,2%) serão diretamente afetadas: quatro estações ecológicas (Caracaraí, Niquiá e Anavilhanas), três parques nacionais (Viruá, Chapada dos Guimarães e Amazônia), uma reserva biológica (Uatumã), uma reserva extrativista (Tapajós-Arapiuns), cinco florestas nacionais (Tapajós, Itaituba II, Itaituba I, Altamira e Humaitá), uma reserva ecológica (Sauim Castanheiras) e as duas áreas do Projeto Dinâmica Biológica de Fragmentos Florestais

Das 73 UCs estaduais existentes na Amazônia, oito (10,9 %) Serão diretamente impactadas: seis áreas de proteção ambiental (Caverna do Moroaga, Margem\Esquerda do R. Negro, Margem\Direita do R. Negro, Lago Cuniã, Cabeceiras do Rio Cuiabá e Chapada dos Guimarães), um parque estadual (Rio Negro\Setor Sul) e uma floresta estadual de rendimento sustentável (Rio Madeira).

Fonte: Nepstad, et al., 2000; Capobianco et al., 2001

**Among the predominant forces that will have a crucial role in regional development and will determine possible scenarios in the region it is worth mentioning the proposed integration and development policy that will allow continuity of construction of the paved highways. This will expand the agriculture frontier and deforestation, configuring a Scenario of Conventional Development. The main characteristic of such scenario is its high likelihood to replicate and even expand the patterns of occupation and development that took place in the last decades by means of plans geared towards economic growth and exploitation of natural resources of the region.**

## Planned Infrastructure for the Legal Amazonia through the Move Forward Brazil Programme

Projecting history regarding construction of paved highways vs. the destruction of forests for the next 25-35 years, the pavement of the planned 6,245 km would bring an additional loss of 120,000 to 270,000 square km of forests, affecting a forest strip of 50 Km on each side of the highways. This new deforested area, added to that existing in the year 2000 – of 570,000 km2 – would increase the proportion of deforested area from the current 15% to 33% after a period of 35 years, not to mention the resulting decay of the remaining forests because of sawmills and burning caused by man. Central Amazonia would be the main region affected by such new wave of agriculture expansion, which so far has been untouched by deforestation caused by timber industry due to the difficult access. These new investments could double current $CO_2$ emissions derived from deforestation and burnings caused by man in Amazonia. Currently, land use change in Amazonia contributes to 2-4 % of the total global carbon emissions to the atmosphere.

*Further pavement of highways would bring expansion of pioneer frontiers, which leads to significant demographic expansion at an average growth rate of 4% per year, and will stabilise at a 2% per year rate by year 2010[1]. Such growth rate means that the Amazon population would reach 40 million inhabitants by 2030, causing impacts of great consequence on indigenous reserves and conservation units.*

Indigenous lands that will be possibly affected by paved highways planned in the Move Forward Brazil Programme

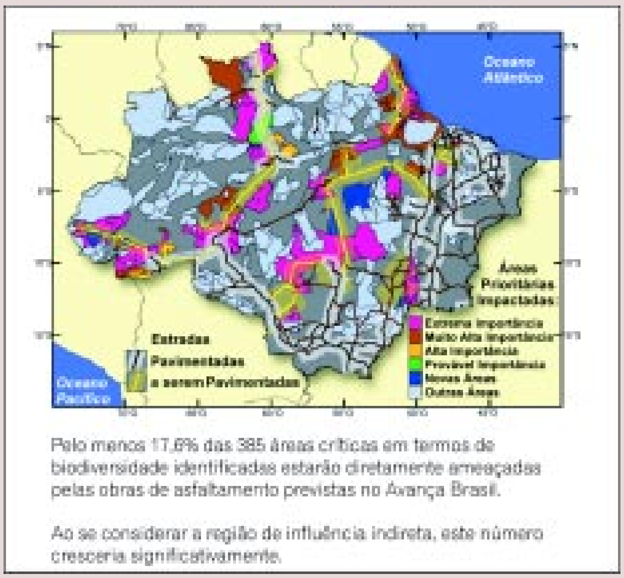
Conservation Units that will be possibly affected by paved highways planned in the Move Forward Brazil Programme

The forward movement of the timber industry over forest areas, is a result of facilitated access and the expansion of market demands. It is also due to the small monitoring capacity of the authorities. The production of timber could double in the next three decades.

Priority areas for conservation of biodiversity that will be possibly affected by paved highways planned in the Move Forward Brazil Programme

To build a new historic model that consciously incorporates the search for sustainability in Amazonia makes sense only if composed of specific political proposals and programmes at national, regional and sub-regional levels. For such programmes to be effective they need to be built on a broad and democratic debate. They need to provide realistic responses to some of the basic issues of sustainability policy in the region. Among these questions it is possible to mention land problems, use of deforested lands and adequate use of forest ecosystems. The last decades brought an increase in the number of specialists and representatives of social sectors concerned about seeking sustainable alternatives for the region. The next years should come with the development of new proposals and mobilisation of political and social forces that are able to implement a novel destiny for Amazonia.

Figure 9 - Priority areas for the conservation of biodiversity likely to be affected by the road recovery and pavement, foreseen in the*Avança Brasil* Programme.




Fonte: Nepstad, et al., 2000; Capobianco et al., 2001

chapter 5

# recommendations

# recommendations

## 1 Uncertain Future

The Third World GEO publication from the United Nations, in 2002, presents four possible scenarios for the planet in the next thirty years. Each scenario receives differentiated weights for a group of similar variables. These variables include economic and social uses and predominant abuses of natural resource bases. These variables depend on the balance among the nations and their ethical premises and purposes.

In the first scenario, globalisation and economic liberalisation are held as “indispensable elements to the economic development process”, with growing negative impacts on the environment. In scenario two, “social and environmental goals” would determine economic growth. The evaluation of the environmental cost would be priority. This factor would determine the approval, or not, of the political projects, reducing their impacts on the natural resource bases. Scenario three presents the worst possible perspective, where the preponderance of the economical safety of industrialised countries would justify conflict and isolation. This scenario would generate serious consequences for the integrity of the planet. In contrast to this horrific scenario, the last alternative of possible future presented by the UN would favour consensus and understanding among nations in the united construction of economic and environmental sustainability policies.

This chapter deals with the current stage of this specific construction effort, in which many countries are already involved. Some countries maintain their commitment in industrialised and underdeveloped countries. However, others in the same categories, do not. A future is being built with internal and international dissidence, with consensus and conquest, with accomplished commitments and faulty negligence, as well as our hopes. We must ask ourselves which hopes these are.

## 2 Apparent Local Dichotomy

The hypothetical contradiction - environment/development - apparently underlies the resistance many times found in countries with economies in transition. This is true for the action of the State, as well as acceptance by society and the implementation of changes that lead to the appropriate administration of the environment.

Such hypothesis needs to be dealt with as a reality. Developmental planning strategies based on economic models that prioritise monetary return in detriment to any other aspect appear as possible causes. Mechanisms of sectorial development and fragmented administration, which disrespect the interrelations among the various components of the environmental system, understood as natural, economic and social resources.

This hypothesis and its possible causes seem to stand out in the State’s action. Sectorial despoiling occurs with the economic and technological characteristics of the development model implanted at the expense of the apparent natural fertility of forest areas that is progressively devastated. Since the beginning of the process of accelerated industrialisation in the fifties until the nineties, environmental degradation was considered to be the “normal” price. Therefore, it was a politically acceptable price to pay for the much-desired development.

Over the last decade, the adoption of the sustainable development model as a desirable goal generated a series of changes and readjustments in public policies and production and consumption patterns in the country. Dissidence and conflicts contribute as well. These are presented in the third and second chapters of this report. In terms of accomplished commitments and criticism of faulty negligence, the support of the Brazilian population has been decisive in the construction of a new agenda for the integrated environmental administration. This is described in chapter one. In agreement with this approach, chapter four of this GEO report presents two alternative scenarios for the environmental situation in Brazil.

This biased scenario, according to the UN, maintains globalisation principles, and consequent already ascertained impacts-income concentration. There is also some workstation elitism and the elimination of other types. There is growing unemployment in many industrialised and underdeveloped countries alike. There is excessive and concentrated consumption within a small part of the world's population. There is growing political, social, economical and environmental impoverishment with the accompanying increase in social, economical and environmental inequalities. The desirable scenario redeems the commitments set in the Rio-92 Conference, which were ratified through several international conventions mentioned in the chapter corresponding to the replies to policies.

## 3 Apparent Global Dichotomy

On the other hand, the proven correlation between high consumption levels and waste on a significantly predatory scale found in some countries with best developed economies in the planet. Even with resistance there has been the implantation of regulatory consumption parameters and these are necessary changes for the appropriate environmental management.

Market strategies focused on the maximisation of invested capital and expected profit, in detriment to any other aspect, seem to answer for the mentioned resistance or, in some cases, for the opposition of some countries in relation to the implementation of the necessary changes. Other difficulties are the administration mechanisms that disregard interrelations among the several components of the environmental system, including natural, economical and social resources, and the significant impacts that the "largest financial return no matter what price" causes in terms of environmental degradation in a planetary scale. Consequent isolated actions, arising out of this situation, directed towards the preservation of its own economic safety, 'at any price ', are potential conflict generators, whose dimensions only the future will be able to reveal. Arguments which illustrate these practices defend the idea that, "economic growth comes first, cleaning would be a consequence", and also that "we needed a flexible focus", "supporting the Kyoto Protocol would cost our economy (North American) 4.9 million jobs", "sustainable economic growth is the key to environmental progress because it offers resources to be invested in clean technologies" ("O Globo" newspaper, 02/15/2002, p.24). These declarations which show the United States position, followed by Canada, and more recently, Australia, have broken the 'good deed chain' - the positive domino effect caused by the diffusion of world-wide solidarity actions, as an example, the countries of the European Union which ratified as a group, the Kyoto Protocol last May, 31st, followed by Japan, the fourth largest world transmitter of greenhouse gases. These countries are all committed with the construction of the desirable future.

Apparently, resistance to change presents similar characteristics to the economic development model implanted in the seventies in Brazil, affecting social equity and the natural fertility of huge forest areas that are progressively being devastated. Recently, however, the rhythm of environmental degradation due to excessive consumption by the richest countries has grown exponentially. This has begun to be considered the "normal" price of the self-attributed hegemony disputed by some as acceptable for those nations.

## 4 Two Challenges:

Taking the necessary measures which will lead to significant changes in attitude will demand facing fundamentally important challenges in two distinct performance areas. These are the national one and the global one.

The national challenge encompasses two components. The first determines a search for life quality improvement in the already occupied areas, particularly in the great urban concentrations that have been largely degraded in terms of overuse of natural resources (water, for instance). They have also represented a threat to the supply of indispensable life infrastructure in all aspects. The second challenge consists of guaranteeing preservation and competent exploitation of the remaining natural resources. This approaches the issue of sustainable management of these resources as a condition that the expansion of these areas that are still not so densely populated, happen in a more appropriate way.

In Brazil, there is a plurality of agencies with specific attributes that are often similar, and with performance fields that frequently overlap. These agencies generally perform without links or alliances. This results first in significant waste, and finally, in regional development program discontinuity. This institutional characteristic of the Brazilian government action has as a consequence, the overvaluing of hierarchical and sectorial analyses of what happens in the national territory. This consequently results in interventions with equal content and limitations.

According to what has been previously described, economic sector growth disregards its interrelationships with specific geographical dimensions (territory) where it is located. This space dimension, such as environmental, economic, cultural and social nature are potential generators of other development opportunities. These opportunities, when appropriately exploited, could be taken advantage of by the various social groups in which and from which they live. When neglected, they become, sooner or later, generators of conflict.

The promotion of development the territory's organisational tools is innately and insolubly linked to the development of society. This development process foes through the task of assuring access equity to natural, economic and cultural resources. These resources, when appropriately used, are an inherent part of sustainable development opportunities. Sustainability lies in the environmental adaptation (economic, social, cultural and ecological) of the exploitation means adopted. It is guaranteed and supervised when based on equity practice of access to those resources and by collective and/or individual participation from society. This participation includes citizens who once organised, will defend their rights, and their children's and grandchildren's, in regard to the use of the territory assets.

The global challenge determines the improvement of consensus among nations on the need of a single effort in order to guarantee the necessary conditions for the preservation of the planet's environment. Some countries isolated positions point to the urgent need to inform the public and spread the idea of the environment as a whole, in thematic as well as economic, social, cultural, geopolitical terms.

The consequences of the aimed at integrated approach may be better understood in contrast to a picture of what would happen in its absence. Examples of this are many, including the recent history of the Amazon Region, where the "transformation of a range of varied ecosystems is observed in agriculture-ecosystems, without leading to human development" (IBGE, 199O, p.3).

## 5 Purposes and Desirable Changes

The previously described context illustrates development programs and limitations to the generation of wealth that are based on sectorial growth programs that disrespect environmental sustainability parameters. The definitions of these parameters, however, demands homogeneous information concerning a wide range of factors, whose interrelationships need to be measured and comparatively evaluated according to specific methodology.

**a) Conditions:**

The need to overcome these difficulties and limitations in view of challenges, and to appropriately develop economic, production (processes and techniques), natural (physical-territorial) and human (creativity and disposition) potential, determines certain changes within the institutional background, which currently supports governmental action.

**b) Co-ordination:**

Sectorial action co-ordination, on the three government levels, federal, state and municipal (local), is a condition of the achievement of a common objective: "The ordering of regional spaces signalled by the search of total development of the Brazilian society" (IBGE, The Brazilian Institute of Geography and Statistics, ibid. p. 3).

**c) Production and consumption patterns:**

Besides the institutional background, one may still point out among the necessary changes, the need to review the usage, exploitation (techniques and processes), and natural resource transformation ways, as basis to the development of productive activities, considering their importance within the country's socio-economic context.

**d) Inter relationships:**
Equally important to the success of these changes is the analysis of society-nature interrelationships. This must be done including the several aspects in which state ecology and territorial planning is possible, and must take place with good will policies. There is also need for consequent incentives for research aiming at progress.

**e) Economical prevalence:**
The economical focus that is predominant in the selection of the best developmental alternative usually requires urgent review in the planning procedures adopted. The compatibility of this focus with the concept of real sustainability, considered as "the result of the balance sheet between ecological, economic and social potentialities and limitations" similarly demands studies focusing on suggestions for natural resource registering methods for national patrimony, considering the possibility of incentive policy review (including fiscal review) concerning exploitation of the area.

**f) Implementation:**
The implementation of these suggestions, their negotiations with the several government levels, and their traditional administration and planning tools, determine the review of the administration mechanisms currently adopted.

**g) Zoning, process and evaluation:**
The impacts these suggestions have among themselves and on the territorial occupation process need to be permanently evaluated as conditions for the effectiveness of future regional plans of territory development and organisation.

## 6 Some local guidelines

### 6.1 Subsoil

In spite of the significant participation of the mineral, petroleum and gas sectors, with 13.9% of the National GIP (Barreto, 2001 and Machado, 2002), they lack concern with the environment. This is true mainly in respect to passive environments and oil spill disasters. However, the government's recent actions and company investments indicate better control of the situation in the coming years.

The inadequacy of basic information is observed in terms of mineral and water, palaeontological and speliological resources, in order to adequately evaluate subsoil degradation and environmental protection, as well as the potential it has in light of the various usage types.

With a view towards basic knowledge expansion regarding the subsoil (SSM/MME-2000), the Brazilian mineral sector will have an important role in the world market of basic components. The tendencies of greater environmental control in the extraction, transformation, refinement and distribution processes will contribute to society's welfare over the next decades.

It is observed that the stage of process analysis for environmental licensing that is related to the use of the subsoil happens in a slow manner that is often harmful to the interested parties. This is due to the lack of technical training (mining, petroleum, subsoil water, territory administration) of responsible agencies on the federal as well as state and municipal levels (chap.6). If this lack of awareness from the responsible parties persists in regard to the environmental licensing the situation will tend to worsen.

**Recommendations:**

**a)** The recognition of numerous environmental liabilities caused by mining and metallurgy since the 50's requires adequate depth and dimension.

**b)** Although in smaller numbers than those observed in the 70's and 80's, prospecting in indigenous protected areas is still present in some states of the Amazon Region, such as Rondônia (The River Roosevelt Basin), Amapá, Amazonia and Roraima, where it is performed by prospectors and entrepreneurs with the approval of the indigenous community. In some cases, communities themselves perform it. Indigenous population growth and its evolution that incorporates new habits, have become demands that shall only be assisted by rational exploitation of their lands.

**c)** Geological nature attractions, such as caves, palaeontological ranches, canyons, waterfalls, geologic/geomorphologic relief, and those possessing high potential for ecotourism are of great current economic appeal. These areas have been the objects of the public's attention through appropriate environmental legislation, and also through greater participation from society in their preservation. In the case where broad institutional action lines are implemented, according to a proposal by CECAV - IBAMA, it is estimated that in the next decades, these patrimonies will reach a high protection level.

**d)** Ongoing in the sphere of executive power, there is a restructuring program of the mineral sector (PRISMA, 2001). The referred program defines new institutional and legal frameworks, which will also incorporate issues related to the environment, including the extinction and closing of mines, and future definitions for the use of affected grounds. It also includes aspects related to safety and worker health. These actions should really improve subsoil protection.

There is a need to emphasise that the processes of Brazilian subsoil degradation occurred slowly from 1972 to 1992, increasing at a faster pace from 1992 to 2002. This is largely due to the implementation of environmental legislation, government's guiding performance, non-governmental organisations, the media, and mainly through the population's awareness. The future perspectives are exciting in relation to the sustainable use of Brazilian subsoil.

## 6.2 Water Resources

**Considering that:**

**a)** the National Water Resource Policy - PNRH, established by Decree no. 9,433, January 7, 1997, represents a deep change in the administration of waters in the country, and its effective implementation depends on the government and the community users;

**b)** during the five years of existence of Decree no. 9,433, it has been observed that the largest obstacles for its implantation lay in the implementation of charges for water resources use, and the creation of Water Agencies. Both elements are innovative to water control in the country;

**c)** to double water dominion, recognised by the federal constitution, implies delicate negotiations among water resource managers from the government and the states, between users and civil associations, for the implantation and operation of PNRH tools in the basins that contain water bodies with those characteristics;

**d)** the creation of the National Water Agency by Decree no. 9,984, dated from July 17, 2000, as Federal Agencies of Water National Resource Policy implementation, and of the co-ordination of the National Water Resource Administration System, which strengthens the Government institutionally for the administration of water resources.

**Recommendations:**

**a)** the creation of fortifying institutional programs of water resource managing agencies in the states and Federal District, considering the urgent need to regularise current uses as an indispensable condition to the progress of PNRH implantation tools;

**b)** the creation of relationship mechanisms between the government and states for the establishment of integrated procedures for the implantation and operation of administrative tools in river basins with shared dominion;

**c)** that the government on three levels, federal, state and municipal, supports the strengthening of the already existing Water Basins Committees, as well as initiatives for the creation of new committees.

## 6.3 Pesticides

The answer to pressures, impact and the current state of the environment should be taken into account in order that expected solutions may minimise negative effects. In other words, the adopted measures must improve the environment. The impact of the use of pesticides in the Brazilian water basins is still a research gap in the country. This area is in need of financial resource allocations for surveys and for the accomplishment of more detailed environmental diagnoses. These diagnoses should preferably be geographically referenced; as well as include the development of maps in appropriate scale to this sort of evaluation.

**Recommendations:**

**a)** In general, more detailed work should be done, counting on more time within the states aiming to prove the need or not of survey of applied products in the agricultural activities in water basin areas. This should occur giving priority to studies in areas that are believed to be more fragile and more susceptible to human provision subsoil water contamination. This survey will reduce project duplication and will encourage the documentation and popularisation of these results, which have yet to be accessed.

**b)** The need for training for specialists and producers on pesticide application technology is clear. The correct use of these products is essential for the control of diseases/plagues of cultivation in the whole country. In addition, the implementation of monitoring programs aimed at mapping pesticide environmental impacts should take place in order to allow the definition of more focused research projects. As a result, further government support is needed for the use of Ecological Management strategies across the country. This effort should also aim at assisting the concerned entrepreneurs' demands regarding sanitation and commercial barriers in relation to pesticides and the environment across the country.

**c)** Future projects should assist in the definition of territorial occupation policies in areas of subsoil water supply. These areas are of strategic importance to the country. They should also assist in the evaluation of water and linear erosion in the transport of nutrients and pesticides.

**d)** There is a great diversity of subjects involved in the environmental impact issue and the use of pesticides in water basins. There are also a great number of government and state institution specialists that have been trained in guidelines that were previous to sustainability. There is lack of training for researchers on subjects related to the sustainability of water resources across the country. There is a lack of training that focuses on evaluating the environmental impacts of agriculture on water resources. Achieving the goal of improved and updated training programs has become a priority.

**e)** Give preference to governmental precautionary actions whenever possible, in anticipation of mitigating circumstances.

## 6.4 Ordering and Territorial Administration

The correct use of territorial space is one of humanity's largest objectives. However, this objective has never been so important as it is today. The world population growth which has occurred in the last decades, from 2.5 billion inhabitants in 1950 to more than 6 billion inhabitants in 2000 (United Nations data), shows the severity of the environmental crisis. This population grows at a gross rate of 78 million inhabitants a year and this requires a great amount of natural resources for survival. On the other hand, this population generates great amounts of pollution that the environment will probably take millions of years to decompose and recycle. The environmental crisis is felt globally, and this is no different in Brazil. One of the solutions to overcome the environmental crisis is correct administration of the territory.

**Recommendations**

To accomplish territorial administration, it is necessary to first become familiar with the territory. This must be done with maps that assimilate the environmental, political and social dynamics that occur. This mapping will demand a territorial-synthesis unit, in order to allow the analysis of the interrelations between activities and environmental assets.

**a)** The definition of a typology based on the interactive relationships between the city and the environment, and between the city and the rural space that separates them is necessary. This definition must consider the ecological context of these elements in order to allow the establishment of a territorial synthesis unit of natural and constructed resources and of socio-economic uses. Given the comparison based on hierarchical criteria and the resource potential scale, in addition to the intensity of exchange or interaction between the city with the territory under its influence, the establishment of patterns to enable the appropriate administration of the environment must be made possible. This must be done in a way that takes into account both natural and constructed patrimony.

**b)** The intensification of the use of fertilisers and pesticides must be taken into consideration in the selection of criteria that will enable the creation of a hierarchy in anthropological-ecological bases. Other elements that must be considered are the decrease in the capacity of recovery of the subsoil waters provoked by the expansion of the cultivated area and by the compacting of the soil as a consequence of agricultural mechanisation, linked to expansion of the urban areas. These are examples to be taken into consideration, along with the identification of ecological characteristics and the identification of “environmental systems”. This type of identification will be more appropriate to the territorial reality.

**c)** For the registration, organisation, recovery, analysis and availability of the generated data on the internally identified dynamics, and among territorial categories, a system which supplies referenced geographic information is necessary. This system should be used by the various governmental and non-governmental sectors of the country.

## 6.5 A Geographic Information System for Territorial Administration

Currently in Brazil, the existing geographic information systems in institutions follow the administrative model installed in the country. This means that since the institutions are not integrated administratively, technically or politically, the implemented systems are also not integrated. Each institution has its own system that possesses its own data model and consequently, generates the geographic information according to its own standards without worrying if such information can be used by other institutions. Data, information and project methodology sharing are still hesitant and inefficient. Even when sharing occurs, the uses of data and information are precarious because there isn’t standardised data or a geographic information model in the country yet.

### Recommendations

Territorial administration is an activity that involves the integration of all of the government and non-governmental sectors. The political, administrative and technical alliance of all these sectors may be the biggest challenge in achieving the efficient administration of the Brazilian territory. Once the goals for the accomplishment of these alliances have been established, it is possible to start a system capable of generating geographical information to help in territorial administration.

**a)** One of the requirements of a geographic information system for territorial administration is a unique and standardised data model for Brazil. This data model can only be built with the participation of all sectors of society. Standardisation of the data model facilitates the development of project methodologies, data documentation, and consequently, exchange and use by all sectors.

**b)** Another characteristic that a system of geographic information for territorial administration should present is the possibility of expansion of its functions, which is, the system should enable the inclusion of new functions for analyses and specific simulations on the executed actions or the ones to be taken over the territory.

**c)** A system of geographic information for territorial administration should generate information that would be simple to obtain and largely available to society in general. Therefore, information transfer with geographic references through the use of Internet should also be another characteristic of this system.

**d)** Finally, this system should be specified and built by public Brazilian Institutions, mainly by the Brazilian universities.

## 6.6 Scenarios

Following the decision of PNUMA, IBAMA/MMA and partner institutions in GEO Brazil's effort, the integrated environment evaluation report was developed. This was done taking into consideration that the available socio-economic data is isolated (this data is not grouped by water basin, nor by biome).

**Considering** the lack of timely data series on the environmental variables,

**Considering** the lack of systematised information on the use of the soil and natural resources,

**The recommendations are:**

**The creation** of a standing committee of all partner institutions, in order to monitor the course of GEO Brazil's decisions;

**The creation** of an 'Integrated Socio-economic and Environmental Information System (**SII**) ', which produces and receives data from partner institutions, and delivers data as requested;

**The creation** of an 'Integrated Modelling and Simulation Centre (**CIMS**)', for the formulation and evaluation of environmental scenarios. This evaluation would incorporate tendencies as well as desirable actions. This centre will rely on the 'Integrated Socio-economic and Environmental Information System (**SII**)" data, proposed above, and it will also aid the **SII** project**, revealing** the demands of the environment's integrated evaluation. For instance, this centre will supply **SII** the variables that need to be monitored, so that '**Indicators**' proposed at GEO Brazil may be developed and calculated. This Centre will be responsible for the development and calculation of the indicators proposed in GEO Brazil, which will be used in the modelling and simulation of scenarios.

This centre (**CIMS**) represents an evolution in the integrated environmental evaluation methodology, as it will use mathematical and advanced computational resources. The centre will provide scenarios based on information contained in a great number of variables. Without the use of the mathematical model and computational simulation, it is impossible to make accurate conclusions concerning a great number of variables that are included in the formation of an environmental scenario.

## 6.7. Biodiversity and Forests

Brazil is one of the five countries with the largest biodiversity in the world. The Atlantic Forest fosters 27 percent of the plant species known in the planet. The *Cerrado* is the richest savannah among all and about 40 percent of its plants are endemic to it. In the *Caatinga*, 30 percent of the arboreous and bushy species described are endemic to the area. Pantanal is the largest floodable plain in the world and the Amazon Forest is the largest remaining tropical forest on earth, harbouring 10 percent of the world's available fresh water. The protection and the sustainable use of the natural resources offered by these ecosystems will ensure future life quality. Today's society, however, has to be aware of the need for an effective action both individually and by means of public policies which ensure the preservation of the species and the ecosystems. In view of this situation we propose:

**Recommendations for biodiversity**

**a)** to increase in 150 percent the number of endangered species which were worked on.

**b)** to increase the works which focus on the recovery of endangered species of fauna and flora.

**c)** to review the norms which regulate the use of Brazilian and exotic wildlife species, as well as exotic and native flora species, with scientific and trade purposes.

**d)** to control the access to genetic resources, including bioprospection.

**e)** to organise the creation and use of transgenic organisms.

**f)** to establish public policies aimed at the implemention of international conventions directly or indirectly related to the conservation of national and international biodiversity.

**g)** to increase control and inspection of illegal transportation and trade of national fauna and flora species. To provide a better inspection in ports, airports, railways and roads both in the country and abroad.

**h)** to make feasible and to organise the establishment of ecological corridors at the national and transboundary level.

**i)** to intensify the sanitary control of legally imported species, as well as those involuntarily entering the country.

**j)** to intensify the control and erradication of exotic species that may jeopardise the balance and survival of native species.

**k)** to introduce the protection and reforesting of riverbank vegetation.

**l)** to support and encourage the research of less collected species, such as insects, for example, which are important seed spreading agents and effectively contribute to maintaining ecosystems.

**m)** to encourage the development of biodiversity inventories for ecosystems and biomes.

**n)** to increase the area of conservation units to 10 percent of the Brazilian territory, specially areas recognised as endemic hubs.

**o)** to consolidate the conservation units which were already created and to implement management plans in the federal, state and municipal units.

**p)** to establish Environmental Awareness programmes aimed at the conservation of biodiversity.

**Recommendations for Forests**

**a)** to improve the control of wood coming from forest management plans authorised both nationally and internationally.

**b)** to encourage the productive sector to use alternative wood to reduce the pressure on overexploited high-quality species such as mahogany, virola, ipe wood, imbuia and peroba.

**c)** to encourage the good use of biomass for the generation of energy from forest exploitation residues.

**d)** to encourage alternative energy sources to eliminate the use of firewood from *Caatinga* native vegetation.

**e)** to improve inspection and control of wood logging, transportation and processing.

**f)** to increase inspection in illegal selective logging areas to prevent deforestation.

**g)** to develop forest exploitation technologies, avoiding loss of vegetable biomass.

**h)** to reorganise quality certification mechanisms, aimed at increasing the access of logging companies.

**i)** to integrate the agricultural policy to the forest policy seeking to promote new settlements only in already degraded areas.

**j)** to make possible the implementation of economic tools allowing the increase of planted forest areas as a substitute for native forests.

## 7. SOME global GUIDELINES

The international discussions that precede The Rio+10 Conference focus on poverty relief as the main topic. However, the examination of structural causes would complementarily demand, "wealth relief ", in other words, the effects of excessive consumption of the rich over the poor (Ecological JB, "JB Ecológico" 06/29/2002, p.11). In that sense, facing the global challenge, as previously mentioned, demands the construction of an international consensus on some fundamental issues defined locally and regionally. This construction has been gradually accomplished through efforts such as the one undertaken by the Forum of Environmental Ministers of Latin America and the Caribbean. In the seventh meeting of the Intersectorial Committee from the mentioned Forum, held in São Paulo between May 15 and 17 of the current year, those Ministers approved the "Latin America and the Caribbean Initiative for Sustainable Development" document, considering some fundamental issues, among which we may point out the ones presented below.

### 7.1. To reinforce the consolidated positions from Rio - 92

**a)** To ratify the designated commitment of 0.7% of GDP from industrialised countries to developmental assistance, as approved in Agenda 21.

**b)** To accomplish the commitments within the Doha Declaration, and in the Monterrey Consensus to assure the access to the market and financial resources requested to reach the goals of sustainable development, particularly in support to the efforts of developing countries.

**c)** To guide the creation of new financial mechanisms, including the cancellation of the developing countries debt, in particular, of less developed countries, and the creation of a contingency fund to face natural disasters.

**d)** To fully apply the common responsibility principle. This should be accomplished, however, differentiated according to the state, and the respect to the sovereign right of each country on their natural resources.

**e)** To reiterate the commitment with the prevention principal according to the definition that is stated in the Rio Declaration, as a key component of the environmental policy, in order to safeguard our natural and social patrimony.

**f)** To grant priority to the interests of Caribbean countries, especially in execution to the Barbados Action Plan.

**g)** To reinforce the participation of the various non-governmental agents, and the transparency in the processes of decision taking, strengthening initiatives such as: Sustainable Development National Councils and the formulation of national and local Agendas 21.

**h)** To promote the construction of a new ethical practice for sustainable development, which considers the processes developed to the moment, as it is the case of the " Earth Letter".

**i)** To implement the Guidelines on Sustainable Consumption approved by the United Nations Commission on Sustainable Development in 1999.

### 7.2. Operational Guidelines

The programs and projects proposed by the Forum of Environment Ministers of Latin America and the Caribbean, to face the challenges of sustainable development, within an ethical framework, should assist the operational guidelines as presented below.

**a)** To promote sustainable economic growth, and the definition of mechanisms and Instruments to face new instability fronts, propitiating the capacity of internal agreement and private capital economy;

**b)** To support the implementation of public policies towards poverty reduction, and social differences, job generation and the promotion of sustainable development with justice, equity and social inclusion;

**c)** To execute integrated human health and environmental measures to assure that the population's health and welfare is increasingly recognised, and systematically translated into policies and programs;

**d)** To point out bonds between unsustainable consumption patterns and the internalisation of production patterns, in particular towards the growing importance of consumers' and companies' awareness in applying concepts of social and environmental responsibility;

**e)** To develop new sustainable competitiveness bases for the productive structure of countries of the region, with the purpose of expanding their inclusion in the world economy, proposing orientation strategies for the effective opening of foreign markets to all developed countries, as a condition for the objective of sustainable development in the area;

**f)** To create or to strengthen economic, fiscal and tributary tools for the promotion of sustainable development;

**g)** To stimulate the adoption by the governments and by the productive sector, of voluntary tools (certificates, ISO 14,000, certificates for tourist sustainability, etc.), applicable to the process of sustainable development;

**h)** To begin or to continue the processes of environmental and natural resource appreciation, for the use of comparative advantages in the area, incorporating indicators regarding liabilities and environmental assets, in order to include them in the national legislation systems;

**i)** To support regional actions and sub-regional efforts, in particular the Caribbean (SIDS) , the Amazonian countries (TCA), the Andean Area (CAN), "Mercosul" and Central America (ALIDES);

**j)** To strengthen the regional, sub-regional and national institutions, as well as the sub-national levels, for the instrumentation, continuation and monitoring of policies, programs and resulting projects from this initiative;

**k)** To formulate strategies of incorporation, transfer and technological development, which shall be supported through the mobilisation and expansion of resources from existing financial institutions;

**l)** To perfect and to adapt the systems of existing sustainability indicators or to build new systems of indicators to meet social, economic or political particularities of the area;

**m)** To develop actions of South-South co-operation, which may favour the efforts, strengths and opportunities of countries in development, in regards to sustainability development and to the people of the region;

**n)** To promote the development of *sui generis* methodology in regard to traditional knowledge protection, based on tools and mechanisms of distinct nature; to see that current intellectual property systems consider the association of traditional knowledge and biological diversity in the evolution of patent requests and other related rights.

## 8 GUIDING GOALS AND INDICATIVE PURPOSES

The construction of the mentioned regional consensus passes through the implementation of some goals presented as following, whose definition is result of the same understanding effort undertaken by the Environment Ministers Forum.

### 8.1. Biological Diversity

**a) The increase of arboreal surface**
to assure the sustainable management of forest resources of the area, significantly reducing the current deforestation rates.

**b) Territory according to protected areas**
to significantly increase the surface of the regional territory according to protection areas, considering in its definition, transition zones and biological corridors.

**c) Genetic resources-Equal Benefit Distribution**
to adopt regulation frameworks for access to genetic resources, as well as fair and equal participation in benefits derived from them, compatible with the Agreement on Biological Diversity.

### 8.2. Water Resource Administration

**a) Water Basin Management**
to improve and to strengthen the institutionalisation of the integrated management of water basins and subsoil waters among others, through the establishment of water basin committees, with the participation of government, civil society, and the private sector and all involved agents.

**b) Marine-coastal Management and its Resources**
to implement environmental, national and regional action plans for the integrated management of the coasts, with particular attention to the small insular states in development.

**c) Better quality of Terrestrial Waters**
to improve the quality of effluents and to reduce the contaminating discharges on surface water bodies and subsoil ones, as well as on the coastal area.

## 8.3. Vulnerability and sustainable cities

### 8.3.1. Territorial ordering

**a)** To implement territorial order plans and policies, from a sustainable development focus.

**b)** To incorporate instruments for risk administration in the ordering plans.

### 8.3.2. Affected areas by degradation processes

To significantly reduce the surface of the regional territory submitted to erosion, salinisation and other processes of soil deterioration.

### 8.3.3. Air Contamination

To reduce the concentration of air pollutant emissions.

### 8.3.4. Water Contamination.

To expand the covering of tap water services and of residual water treatment.

### 8.3.5. Solid Waste

**a)** To significantly reduce the generation of solid waste (domestic and industrial) and to promote recycling and reuse.

**b)** To implement the integrated management of solid waste (domestic and industrial), including treatment and final adequate destination.

### 8.3.6. Vulnerability in face of the atrophic disasters and those caused by natural phenomena.

To implement and to strengthen regional co-operation mechanisms for risk management and the decrease of atrophic disasters and those caused by natural phenomena, including the formulation of a regional system, of previous alert and the formation of immediate action groups.

## 8.4. Social Aspects, including Health, Inequity and Poverty

### 8.4.1. Health and Environment

**a)** To implement policies and plans to reduce environmental risks which may cause health damage. These specially signify those of water transmission through vectors, atmospheric contamination and exposition to chemical substances.

**b)** To increase the amount of healthy area per person

### 8.4.2. Environment and Job generation

To promote the formulation and progress of projects and sustainable development programs, which may contribute to job generation and avoid migrations.

### 8.4.3. Poverty and Iniquity

To drastically reduce poverty levels in countries of the region.

## 8.5. Economic Aspects, including Competitiveness, Trade and Production Patterns and Consumption (Energy)

### 8.5.1. Energy

To administer the use of the renewable energy in the area below 10% of the total energy percentage of the region for 2010.

### 8.5.2. Cleaner production

**a)** To install Centres of Cleaner Production in all the countries of the region.

**b)** To incorporate the concept of cleaner production in a significant portion of the main industries, with emphasis on the small and average industry.

#### 8.5.3 Economic tools

To establish a system of economic incentives for projects of production and industrial transformation, which may save natural resources and energy, and which may produce the final reduction of effluents into water, soil and air.

### 8.6. Institutional aspects

#### 8.6.1. Environmental education

To improve and strengthen the incorporation of the environmental dimension in formal and informal education, in economy and in society.

#### 8.6.2. Training and qualification of human resources

**a)** To eradicate illiteracy and to universalise the registration of elementary and secondary education.

**b)** To establish programs for the creation of responsibilities in the administration of sustainable development for the public, and private sectors and the community.

#### 8.6.3. Evaluation and indicators

To develop and implement an evaluation process on the progress of sustainable development objectives, adopting sustainability indicator systems, at national and regional levels that attend social, economic and political particularities of the regional.

#### 8.5.4. Society's Participation

To create and strengthen participation mechanisms in sustainable development topics, with governmental and non-governmental representation, and from main groups in the entire region.

# annexes

# annex 1 - statistics

## Presentation

The present report, elaborated by the Geo-sciences Department at IBGE, presents a set of indicators compiled to make up the statistical annex of Environment Outlook - BRAZIL, under the responsibility of IBAMA. It consists of a preliminary version subject to the evaluation of coordinators participating in the making of this report.

This document presents a total of 141 indicators obtained from safe and reliable sources in Brazil. It is made up of data organized by themes and sub-themes and of a metadata report. The latter presents concepts, units of measure, sources, comments on methodology and Observations about each indicator.

The main reference for the selection of constant variables was the statistical annexes of documents published by UNEP, the Global Environment Outlook 2000 - Latin America and the Caribbean[1], and by the UNIVERSITY OF COSTA RICA and UNEP - Geo – Environmental Statistics in Latin America and the Caribbean[2].

The terminology, concepts and categories used in its elaboration were adjusted to Brazilian usage. In addition, different methods have been used in order to adjust to availability and the characteristics of data sources.

[1] UNEP. Global Environment Outlook 2000 – Latin America and the Caribbean, San José: Development Observatory, 2000. 144 p.
[2] UNIVERSIDAD DE COSTA RICA, PNUMA. Geo - Estadísticas Ambientales de América Latina y el Caribe. San José: Observatorio del Desarollo/Universidad de Costa Rica, 2001. 208 p.

# A – STATE OF THE ENVIRONMENT AND TRENDS

## A.1 - EARTH

### A.1.1 - Use

| | |
|---|---|
| **1** | **Ground surface / Territory** |
| **Unit:** | 1000 ha |
| **Concept** | Area = quantity projected in a horizontal plan within the limits of a polygon. The area of the Brazilian territory is the result of the sum of continental islands, coastal islands and oceanic islands and the internal area delimited by the perimeter that surrounds all of its federal units. |
| **Comments** | Unlike the concept presented for ground surface in the catalogue GEO - Environmental Statistics for Latin America and the Caribbean, the concept of territory presented in this document includes bodies of water found within the territory. Considering the administrative political structure effective on December 31,1997 the total area is 8,547,403.5km$^2$ (including the oceanic islands of Fernando de Noronha, Martin Vaz and Da Trindade). The area is larger than the one considered to be that of the Brazilian territory in the 1980s by 0.42%. This results from an improvement in methodology. The first official estimate of the Brazilian ground surface was made in 1889. Measurements and calculations based on information from the first pages of the Declaration of the Emperor, published in 1883, arrived at an area of 8,337,218km$^2$. Further development of the document made it possible to revise the outline of international limits and that of the coastline. In the studies and geographic interpretations for the definition of borders on bodies of water within the country and on the territory, the concepts published by the United States Bureau of the Census were applied. The revision of the Brazilian area, approved by Resolution no. 392 of the General Assembly of the National Council of Geography on October 29, 1952, made the area of 8,513,844 km$^2$ official. |
| **Source** | IBGE – Brazilian Annual Statistical Report, 1999. |
| **Observations** | |

| | |
|---|---|
| **2** | **Lands Used for Temporary and Permanent Cultivation** |
| **Unit:** | 1000 ha |
| **Concept** | Lands where short-term (temporary) crops are cultivated, either resting of being used, and lands used for long-term (permanent) crops. The former normally require re-plantation after each harvest within a period of time no longer than one year. The latter don't require re-plantation as they produce for several successively years. |
| **Comments** | These include areas where there are plantations and those being prepared for cultivation of temporary and permanent crops. The former include areas for the cultivation of forage intended for harvesting and those normally used for temporary crops but which, were not being used for that end at the time of the Census due to climatic factors (droughts, heavy rains, etc.). As for permanent crops, they also include areas where there are permanent crop seedling nurseries, as well as areas where rubber trees, maté plants and heart of palm are planted. |
| **Source** | IBGE – Agricultural and Cattle Ranching Census – 1970,1975,1980, 1985 and 1996 |
| **Observations** | |

**3** | **Lands used for Temporary Crops**

**Unit:** 1000 ha

**Concept** Lands where short-term (temporary) crops are cultivated, either resting or being used, normally for a period of time no longer than one year. They usually require re-plantation after each harvest.

**Comments** These include areas where there are plantations and those being prepared for cultivation of short-term crops. They include areas for the cultivation of forage intended for harvesting and those normally used for temporary crops but which, were not being used for that end at the time of the Census due to climatic factors (droughts, heavy rains, etc.).

**Source** IBGE - Agricultural and Cattle Ranching Census, 1970, 1975, 1980, 1985 and 1986

**Observations**

**4** | **Lands used for Permanent Crops**

**Unit:** 1000 ha

**Concept** Areas for cultivation of long-term crops that do not require re-plantation after each harvest, continuing to produce for several years.

**Comments** These include areas where there are plantations and those being prepared for cultivation of permanent crops. They also include areas where there are permanent crop seedling nurseries and areas where rubber trees, maté plants and heart of palm are planted.

**Source** IBGE - Agricultural and Cattle Ranching Census, 1970, 1975, 1980, 1985 and 1996

**Observations**

**5** | **Lands used for Temporary Crops per Inhabitant**

**Unit:** ha/100 inhabitants

**Concept** Proportion of land where short-term (temporary) crops are cultivated, resting or being used, in relation to the total population.

**Comments** For the year 1970, resting lands were not included because they were classified as productive lands not being used.

**Source** IBGE - Agricultural and Cattle Ranching Census, 1970, 1975, 1980, 1985 and 1996; IBGE Brazilian Annual Statistical Report, 1985; Population Count 1996.

**Observations**

**6** | **Lands not used for Temporary or Permanent Crops**

**Unit:** 1000 ha

**Concept** These include all land that is not specifically used for temporary or permanent crops, such as: permanent pastures, forest areas, areas where there are constructions, etc.

**Comments** This information was obtained by subtracting the areas where there are temporary and permanent crops from the total area of the Brazilian territory, including the areas of the islands of Da Trindade (10.1km$^2$) and Martim Vaz (0.3km$^2$), the region under dispute - PI/CE (2,977.4 Km$^2$) and the area of the State District of Fernando de Noronha (18.4 Km$^2$), adding up to a total of 8,547,403.5.

**Source** IBGE - Agricultural and Cattle Ranching Census, 1970, 1975, 1980, 1985 and 1996; IBGE - Population Count 1996.

**Observations**

| | |
|---|---|
| **7** | **Agricultural Surface** |
| **Unit:** | 1000 ha |
| **Concept** | The sum of the areas of land used for temporary and permanent cultivation, planted and natural pastures, unused productive lands and planted forests. |
| **Comments** | Unused productive land and land that has not been used for over four years were included. |
| **Source** | IBGE - Agricultural and Cattle Ranching Census, 1970, 1975, 1980, 1985 and 1996. |
| **Observations** | |

| | |
|---|---|
| **8** | **Irrigated Lands** |
| **Unit:** | 1000ha |
| **Concept** | Total irrigated area at cattle ranching facilities, except for manual irrigation. |
| **Comments** | The following irrigation methods were considered: flooding, infiltration, aspersion and others. |
| **Source** | IBGE - Agricultural and Cattle Ranching Census 1970, 1975, 1980, 1985 and 1996. |
| **Observations** | |

## A.2 - FORESTS

### A.2.1 – State and Use of Forests

| | |
|---|---|
| **9** | **Variation in Forest Area – Native Forests -Legal Amazon** |
| **Unit:** | 1000ha/year |
| **Concept** | Annual deforestation rate (area annually deforested) for the States of the Legal Amazon (9 states: PA, AM, RR, RO, AC, AP, TO, MT and MA). |
| **Comments** | 1) The deforestation rate in the Amazon was calculated based on the comparative analysis of satellite images (LandSat TM) obtained during consecutive years. Satellite images are obtained, processed and interpreted by the National Institute for Space Research (PRODES- Amazon Deforestation Monitoring Program), which makes deforestation rates available on the Internet.<br>2) Primary and secondary forest clear cutting is counted as deforestation. Primary forest areas are predominant in the Amazon.<br>3) The states where deforestation was calculated are: PA, AM, RR, RO, AC, AP, TO, MT and MA. |
| **Source** | National Institute for Space Research - PRODES (Ministry of Science and Technology) |
| **Observations** | |

| | |
|---|---|
| **10** | **Percentage Variation in Forest Area – Native Forests / Legal Amazon** |
| **Unit:** | % per year |
| **Concept** | Annual deforestation percentage rate ([area deforested each year / remaining forest area] x 100) for the Legal Amazon (9 states: AM, PA, RO, AP, MT, RR, AC, TO and MA). |
| **Comments** | 1) The deforestation rate in the Amazon was calculated based on the comparative analysis of satellite images (LandSat TM) obtained during consecutive years. Satellite images are obtained, processed and interpreted by the National Institute for Space Research (PRODES- Amazon Deforestation Monitoring Program), which makes deforestation rates available on the Internet. |

| | |
|---|---|
| | 2) Primary and secondary forest clear cutting is counted as deforestation. Primary forest areas are predominant in the Amazon. |
| | 3) The states where deforestation was calculated are: PA, AM, RR, RO, AC, AP, TO, MT and MA. |
| **Source** | National Institute for Space Research - PRODES (Ministry of Science and Technology) |
| **Observations** | 1980 and 1985 – average annual variation rate for the period between 1978 and 1988. 1993 and 1994 – average annual variation rate in this period. |
| **11** | **Variation in Forest Coverage – Native Forests / Remaining Atlantic Forest** |
| **Unit:** | 1000ha/5 years |
| **Concept** | Deforestation rate per five-year period (area deforested over a period of 5 years) in part of the region originally covered by the Atlantic Forest (9 states: ES, GO, MS, RJ, MG, SP, PR, SC and RS). |
| **Comments** | 1) The deforested area in the Atlantic Forest was calculated based on the comparison of satellite images (LandSat TM) obtained every 5 years. Satellite images are provided by the National Institute for Space Research and processed and interpreted by the NGO "SOS Atlantic Forest", which makes the information available on the Internet. 2) The states where Atlantic Forest deforestation was calculated are: ES, MG, GO, MS, RJ, SP, PR, SC and RS. |
| **Source** | NGO "SOS ATLANTIC FOREST" ("SOS **MATA ATLÂNTICA**") |
| **Observations** | |
| **12** | **Percentage Variation in Forest Coverage – Native Forests / Remaining Atlantic Forest** |
| **Unit:** | % in 5 years |
| **Concept** | Percentage deforestation rate per five-year period (area deforested over a period of 5 years / remaining forest area in the beginning of the period] x 100) in part of the region originally covered by the Atlantic Forest (9 states: ES, GO, MS, RJ, MG, SP, PR, SC and RS). |
| **Comments** | 1) The area deforested in the Atlantic Forest was calculated based on the comparison of satellite images (LandSat TM) obtained every 5 years. In order to arrive at the deforestation percentage rate, the total deforested area was divided by the remaining forest area in the beginning of the period. 2) Satellite images are provided by the National Institute for Space Research and processed and interpreted by the NGO "SOS Atlantic Forest", which makes the information available on the Internet. 3) The states where Atlantic Forest deforestation was calculated are: ES, MG, GO, MS, RJ, SP, PR, SC e RS. |
| **Source** | NGO "SOS ATLANTIC FOREST" ("SOS MATA ATLÂNTICA") |
| **Observations** | Period: 1990 - 1995 |
| **13** | **Forest Coverage – Native Forests / Remaining Atlantic Forest** |
| **Unit:** | 1000ha |
| **Concept** | The Atlantic Forest region includes the group of humid tropical forest formations that originally covered the coast of Brazil from RN to RS and the interior of the south and southeast regions, reaching the Central West of the country (GO and MS). In terms of original total area, the Atlantic Forest is the second largest |

group of humid tropical forests in Brazil (the first one is the Amazon). There is a great deal of biodiversity and, due to its geographical location, it underwent great devastation from the beginning of the colonization of the country. Nowadays, most of the remaining Atlantic Forest consists of secondary forests.
The area where remaining Atlantic Forest is found is presented for some of the states where it occurred originally (ES, MG, GO, MS, RJ, SP, PR, SC and RS).

**Comments** 1) The remaining Atlantic Forest area was obtained based on the analysis and interpretation of satellite images (Land-Sat TM). The images are provided by the National Institute for Space Research and processed by the NGO "SOS Atlantic Forest".
2) Remaining forest areas were only identified and mapped in part of the Atlantic Forest area. The data presented corresponds to the remaining Atlantic Forest area in the states of ES, MG, GO, MS, RJ, SP, PR, SC and RS.

**Source** NGO "SOS ATLANTIC FOREST" ("SOS MATA ATLÂNTICA")

**Observations**

**14** **Forest Fires and Clearing and Burning / Number of Heat Spots**

**Unit:** No.

**Concept** There are forest fires and clearing and burning in the Brazilian territory. They are represented by the number of heat spots detected by the satellite (NOAA series). In most cases, specially in the Amazon (in the Deforestation Arch) and in Central Brazil, these spots are areas where native vegetation was cut down and burnt for cattle ranching and agricultural purposes.

**Comments** 1) The data collected by the satellites are analysed and interpreted by the National Institute for Space Research (Ministry of Science and Technology), which forwards the information to IBAMA (Ministry of the Environment). IBAMA then consolidates it and makes it available to the public on the Internet (AMAZON EMERGENCY FIRE PREVENTION AND CONTROL PROJECT).
2) Some of the heat spots detected correspond to the use of fire for pasture renewal and for harvesting sugar cane. They are not related to native vegetation clearing and burning for creating new areas for agro-pasture use.
3) Burning is the authorised and controlled use of fire in rural properties for the purposes of pasture renewal, sugar-cane harvest, clearing of new agro-pasture areas, etc. They are authorized by the responsible environmental agencies. Forest fires result from unauthorized use of fire and burning that went out of control, destroying not only areas with native vegetation but also those used for cattle ranching and agriculture.
4) For the years 1998 and 1999, the data presented include the heat spots detected during the period from June to December.

**Source** IBAMA (AMAZON EMERGENCY FIRE PREVENTION AND CONTROL PROJECT) – Evaluation and Monitoring of Forest Fire Risk in Critical Areas

**Observations** 1998 and 1999 - data referring to the period from June to December.
2001 – 145,708 heat spots.

**15** **Forest Coverage – Planted Forests**

**Unit:** 1000 ha

**Concept** Total area of planted forests in Brazil. The main species planted in the country are exotic and belong to the Eucalyptus (eucalypts) and Pinus (pine trees) species.

**Comments** 1) The planted forest areas presented were taken from the Agriculture and Cattle Ranching Census by IBGE. The information is the Agriculture and Cattle Ranching Census was gathered based on direct consultation (interviews) with individuals (owners, leasees, administrators, etc.) responsible for agricultural, forestry or cattle-raising establishments.

2) The planted forest areas presented include areas planted with forests, those being prepared for plantation and areas used for seedling nurseries.

**Source** IBGE - Agricultural and Cattle Ranching Census 1970, 1975, 1980, 1985,1995, and 1996.

**Observations** Due to change in the date for gathering data, the results of the last Agricultural and Cattle Ranching Census report back to the years 1995 and 1996.

**16** **Variation in Forest Coverage– Planted Forests**

**Unit:** 1000ha / year

**Concept** Average annual variation rate in the area covered with forests. It is calculated based on the difference between planted forest areas in two consecutive censuses divided by the time gone by between censuses. It corresponds to the difference between the increase in new forest areas e and those where trees have been cut down and not replanted or reformed. It may be positive or negative depending on the expansion or contraction of planted forest areas.

**Comments** 1) The information necessary for the calculation of this rate was taken from the Agricultural and Cattle Ranching Censuses undertaken by IBGE.

2) Because Agricultural and Cattle Ranching Censuses are periodical, carried out every 5 years during the period from 1970 to 1985, the forest coverage variation rates presented are obtained by dividing the difference between planted forest areas in two consecutive censuses by 5, except for the rate referring to the period between the 1985 and 1995/1996 Censuses. For the latter, the period of time used for calculation of the rate was 10.5 years due to changes not only in periodicity but also in the implementation date.

3) The Agricultural and Cattle Ranching Census gathers information on areas where there are forest plantations by interviewing individuals (owners, leasees, administrators, etc.) responsible for rural establishments.

4) The negative variation rate obtained for the period between 1985 and 1995/1996 corresponds to the reduction of the total area of forest plantations in Brazil during this period.

**Source** IBGE - Agricultural and Cattle Ranching Census, 1970, 1975, 1980, 1985, 1995/ 1996.

**Observations** 1970 - 1984 – rates represent the average for 5-year periods.

1985 - 1996 – rates represent average values for a period of 10.5 years.

Negative rate values indicate the reduction of planted forest areas.

**17** **Percentage Variation in Forest Coverage – Planted Forests**

**Unit:** % per year

**Concept** Average annual variation rate in the area covered with planted forests. It measures the percentage variation in planted forest areas in Brazil along time. It may be positive or negative depending on the expansion or contraction of planted forest areas.

**Comments** 1) The information necessary for the calculation of this rate was taken from the Agricultural and Cattle Raising Censuses carried out by IBGE.

2) The annual percentage rate was obtained by dividing the difference between planted forest areas in two consecutive censuses by the planted forest area of

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|---|---|
| | the first one (beginning of the period). This result was then divided by the time gone by between censuses (5 years for the rates of the period from 1970 to 1985 and 10.5 years for the period from 1985 to 1995/1996) and multiplied by 100. 3) Changes in the periodicity of the Agricultural and Cattle Raising Censuses, carried out every 5 years during the period between 1970 and 1985 and in 10.5-year intervals between 1985 and 1995/1996, resulted in the differences in calculation registered in the comment above. 4) The Agricultural and Cattle Ranching Census gathers information on areas where there are forest plantations by interviewing individuals (owners, leasees, administrators, etc.) responsible for rural establishments. 5) The negative variation rate obtained for the period between 1985 and 1995/1996 corresponds to the reduction of the total area of forest plantations in Brazil during this period. |
| **Source** | IBGE - Agricultural and Cattle Ranching Census, 1970, 1975, 1980, 1985, 1995/1996. |
| **Observations** | 1970 - 1984 - rates represent the average for 5-year periods. 1985 - 1995 - rates represent average values for a period of 10.5 years. |

### A.2.2 – Forest Production

| | |
|---|---|
| **18** | **Timber Production** |
| **Unit:** | 1000 $m^3$ |
| **Concept** | Total production considering cut tree trunks, bark and extremities sawed, not intended for use as fuel. |
| **Comments** | The data presented represent total timber production not only from native forests but also from planted forests. The data referring to native forests may be underestimated due to irregular activities common to the vegetal extraction sector. |
| **Source** | IBGE –Vegetal and Forestry Extraction Production, vol. 5 to 14. |
| **Observations** | |

| | |
|---|---|
| **19** | **Coal Production** |
| **Unit:** | t |
| **Concept** | Sum of the production of vegetal coal of all native and forestry vegetation species. Vegetal coal is the fuel that results from partial burning of wood in closed spaces (e.g.: ovens). |
| **Comments** | The data presented refers to the production obtained from native and planted forests. The data referring to native forests may be underestimated due to irregular activities common to the vegetal extraction sector. |
| **Source** | IBGE - Vegetal and Forestry Extraction Production, vol. 5 to 14. |
| **Observations** | |

| | |
|---|---|
| **20** | **Firewood Production** |
| **Unit:** | 1000$m^3$ |
| **Concept** | The production of firewood is the total amount of raw wood obtained from branches and tree trunks of an adequate size for use as fuel in ovens, boilers, stoves, etc. |

| | |
|---|---|
| **Comments** | The data presented represent the total production of firewood obtained from native and planted forests. The amount of firewood used to make vegetal coal has been excluded from firewood production. The data referring to native forests is underestimated due to problems with irregular activities common to the extraction sector. |
| **Source** | IBGE - Vegetal and Forestry Extraction Production, Vol. 5 to 14. |
| **Observations** | 1986 - 172540<br>1987 - 166838<br>1988 - 141374<br>1989 - 138875 |

## A.3 - BIODIVERSITY

### A.3.1 - Protection

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|---|---|
| **21** | **Protected areas / Number** |
| **Unit:** | N° |
| **Concept** | Federal Conservation Units allocated for preserving the original state of the natural resources<br>so that they may be used by present and future generations. |
| **Comments** | State and Municipal Conservation Units are not included in this indicator. |
| **Source** | IBAMA - Brazilian Institute on Environment and Natural Renewable Resources |
| **Observations** | Information was up-dated by IBAMA on 01/14/2002.<br>Data on the number of protected areas correspond to the year the conservation units were created.<br>Number of protected areas on 08/10/2001 was 226 Units of Conservation. On 01/14/2002 this number increased to 228. |

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|---|---|
| **22** | **Protected Areas / Total Area** |
| **Unit:** | Km2 |
| **Concept** | Total area, in Km$^2$, of Federal Conservation Units allocated for the preservation of their original state for use by present and future generations. |
| **Comments** | State and Municipal Conservation Units are not included in this indicator. |
| **Source** | IBAMA |
| **Observations** | 2001 - 460817.86<br>On 01/14/02 465948.10 |

| | |
|---|---|
| **23** | **Areas of total protection / number** |
| **Unit:** | N° |
| **Concept** | Protected areas of indirect use or of total protection, with an absolute restriction on exploitation or use of natural resources, permitting only the indirect use of its sources. Conservation units with total restriction or indirect use include National Parks, Biological Reservation Parks, Ecological Reservations and Ecological Stations. |
| **Comments** | State and Municipal Conservation Units are not included in this indicator. |
| **Source** | IBAMA |
| **Observations** | According to IBAMA, protected areas of indirect use are classified into two management categories, with corresponding IUCN-recognized categories (1994). |

Category 1 (Strict Natural Reservation) - Biological Reservations (BR); Ecological Stations (ES) and Ecological Reservations (ER)
Category 2 (National Park) - (NP)
On 08/10/2001 the number of Integrally Protected Areas was 100 conservation units; on 01/14/2002: protected areas of indirect use were 101 conservation units.

**24** — **Areas of Total Protection / Area**

**Unit:** Km2

**Concept** Totally protected areas of indirect use are in Km², with an absolute restriction on exploitation or use of natural resources, permitting only indirect use. Conservation Units with total restriction or with indirect use include National Parks, Biological Reservations, Ecological Reservations and Ecological Stations.

**Comments** State and Municipal Conservation Units are not included in this indicator.

**Source** IBAMA

**Observations** 2001 - 184422.40 on 01/14/02 184506.56.
According to IBAMA, protected areas of indirect use are classified into two management categories, with corresponding IUCN-recognized categories (1994).
- Category 1 (Strict Natural Reservation) - Biological Reservations (BR); Ecological Stations (ES) and Ecological Reservations (ER),
- Category 2 (National Parks) - National Parks (NP)
- Category 2 (National Park) - (NP)

**25** — **Areas of Sustainable Use / number**

**Unit:** N°

**Concept** Protected areas of Sustainable Use, whose objective is to discipline the process of land occupation and promote protection of abiotic and biotic resources within its borders, fostering the well-being of the human population that live in the area, protect and improve local ecological conditions and maintain landscape and relevant cultural symbols. Conservation Units of sustainable or direct use include Environmental Protection Areas, National Forests, Extraction Reservations and Areas of Relevant Ecological Interest.

**Comments** State and Municipal Conservation Units are not included in this indicator.

**Source** IBAMA

**Observations** 08/10/01 - 126
01/14/02 - 127
According to IBAMA, areas of sustainable or direct use are classified into two management categories, with the area recognized in categories by IUCN (1994).
Category V - (Terrestrial Landscape and Protected Marine Landscape) - Environmental Protected Areas (EPA) and Areas of Relevant Ecological Interest (AREI).
Category VI - (Protected Areas with Handling Resources) - National Forests (NAFO) and Extraction Reservations (EXR).

**26** — **Areas of Sustainable Use / Area**

**Unit:** Km2

**Concept** Surface of protected area of sustainable use, with the aim of disciplining the land occupation process and promoting the protection of resources within its limits, fostering the well-being of human population that live within the area, protecting and improving the local ecological conditions and maintaining the landscape and relevant cultural symbols. Conservation Units of sustainable or direct use include Environmental Protection Areas, National Forests, Extraction Reservations and Areas of Relevant Ecological Interest.

**Comments** State and Municipal Conservation Units are not included in this indicator.

**Source** IBAMA

**Observations** According to IBAMA, the protected areas of sustainable or direct use are classified into two management categories, with the area recognized in categories by IUCN (1994).

In 08/10/2001 area surface of sustainable use was of 276488.27 km $^2$. In 01/14/2002, these areas of sustainable use increased to 281534.35km$^2$.

**27** **Natural Monuments / number**

**Unit:** N°

**Concept** Also known as natural sites, are considered national patrimony and constitute areas of reproduction and subsistence that are of extreme importance to countless species of fauna and flora characteristic of each natural habitat.

**Comments**

**Source** Ministry of the Environment - MMA; UNESCO

**Observations** Year 2001 was the last year in which the exact number of natural monuments was provided.

Year 2001 - 7

**28** **Natural Monuments / Area**

**Unit:** Km2

**Concept** Total area of National Monuments.

**Comments**

**Source** Ministry of the Environment - MMA; UNESCO

**Observations** 2001 - 36271.79.

UNESCO was consulted for detailed information regarding the year of creation of Conservation Units (CU).

## A.3.2 - Species

**29** **Total number of known species / Mammals**

**Unit:** N°

**Concept** Native species of existing taxon in a natural habitat, terrestrial and/or aquatic, within a population or research area, with large territorial distribution.

**Comments**

**Source** IBAMA

**Observations** 2001 - 518

**30** **Total number of known species / Birds**

**Unit:** N°

**Concept** Native species of taxon existing in a natural habitat, terrestrial and/or aquatic, within a population or research area, with large territorial distribution.

**Comments**

| | |
|---|---|
| **Source** | IBAMA |
| **Observations** | 2001 - 1677 |
| | |
| **31** | **Total number of known species / Reptiles** |
| **Unit** | N° |
| **Concept** | Native species of the existing taxon in a natural habitat, terrestrial and/or aquatic, within a population or research area, with large territorial distribution. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | 2001 - 468 |
| | |
| **32** | **Total number of known species / Amphibians** |
| **Unit** | N° |
| **Concept** | Native species of the existing taxon in a natural habitat, terrestrial and/or aquatic, within a population or research area, with large territorial distribution. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | 2001 - 517 |
| | |
| **33** | **Total number of known species / Fish** |
| **Unit** | N° |
| **Concept** | Native species of the existing taxon in a natural habitat, aquatic, within a population or research area, with large territorial distribution |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | 2001 - 300 estimated value. |
| | |
| **34** | **Total number of known species / Plants** |
| **Unit:** | N° |
| **Concept** | Native species of surface plants in natural eco-systems, with taxonomic distribution within the Brazilian territory. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | 2001 - 56,000 estimated value. |
| | |
| **35** | **Total number of endangered species /** |
| **Unit** | N° |
| **Concept** | Native Brazilian species of endangered mammals and/or probably extinct in natural habitat. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | Document nº1522, from December 19, 1989, officially recognizes the list of endangered species of the Brazilian Fauna.<br>Document nº45- n, from April 27, 1992 includes the species Leontopitheucus caissara (1990) – Black-headed Lion Tamarin and, Document nº 62 from June 17, 1997 includes 9 species of endangered bats in Brazil. |

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| **36** | **Total number of endangered species / Birds** |
| **Unit** | N° |
| **Concept** | Native Brazilian species of endangered birds and/or probably extinct in natural habitat. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | Document nº 1522, from December 19, 1989, officially recognizes the list of endangered species of Brazilian fauna. Document nº 062, from June 17, 1997, includes a specific bird species - *Stynphalornes acutirostres* - the *bicudinho-do-brejo*. |

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|---|---|
| **37** | **Total number of endangered species / Reptiles** |
| **Unit** | N° |
| **Concept** | Native Brazilian species of endangered reptiles, and/or probably extinct in natural habitat. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | Document nº 1522, from December 19, 1989, recognizes officially the list of endangered reptiles of the Brazilian fauna. |

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|---|---|
| **38** | **Total number of endangered species / Amphibians** |
| **Unit** | N° |
| **Concept** | Native Brazilian endangered species, and/or probably extinct in natural habitat. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | Document nº 1522, from December 19, 1989, officially recognizes the list of endangered amphibious of the Brazilian Fauna. |

| | |
|---|---|
| **39** | **Total number of endangered species / Freshwater fish** |
| **Unit** | N° |
| **Concept** | Native Brazilian endangered freshwater species, and/or probably extinct in natural habitat. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | Document nº 28 from March 12, 1998, includes one species of freshwater fish on the official list of endangered species of the Brazilian Fauna. |

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|---|---|
| **40** | **Total number of endangered species / Invertebrates** |
| **Unit** | N° |
| **Concept** | Native Brazilian endangered invertebrates, and/or probably extinct in natural habitat. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | Document nº 1522, from December 19, 1989, officially recognizes the list of endangered species of the Brazilian Fauna. |

| | |
|---|---|
| **41** | **Total number of endangered species / Plants** |
| **Unit** | N° |
| **Concept** | Native Brazilian endangered vascular plants (*plantas vasculares*), and/or probably extinct in natural habitat on Brazilian territory. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | Law nº 7735, from February 22, 1989, officially recognizes the list of endangered species of the Brazilian Flora, indicating IBAMA as the official agency responsible for the publication of the list.<br>IBAMA Document nº 37-N , from April 3, 1992, in addition to recognizing the list of endangered species, also determines that the presence of a given species on the official list implies that all its sub-species, if existent, are endangered. |

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|---|---|
| **42** | **Total number of endemic species / Mammals** |
| **Unit** | N° |
| **Concept** | Native species of the mammiferous fauna, restricted to a specific geographical area. (Resolution CONAMA- 12/94) |
| **Comments** | |
| **Source** | Ministry of the Environment - MMA - Department of Biodiversity and Forests. |
| **Observations** | 2001 - 96. |

| | |
|---|---|
| **43** | **Total number of endemic species / Birds** |
| **Unit** | N° |
| **Concept** | Native species of bird fauna, restricted to a specific geographic area (Resolution CONAMA 012/94). |
| **Comments** | |
| **Source** | Ministry of the Environment - MMA - Department on Biodiversity and Forest. |
| **Observations** | 2001 - 191 |

| | |
|---|---|
| **44** | **Total number of endemic species / Plants** |
| **Unit** | N° |
| **Concept** | Native Flora species, restricted to a specific geographic area (Resolution CONAMA - 012/94). |
| **Comments** | |
| **Source** | Conservation International |
| **Observations** | 2001 - 8000<br>The number of endemic species found are in reference to the Atlantic Forest. No data was found about the rest of Brazil. |

## A.4 - MARINE AND COASTAL AREAS

### A.4.1 - Marine use

| | |
|---|---|
| **45** | **Total production of marine fishing** |
| **Unit** | t |
| **Concept** | Estimated production of both marine and cultivated fishing. |
| **Comments** | |
| **Source** | IBAMA and CEPENE. |
| **Observations** | |

| | |
|---|---|
| **46** | **Production of marine fishing / Capture** |
| **Unit** | t |
| **Concept** | Estimated production of marine fish. |
| **Comments** | |
| **Source** | IBAMA and CEPENE. |
| **Observations** | |

| | |
|---|---|
| **47** | **Production of marine fishing / Aquaculture** |
| **Unit** | t |
| **Concept** | Estimated production of marine fishing. |
| **Comments** | |
| **Source** | IBAMA and CEPENE. |
| **Observations** | |

## A.5 - FRESHWATER

### A.5.1 - Use

| | |
|---|---|
| **48** | **Total production of freshwater fishing** |
| **Unit** | t |
| **Concept** | Estimated production of freshwater and cultivated fishing. |
| **Comments** | |
| **Source** | IBAMA and CEPENE. |
| **Observations** | |

| | |
|---|---|
| **49** | **Total production of freshwater fishing / Capture** |
| **Unit** | t |
| **Concept** | Estimated extraction production of freshwater fish. |
| **Comments** | |
| **Source** | IBAMA. |
| **Observations** | |

| | |
|---|---|
| **50** | **Total production of freshwater fishing / Aquaculture** |
| **Unit** | t |
| **Concept** | Estimated production of freshwater fishing. |
| **Comments** | |
| **Source** | IBAMA |
| **Observations** | |

## A.6 - ATMOSPHERE

### A.6.1 - Contamination

| | |
|---|---|
| **51** | **$CO_2$ Emission by combustible burning.** |
| **Unit** | 1000 t |
| **Concept** | Estimated volume of carbon dioxide emission ($CO_2$) originating from liquid, solid and gaseous fossil combustion. |

**Comments** According to Reports of the Carbon Emission of Convention on Climate Change / MCT, calculations of $CO_2$ emission of liquid, solid and gaseous fossil combustion were made based on a "top-down" methodology, developed by the IPCC (Intergovernmental Panel on Climate Change), which considers that, once introduced into national economy, in a given year, the carbon contained in the combustible is either released into the atmosphere or retained in a specific manner (i.e., through supply increase), by use in non-energetic products or its own retention (partially inoxidated).

In calculating the $CO_2$ emission, a balance is made involving a domestic primary combustible, the liquid combustible import and internal supply variation of these combustibles.

**Source** Ministry of Science and Technology - MCT.

**Observations**

**52** **$CO_2$ emission / By gaseous fossil combustibles**

**Unit** 1000 t

**Concept** Estimated volume of carbon dioxide emission ($CO_2$) originating from natural gas and refinery gas.

**Comments** According the Report on Carbon Emission of Climate Changes Convention/ MCT, calculations of $CO_2$ emission of gaseous fossil combustibles was made based on the "top-down" methodology developed by IPCC (Intergovernmental Panel on Climate Change), which considers that, once introduced into the national economy, the carbon contained in the combustible is either released into the atmosphere or is retained in a specific manner (i.e., through combustible supply increase, by absorption of certain non energetic products or by its own retention partially inoxidated). In calculating the $CO_2$ emission, a balance is made involving primary combustible domestic production, the liquid import of primary and secondary combustibles internal variation of such combustible supplies.

**Source** Ministry of Science and Technology - MCT.

**Observations**

**53** **$CO_2$ Emission / By combustible liquid fossils**

**Unit** 1000 t

**Concept** Estimated volume of carbon dioxide emission ($CO_2$) originating from petroleum, natural gas liquid, fuel, kerosene used in aviation, illumination kerosene, diesel oil, combustible oil, lpg, glp, naphtha, tarmac (asphalt), lubricants, petroleum coke and other non-energetic petroleum products.

**Comments** According to the Report on Carbon Emission of the Climate Changes Convention/ MCT, the calculation of $CO_2$ emission of liquid fossil combustibles was made based on the "top-down" methodology, developed by IPCC (Intergovernmental Panel on Climate Change), which considers that, once introduced into the national economy, carbon contained in the combustible is either released into the atmosphere or is retained in a specific manner (i.e., through combustible supply increase, by absorption of certain non energetic products or by its own retention partially inoxidated). In calculating the $CO_2$ emission, a balance is made involving primary combustible domestic production, the liquid import of primary and secondary combustibles internal variation of such combustible supplies.

**Source** Ministry of Science and Technology - MCT.

**Observations**

54 **CO2 Emission / By solid fossil combustibles**

**Unit** 1000 t

**Concept** Estimated volume of carbon dioxide emission ($CO_2$) originating from metallurgic charcoal, vapour charcoal, tar and coke.

**Comments** According to the Report on Carbon Emission of the Climate Changes Convention/ MCT, a calculation of $CO_2$ emission of solid fossil combustibles was made based on the "top-down" methodology, developed by IPCC (Intergovernmental Panel on Climate Change), which considers that, once introduced into the national economy, the carbon contained in the combustible is either released into the atmosphere or is retained in a specific manner (i.e., through combustible supply increase, by absorption of certain non energetic products or by its own retention partially inoxidated). In calculating the $CO_2$ emission, a balance is made involving primary combustible domestic production, the liquid import of primary and secondary combustibles internal variation of such combustible supplies.

**Source** Ministry of Science and Technology - MCT.

**Observations**

55 **CO2 emission / By cement production**

**Unit** 1000 t

**Concept** Estimated volume on carbon dioxide emission ($CO_2$) originating from cement production, related to the production of clinker (a mixture of calcareous rocks and silicate ), cement's main component.

**Comments** According to the Report on Carbon Emission of the Climate Changes Convention/ CCC of the Ministry of Science and Technology - MCT, the conversion EF factor was used, clinker = 0.5071 which correlates the clinker production to the $CO_2$ emission.

**Source** Ministry of Science and Technology - MCT.

**Observations**

56 **Sulfur dioxide emission (SO2)**

**Unit** Gg

**Concept** Estimated volume of sulfur dioxide emission ($SO_2$) originating from industrial, chemical and petrochemical processes.

**Comments** According to the Report on Carbon Emission of the Climate Changes Convention/ CCC, the method of calculating $SO_2$ emission correlates, through emission coefficients, the gases emanating from the production processes with the quantities produced.

**Source** Ministry of Science and Technology - MCT.

**Observations**

57 **Emission of nitrogen oxides (NOx)**

**Unit** Gg

**Concept** Estimated volume of nitrogen oxide emission ($NO_x$) originating from chemical, industrial and petrochemical processes.

**Comments** According to the Report on Carbon Emission of the Climate Changes Convention/ CCC, the method used to calculate $NO_x$ emission correlates, through emission coefficients, the gases emanating from the production processes with the quantities produced.

**Source** Ministry of Science and Technology - MCT.

**Observations**

| | |
|---|---|
| **58** | **Hydrocarbon emission (HC)** |
| **Unit** | Gg |
| **Concept** | Estimated volume of hydrocarbon (HC) emission originating from petrochemical industrial processes. |
| **Comments** | According to the Report on Carbon Emission of the Climate Changes Convention/ CCC, the method used to calculate the HC emission correlates, through emission coefficients, the gases emanating from the production processes with the quantities produced. |
| **Source** | Ministry of Science and Technology - MCT. |
| **Observations** | |

| | |
|---|---|
| **59** | **Carbon monoxide emission (CO)** |
| **Unit** | Gg |
| **Concept** | Estimated volume of carbon monoxide emission (CO) originating from chemical and petrochemical production processes. |
| **Comments** | According to the Report on Carbon Emission of the Climate Changes Convention/ CCC, the method used to calculate the CO emission correlates, through emission coefficients, the gases emanating from the production processes with the quantities produced. |
| **Source** | Ministry of Science and Technology - MCT. |
| **Observations** | |

## A.7 - SANITATION

### A.7.1 - Access

| | |
|---|---|
| **60** | **Percentage of the population with access to the main water supply** |
| **Unit** | % |
| **Concept** | Population percentage living in homes supplied with water originating from a general distribution system, with an internal pipeline or, at least, one that is located on the property of territory where they live. |
| **Comments** | A significant portion of the population is supplied either by well or private spring, whose water quality may or may not be satisfactory. The present indicator considers only the population group that has access to the main water supply system. |
| **Source** | IBGE, PNAD 1992, 1993, 1995, 1996, 1997, 1998 e 1999; IBGE – Demographic Census 2000. |
| **Observations** | |

| | |
|---|---|
| **61** | **Population percentage with access to main water supply / Rural area** |
| **Unit** | % |
| **Concept** | Population percentage living in homes supplied with water originating from a general distribution system, with an internal pipeline or, at least, one that is located on the property of territory where they live. |
| **Comments** | A significant portion of the population is supplied either by well or private spring, whose water quality may or may not be satisfactory. The present indicator considers only the group of population having access to the main water supply system. |

| | |
|---|---|
| **Source** | IBGE, PNAD, 1992, 1993, 1995, 1996, 1997, 1998 e 1999; IBGE – Demographic Census 2000. |
| **Observations** | |
| **62** | **Population percentage with access to main water supply / Urban area** |
| **Unit** | % |
| **Concept** | Population percentage living in homes supplied with water originating from a general distribution system, with an internal pipeline or, at least, one that is located on the property of territory where they live. |
| **Comments** | A significant portion of the population is supplied either by well or private spring, whose water quality may or may not be satisfactory. Thus, present indicator considers only the group of population having access to the main water supply system. |
| **Source** | IBGE, PNAD, 1992, 1993, 1995, 1996, 1997, 1998 e 1999; IBGE – Demographic Census 2000. |
| **Observations** | |
| **63** | **Population percentage with access to main sewerage collecting system** |
| **Unit** | % |
| **Concept** | Population percentage living in homes with sewage collection pipeline connected to a main sewerage collecting system which conducts to a general dejection area, even when the system does not have a treatment station. |
| **Comments** | Adequate access to main sewage sanitation system can be presumed with houses connected to a collection pipeline. |
| **Source** | IBGE, PNAD , 1992, 1993, 1995, 1996, 1997, 1998, 1999; IBGE- Demographic Census 2000. |
| **Observations** | |
| **64** | **Population percentage with access to main sewerage collecting system / Rural zone** |
| **Unit** | % |
| **Concept** | Population percentage living in homes in rural areas with sewage system connected to a collection sewerage system that transports the used water to a treatment station or to a place of final disposal. |
| **Comments** | Adequate access to sanitation sewage system can be presumed with houses connected to a collection pipeline. |
| **Source** | IBGE, PNAD , 1992, 1993, 1995, 1996, 1997, 1998, 1999; IBGE- Demographic Census 2000. |
| **Observations** | |
| **65** | **Population percentage with access to the main sewerage collection system/ Urban zone** |
| **Unit** | % |
| **Concept** | Population percentage living in homes in urban areas with sewage system connected to a main sewerage collection system which transports the used water to a treatment station or to a place of final disposal. |
| **Comments** | Adequate access to sewage sanitation system can be presumed with houses connected to a collection pipeline. |
| **Source** | IBGE, PNAD, 1992, 1993, 1995, 1996, 1997, 1998, 1999; IBGE- Demographic Census 2000. |
| **Observations** | |

| | |
|---|---|
| **66** | **Population percentage with access to central garbage collecting system** |
| **Unit** | % |
| **Concept** | Population percentage living in houses with direct or indirect garbage collection conducted by private companies or public collecting posts, that service the residential area. |
| **Comments** | |
| **Source** | IBGE, PNAD Demographic Census 2000. |
| **Observations** | |

| | |
|---|---|
| **67** | **Population percentage with access to central garbage collecting system / Rural zone** |
| | **Unit** % |
| **Concept** | Population percentage living in residential rural area, with direct or indirect garbage collection conducted by private companies or public collecting posts, that service the area where they reside. |
| **Comments** | |
| **Source** | IBGE, PNAD, Demographic Census 2000 |
| **Observations** | |

| | |
|---|---|
| **68** | **Population percentage with access to central garbage collecting system/ Urban zone** |
| **Unit** | % |
| **Concept** | Population percentage living in residential rural area, with direct or indirect garbage collection conducted by private companies or public collecting posts, that service the residential area. |
| **Comments** | |
| **Source** | IBGE, PNAD, Demographic Census 2000 |
| **Observations** | |

# B – SOCIO-ECONOMIC AND CULTURAL FACTORS

## B.1 - POPULATION / EMPLOYMENT

### B.1.1 - Demographic

| | |
|---|---|
| **69** | **Half year total population** |
| **Unit:** | 1 000 inhabitants |
| **Concept** | Is the total resident population in July 1st, projected by the component method. |
| **Comments** | 1) National projection obtained by the sum of state projections;<br>2) Population projection by the component method, with revision of the hypothesis of fertility rate decline and incorporation of international migration balance. |
| **Source** | IBGE – Statistic Yearbook of Brazil - 1970, 1975, 1998 e 1999. |
| **Observations** | |

70 **Average annual rate of population growth**

**Unit:** %

**Concept** It is the annual mean increment of population growth given by the expression: I= tenth root of [ P (t + n)/ P (t)] - 1, being P (t + n) and P (t) population corresponding to two successive dates and the interval of time between these dates, measured in years and fractions of year.

**Comments**

**Source** Demographic census 1960 - 1991. Rio de Janeiro: IBGE, 1970 - 1997; Demographic Census 2000: Preliminary results. IBGE; National Atlas of Brazil. IBGE, Geo-sciences Division - 3ed. Rio de Janeiro: IBGE, 2000, pp. 77.

**Observations**

71 **Population density**

**Unit:** Inhabitant/ $Km^2$

**Concept** Relation between resident population and the land area.

**Comments** 1) The density was calculated in relation to land area;

2) Value of the area for 1996 and 2000 = 8.547.403,5 $km^2$.

**Source** IBGE- Demographic census 1970,1980,1991 and 2000; IBGE – Population count 1996. Rio de Janeiro: IBGE, 1997,v 1: Results related to population sex and household situation.

**Observations**

72 **Total fertility rate**

**Unit:** Mean number of children

**Concept** Mean number of children that a female of a hypothetical selection would have, at the end of the reproductive period, being subject to a determined fertility law, in the absence of mortality from birth until the end of the fertile period.

**Comments**

**Source** IBGE, Research Division. Department of Population and Social Indicators. Division of Population Projection for Brazil by sex and age for the period of 1980 - 2050. Revision.

**Observations**

## B.1.2 - Employment

73 **Half Year Work force**

**Unit:** 1000 inhabitants

**Concept** Active population, including occupied and unoccupied persons in the specified reference period.

**Comments** 1- Reference month of PNAD and Demographic census is September.

2 - PNAD does not encompass the rural areas of Rondônia, Acre, Amazonas, Roraima, Pará and Amapá

3 – Includes people 10 years of age or older.

4 – There was no PNAD in 1994

**Source** IBGE – National Research by Household Sample - PNAD; IBGE – Demographic census.

**Observations**

| | |
|---|---|
| **74** | **Man-woman workforce ratio** |
| **Unit:** | Men=10 |
| **Concept** | It is the coefficient between the female workforce and the male workforce. Workforce- PEA (economically active population). |
| **Comments** | 1 - PNAD does not encompass the rural area of Rondônia, Acre , Amazonas, Roraima, Pará and Amapá.<br>2 - Includes people 10 years of age or older, economically active in the week of reference.<br>3 – There was no research in 1994. |
| **Source** | IBGE – National Research by Household Sample - PNAD; IBGE – Demographic Census. |
| **Observations** | |

| | |
|---|---|
| **75** | **Open unemployment Rate** |
| **Unit:** | % |
| **Concept** | It is the relation between the number of people unoccupied (seeking work) and the number of economically active population in a determined period of reference. |
| **Comments** | 1) PME includes the metropolitan regions of Recife, Salvador, Belo Horizonte, Rio de Janeiro, São Paulo and Porto Alegre. It is a survey undertaken on a monthly basis.<br>2) Month considered: September |
| **Source** | IBGE – Monthly Employment Research- PME |
| **Observations** | |

## B.2 – URBAN AND INDUSTRIAL AREAS

### B.2.1 - Demographic

| | |
|---|---|
| **76** | **Half year urban population** |
| **Unit:** | 1 000 inhabitants |
| **Concept** | Total resident urban population. |
| **Comments** | 1 – For the years of 1975 and 1980 the urban population is the one projected for July 1st. For other years, due to lack of data, urban population data for September was used (month of reference of PNAD and of the Demographic Census 2000)<br>2 – There was no PNAD in 1994 |
| **Source** | IBGE – National Research by Household Sample - PNAD; IBGE – Statistic Yearbook of Brazil 1975; IBGE – Demographic Census 1970 and 1980- Brazil; Demographic Census 2000: Preliminary Results. |
| **Observations** | |

| | |
|---|---|
| **77** | **Urbanisation Rate** |
| **Unit:** | % |
| **Concept** | Percentage of the urban population in relation to total population. |
| **Comments** | |
| **Source** | IBGE , Demographic Census 1970, 1980 ,1991 and 2000; IBGE – Population Count 1996. Rio de Janeiro: IBGE, 1997. V1 : Results related to population sex and household situation. |
| **Observations** | |

78 **Urban population growth**

**Unit:** 1000

**Concept** Result of the variation in absolute terms of the urban population between two successive dates

**Comments**

**Source** Demographic Census 1970 - 1991. Rio de Janeiro: IBGE , 1970 -1997

**Observations** 1980 – referent to the period from 1970 to 1980.
1980 - referent to the period from 1980 to 1991.
1991 - referent to the period from 1991 to 2000.

79 **Urban population annual growth rate**

**Unit:** %

**Concept** Annual average increment of urban population growth

**Comments** It is calculated by the expression: i = n the root of [p ( t + n) / p (t)] - 1
In which P (t + n) and P (t) are urban population corresponding to two successive dates ( n e n + t), and n is interval of time between these dates, measured in year and fraction of year.

**Source** IBGE – Demographic Census 1970- 1991 Rio de Janeiro; IBGE. 1970- 1997; Demographic Census IBGE 2001. Result of the universe.

**Observations** 1980 - referent to the period from 1970 to 1980.
1980 - referent to the period from 1980 to 1991.
1991 - referent to the period from 1991 to 2000.

## B.2.2 – Concentration

80 **Number of municipalities with population with over 750,000 inhabitants.**

**Unit:** N°

**Concept** Number of municipalities with population over 750,000 inhabitants.

**Comments**

**Source** IBGE – Demographic Census 1979, 1980, 1991and 2000; Population Count, 1996. Rio de Janeiro: IBGE, 1997.v 1 : Result related to population sex and household situation.

**Observations**

81 **Half Year Population in municipalities with population over 750.000 inhabitants**

**Unit:** Total in absolute terms

**Concept** Half-year estimate of resident population in municipalities with population over 750.000 inhabitants.

**Comments** Estimates were obtained by the application of the demographic growth tendency method that has as main principle the subdivision of a bigger area, in which the estimate is known, in “ n “ smaller areas. Emphasising that municipalities were considered the smaller areas in relation to the corresponding Federation units.

**Source** IBGE. Research Directory, Department of Population and Social Indicators. Population Estimates.

**Observations** In 1996 there was no calculus for estimate population, as the Population Count was undertaken.

| | |
|---|---|
| **82** | **Proportion of population in municipalities with population over 750.000 inhabitants.** |
| **Unit:** | % |
| **Concept** | Proportion of population in relation to total population. |
| **Comments** | |
| **Source** | IBGE - Demographic Census 1970, 1980, 1991 - 2000; IBGE – Population Count 1996 |
| **Observations** | |

## B.3 - EDUCATION

### B.3.1 - Literacy

| | |
|---|---|
| **83** | **Adult literacy rate, total** |
| **Unit:** | % |
| **Concept** | Literate population of15 years and over, in relation to total population of 15 years and over. A literate person was considered as one capable of reading and writing a simple note in the language known. A person that learned how to read and write but has forgotten it and a person who only writes their own name was considered illiterate. |
| **Comments** | Exclusive rural population from Rondônia, Acre, Amazonas, Roraima, Pará and Amapá. |
| **Source** | IBGE – National Research by Household Sample - PNAD |
| **Observations** | |

| | |
|---|---|
| **84** | **Adult literacy rate, male (15 years and over)** |
| **Unit:** | % |
| **Concept** | Male literate population of 15 years or more in relation to total male population of 15 years or over.<br>Literacy – A literate person was considered as one capable of reading and writing a simple note in the language known. A person that learned how to read and write but has forgotten it and a person who only writes their own name was considered illiterate. |
| **Comments** | Exclusive rural population from the North Region. |
| **Source** | IBGE – National Research by Household Sample - PNAD |
| **Observations** | |

| | |
|---|---|
| **85** | **Adult literacy rate, female (15 years and over)** |
| **Unit:** | % |
| **Concept** | Female literate population of 15 years or more in relation to total female population of 15 years or more.<br>Literacy - A literate person was considered as one capable of reading and writing a simple note in the language known. A person that learned how to read and write but has forgotten it and a person who only writes their own name was considered illiterate. |
| **Comments** | Exclusive rural population from the North. |
| **Source** | IBGE – National Research by Household Sample - PNAD |
| **Observations** | |

## B.4 - HEALTH

### B.4.1 - State

| | |
|---|---|
| **86** | **Life expectancy at birth, total** |
| **Unit:** | Years |
| **Concept** | Average number of years that a newborn would expect to live if he/she were subject to a mortality law observed by a given population during a determined period. |
| **Comments** | |
| **Source** | IBGE – Research Division. Department of Population and Social Indicators. Division of Studies and Analysis of Demographic Dynamics. Projection of the Brazilian Population by Sex and Age for the period of 1980- 2050- 2000 Revision. |
| **Observations** | |

| | |
|---|---|
| **87** | **Life expectancy at birth, male** |
| **Unit:** | Year |
| **Concept** | Average number of years that a newborn would expect to live if he/she were subject to a mortality law observed by a given population during a determined period. |
| **Comments** | |
| **Source** | IBGE – Research Division. Department of Population and Social Indicators. Division of Studies and Analysis of Demographic Dynamics. Projection of the Brazilian Population by Sex and Age for the period of 1980- 2050- 2000 Revision. |
| **Observations** | |

| | |
|---|---|
| **88** | **Life expectancy, female** |
| **Unit:** | Years |
| **Concept** | Average number of years that a newborn would expect to live if he/she were subject to a mortality law observed by a given population during a determined period. |
| **Comments** | |
| **Source** | IBGE – Research Division. Department of Population and Social Indicators. Division of Studies and Analysis of Demographic Dynamics. Projection of the Brazilian Population by Sex and Age for the periods of 1990-1995, 1995-1999, 1998-2000. |
| **Observations** | |

| | |
|---|---|
| **89** | **Gross mortality rate** |
| **Unit:** | x 1000 inhabitants |
| **Concept** | Coefficient between the numbers of deaths occurred during a civil year and the total population half way through the civil year. |
| **Comments** | |
| **Source** | IBGE – Research Division. Department of Population and Social Indicators. Division of Studies and Analysis of Demographic Dynamics. Projection of the Brazilian Population by Sex and Age for the period of 1980 - 2050. Revision. |
| **Observations** | |

| | |
|---|---|
| **90** | **Infant gross mortality rate** |
| **Unit:** | x 1000 born. |
| **Concept** | Frequency of infant deaths (less than a year old) in a population in relation to the number of live newborns in a determined civil year. |
| **Comments** | |
| **Source** | IBGE – Research Division. Department of Population and Social Indicators. Division of Studies and Analysis of Demographic Dynamics. Projection of the Brazilian Population by Sex and Age for the period of 1980 - 2050. Revision. |
| **Observations** | |

### B.4.2 - Resources

| | |
|---|---|
| **91** | **Doctors** |
| **Unit:** | x 1000 inhabitants. |
| **Concept** | Number of middle level posts of in health establishments per 1000 inhabitants. |
| **Comments** | For the year of 1980 the indicator was calculated based on the year data of resident population and for 1985, projected resident population for 1st July. |
| **Source** | IBGE – Synthesis of Social Indicators 2000; Health Statistics: health-sanitary assistance<br>1980,1985,1999. |
| **Observations** | |

## B.5 – COMMUNICATION AND TECHNOLOGICAL ACCESS

### B.5.1 - Communication

| | |
|---|---|
| **92** | **Radios** |
| **Unit:** | % |
| **Concept** | Households that have radio equipment in relation to the total number of households. |
| **Comments** | Exclusive rural population from the North Region. |
| **Source** | IBGE – National Research by Household Sample - PNAD |
| **Observations** | |

| | |
|---|---|
| **93** | **Television receptors** |
| **Unit:** | % |
| **Concept** | Households with TV Households that have TV sets in relation to the total number of households. |
| **Comments** | Exclusive rural population from the North Region. |
| **Source** | IBGE – National Research by Household Sample– PNAD. |
| **Observations** | |

### B.5.2 - Telephone

| | |
|---|---|
| **94** | **Access to Fixed Commuted Telephone Services** |
| **Unit:** | per 1000 inhabitants. |
| **Concept** | Indicator estimated by telephone density represented by the number of fixed accesses installed in STFC per thousand inhabitants. It is used for the evaluation of the effectiveness of telecommunication policy based on satisfied demand. |
| **Comments** | |
| **Source** | ANATEL |
| **Observations** | |

| | |
|---|---|
| **95** | **Access to Telephone – Mobile Cellular Services** |
| **Unit:** | per 1000 inhabitants |
| **Concept** | Indicator used to evaluate the effectiveness of telecommunication policy based on satisfied demand. |
| **Comments** | Indicator estimated by cellular telephone density in the country, represented by the number of accesses per thousand inhabitants. |
| **Source** | ANATEL |
| **Observations** | |

## B.6 – CONSUMPTION AND ENERGY PRODUCTION

### B.6.1 - Energy

| | |
|---|---|
| **96** | **Total production of primary energy** |
| **Unit:** | Tj |
| **Concept** | Sources of primary energy are all kinds of energy that come from natural resources and that can be directly used. They can be renewable or non-renewable. |
| **Comments** | In BEN the total production of primary energy considers renewable and non-renewable sources. For hydraulic energy the theoretical criteria considered was of 1 Kwh = 860 kcal, according to the First Principle of Thermodynamics. |
| **Source** | Ministry of Mines and Energy – National Energy Yearbook (Balance Sheets) - BEN |
| **Observations** | |

| | |
|---|---|
| **97** | **Oil production** |
| **Unit:** | Tj |
| **Concept** | Production of energy from oil – natural liquid fuel, extracted from subterranean mines of continental or maritime reserves. Resulting matter from chemical transformations of animal and vegetable fossils. |
| **Comments** | Important component of the Brazilian energy matrix, due to the exhaustion of world oil reserves, its production is directly linked to technological evolution for oil prospecting. |
| **Source** | Ministry of Mines and Energy – National Energy Yearbook (Balance Sheets) - BEN |
| **Observations** | |

| | |
|---|---|
| **98** | **Natural gas production** |
| **Unit:** | Tj |
| **Concept** | Production of energy from natural gas – mixture of light extracted hydrocarbons. |
| **Comments** | |
| **Source** | Ministry of Mines and Energy – Yearbook (Balance Sheets) - BEN |
| **Observations** | |

| | |
|---|---|
| **99** | **Mineral carbon production** |
| **Unit:** | Tj |
| **Concept** | Production of energy by mineral carbon – cellulose part of vegetation transformed by time, pressure, bacteria and other anaerobic agents, into a carbonated mass. |
| **Comments** | Data presented in the mineral carbon table result from the sum between production values of metallurgic carbons and vapour. |
| **Source** | Ministry of Mines and Energy – National Energy Yearbook (Balance Sheets) - BEN |
| **Observations** | |

| | |
|---|---|
| **100** | **Hydraulic Energy production** |
| **Unit:** | Tj |
| **Concept** | Energy liberated by the fall of great volumes of repressed water, moving a turbine for the transformation of kinetic energy into electric energy, through an electric generator. |
| **Comments** | In relation to values given in BEN, the theoretical criteria for hydraulic and electricity considered was of 1 kwh = 860kcal (according to the First Principle of Thermodynamics), thus values 3,62 times smaller than the ones used in BEN. |
| **Source** | Ministry of Mines and Energy – National Energy Yearbook (Balance Sheets) - BEN |
| **Observations** | |

| | |
|---|---|
| **101** | **Nuclear Production** |
| **Unit:** | Tj |
| **Concept** | Production of thermal energy by fission (break up) of atoms or uranium through nuclear reactors. The energy produced turns an electric generator. |
| **Comments** | Data presented for nuclear production ( U3 O8) do not take into account the value of uranium imports for the years 1996,1997,1998,1999. |
| **Source** | Ministry of Mines and Energy – National Energy Yearbook (Balance Sheets) - BEN |
| **Observations** | |

| | |
|---|---|
| **102** | **Fuel wood production** |
| **Unit:** | Tj |
| **Concept** | Production of energy from portions of pieces of wood used as fuel for fire. Fuel wood production in Brazil comes not only from native vegetation but also from reforestation. |
| **Comments** | Around 40% of fuel wood produced in Brazil are transformed into charcoal, a process named carbonisation or pyrolysis .In Brazil, the industrial use of the later continues to be widely employed, providing significant data. Data supplied include fuel wood production and its derivatives, mainly charcoal. **Source** Ministry of Mines and Energy – National Energy Yearbook (Balance Sheets) - BEN |
| **Observations** | |

**103** **Production of energy by cane products**

**Unit:** Tj

**Concept** The production of energy from cane products, utilises its derivatives as fuel for burning into an oven, transforming thermal energy in the form of vapour.

**Comments** Cane products used for energy production, in general, are remainders of sugar cane pulp and molasses.

**Source** Ministry of Mines and Energy – National Energy Yearbook (Balance Sheets) - BEN

**Observations**

**104** **Production of energy by other primary sources**

**Unit:** Tj

**Concept** Production of energy related to solar, aeolic, waves and tides, wood residues, agricultural residues, lye, manure, water fall, and animal and human force/tracking.

**Comments** In BEN, the production of energy by other primary sources only takes into account those from renewable sources.

**Source** Ministry of Mines and Energy – National Energy Yearbook (Balance Sheets) - BEN

**Observations**

## B.7 – PRODUCTION AND CONSUMPTION OF GOODS

### B.7.1 - GDP

**105** **Gross domestic product at market prices**

**Unit:** Millions R$

**Concept** GDP – Goods and services produced in the country, discounting expenses with inputs used in the production process during the year. It is the measurement of the total gross added value generated by all economic activities.
Added value – Value that an activity adds to goods and services consumed in the productive process. It is the contribution to the Gross Domestic Product by various economic activities, obtained by the difference between the production value and the intermediary consumption absorbed by these activities.

**Comments** The value presented for the last year must be understood as preliminary.
The value presented for the year before the last must be understood as almost definite.
Remaining values are definite.

**Source** IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil of 1990-1995, 1995-1999, 1998-2000.

**Observations** Values of GEO -LAC are being expressed in millions of dollars.

**106** **Gross domestic product at fixed prices**

**Unit:** Millions R$ (year 2000)

**Concept** GDP – Goods and services produced in the country, discounting expenses with inputs used in the production process during the year. It is the measurement of the total gross value added generated by all economic activities.
Added value – Value that an activity adds to goods and services consumed in the productive process. It is the contribution to the Gross Domestic Product by

| | |
|---|---|
| | various economic activities, obtained by the difference between the production value and the intermediary consumption absorbed by these activities. |
| **Comments** | The conversion of GDP values at market prices for the base year of 2000 was undertaken by IPEA that presents the series 1947-2000 at its Internet site. |
| **Source** | IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil; IPEA. |
| **Observations** | GEO-LAC data are in millions of dollars (Millions US$) |

| | |
|---|---|
| **107** | **Gross domestic product per inhabitant** |
| **Unit:** | R$ |
| **Concept** | Coefficient between the GDP value and the estimated value for the resident population in 1st July. |
| **Comments** | The estimate of resident population used for GDP per capita calculation is the one estimated by IBGE based on the 2000 Demographic Census, revised for the whole decade of 1990.<br>The GDP per capita values used were converted for the base year of 2000. |
| **Source** | IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil of 1998-2000. |
| **Observations** | |

| | |
|---|---|
| **108** | **Gross Domestic Product annual growth rate** |
| **Unit:** | % |
| **Concept** | GDP – Goods and services produced in the country, discounting expenses with inputs used in the production process during the year. It is the measurement of the total gross added value generated by all economic activities.<br>Added value – Value that an activity adds to goods and services consumed in the productive process. It is the contribution to the Gross Domestic Product by various economic activities, obtained by the difference between the production value and the intermediary consumption absorbed by these activities. |
| **Comments** | The value presented for the last year must be understood as preliminary.<br>The value presented for the year before the last must be understood as almost definite.<br>Remaining values are definite. |
| **Source** | IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil, 1998-2000. |
| **Observations** | |

### B.7.2 - GDP/aggregate value per sector

| | |
|---|---|
| **109** | **Average annual growth of industrial aggregate value** |
| **Unit:** | % |
| **Concept** | It is the mean growth rate of class added value for industrial economic activities |
| **Comments** | The value presented for the last year must be understood as preliminary.<br>The value presented for the year before the last must be understood as almost definite.<br>Remaining values are definite. |
| **Source** | IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil, 1990-1995, 1995-1990, 1998-2000. |
| **Observations** | |

| | |
|---|---|
| **110** | **Agro-pastoral production** |
| **Unit:** | % GDP |
| **Concept** | Participation of agro-pastoral activities in the added value. |
| **Comments** | The value presented for the last year must be understood as preliminary.<br>The value presented for the year before the last must be understood as almost definite.<br>Remaining values are definite. |
| **Source** | IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil, 1990-1995, 1995-1999, 1998-2000. |
| **Observations** | In the period of 1990 - 1994 – data were calculated from the Resource and Use Tables |

| | |
|---|---|
| **111** | **Industrial production** |
| **Unit:** | % GDP |
| **Concept** | Participation of industrial activities in the added value. |
| **Comments** | The value presented for the last year must be understood as preliminary.<br>The value presented for the year before the last must be understood as almost definite.<br>Remaining values are definite. |
| **Source** | IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil. |
| **Observations** | In the period of 1990 - 1994 - data were calculated from the Resource and Use Tables |

| | |
|---|---|
| **112** | **Production by the Industry of Transformation** |
| **Unit:** | % GDP |
| **Concept** | Participation of transformation industry activity in the added value. |
| **Comments** | The value presented for the last year must be understood as preliminary.<br>The value presented for the year before the last must be understood as almost definite.<br>Remaining values are definite. |
| **Source** | IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil, 1990-1995, 1995-1999, 1998-2000. |
| **Observations** | In the period of 1990 - 1994 – data were calculated from the Resource and Use Tables. |

| | |
|---|---|
| **113** | **Production of Services** |
| **Unit:** | % GDP |
| **Concept** | Participation of service activities in the added value. |
| **Comments** | The value presented for the last year must be understood as preliminary.<br>The value presented for the year before the last must be understood as almost definite.<br>Remaining values are definite. |
| **Source** | IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil. |
| **Observations** | In the period of 1990 - 1994 – data were calculated from the Resource and Use Tables |

## B.7.3 – Composition of GDP

| | |
|---|---|
| **114** | **Consumption plus stock variation / Final Consumption** |
| **Unit:** | % GDP |
| **Concept** | Consumption in the sum of family consumption with public administration consumption.<br>Stock variation is the difference between the final stock value of merchandise, of semi-manufactured products, of goods being produced and raw material from productive sectors in the beginning and the end of the year, evaluated under current average prices. |
| **Comments** | The value presented for the last year must be understood as preliminary.<br>The value presented for the year before the last must be understood as almost definite.<br>Remaining values are definite. |
| **Source** | IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil, 1990-1995, 1995-1999, 1998-2000. |
| **Observations** | |

| | |
|---|---|
| **115** | **Gross generation of fixed capital** |
| **Unit:** | % GDP |
| **Concept** | Added to stock of durable goods destined for use by productive units, undertaken every year, to increase the country's productive capacity. |
| **Comments** | The value presented for the last year must be understood as preliminary.<br>The value presented for the year before the last must be understood as almost definite.<br>Remaining values are definite. |
| **Source** | IBGE – Research Division, Department of National Accounts; System of National Accounts, Brazil, 1990-1995, 1995-1999, 1998-2000. |
| **Observations** | |

## B.7.4 - Exports

| | |
|---|---|
| **116** | **Total exports** |
| **Unit:** | Millions US$ |
| **Concept** | Value of goods and services exported evaluated at FOB prices, that is, only including the internal commercialisation cost until the exit port of goods. |
| **Comments** | Value referent to the years 1970, 1975, 1980, and 1985 were obtained in the Statistic Yearbook of Brazil IBGE, Section of Macro-economic Aggregates – Foreign Sector – Goods Commerce- |
| **Source** | Ministry of Development, Industry and Commerce, Secretariat of Foreign Commerce, Integrated System of Foreign Commerce; Brazil Central Bank, Bulletins, vol. 26 - 37. |
| **Observations** | |

| | |
|---|---|
| **117** | **Exports / Manufactures** |
| **Unit:** | % |
| **Concept** | Value of goods and services exported, evaluated at FOB prices, referent to articles included in the<br>CUCI- Standard Classification for International Commerce - revision 3, regarding chemical and related products, basic manufactures, machines and transport equipment, other manufactured goods and goods not classified, as well as iron. |
| **Comments** | Values that were used as reference were obtained at the Statistic Yearbook of Brazil,<br>Section of Macro-economic Aggregates – Foreign Sector – Goods Commerce. |
| **Source** | Ministry of Development, Industry and Commerce, Secretariat of Foreign Commerce, Integrated System of Foreign Commerce |
| **Observations** | |

| | |
|---|---|
| **118** | **Exports / Fuels, mineral and metals** |
| **Unit:** | % |
| **Concept** | Values of goods and services exported, evaluated at FOB prices, referent to articles included in the CUCI – Uniform Classification for International Commerce – revision 3, regarding mineral fuels, mineral oils and related materials, as well as ores, slag, ash and ashes, and also salt, sulfur, earth, stones, plaster and limestone. |
| **Comments** | Values that were used as reference were obtained at the Statistic Yearbook of Brazil,<br>Section of Macro-economic Aggregates – Foreign Sector – Goods Commerce. |
| **Source** | Ministry of Development, Industry and Commerce, Secretariat of Foreign Commerce, Integrated System of Foreign Commerce. |
| **Observations** | |

| | |
|---|---|
| **119** | **Exports/ Other Primary Products** |
| **Unit:** | % |
| **Concept** | Values of goods and services exported, evaluated at FOB prices, referent to articles included in the CUCI – Standard Classification for International Commerce – revision 3, regarding<br>1 – live animals and products related to animal life;<br>2 – vegetable products;<br>3 – fats and vegetable or animal oils, products from their produced fat, animal or vegetable wax;<br>4 – food industry products, drinks, alcoholic liquids and vinegar, tobacco and its manufactured derivatives. |
| **Comments** | Values that were used as reference were obtained at the Statistic Yearbook of Brazil,<br>Section of Macro-economic Aggregates – Foreign Sector – Goods Commerce. |
| **Source** | Ministry of Development, Industry and Commerce. |
| **Observations** | |

## B.7.5 - Imports

| | |
|---|---|
| **120** | **Total Imports** |
| **Unit:** | Millions US$ |
| **Concept** | Value of goods and services acquired by Brazil from the rest of the world valued at FOB price. |
| **Comments** | Values referent to the years 1975, 1980, and 1985 were obtained from Statistic Yearbook of Brazil,<br>IBGE, Section of Macro-economic Aggregates – Foreign Sector – Goods Commerce |
| **Source** | Ministry of Development, Industry and Commerce, Secretariat of Foreign Commerce, Integrated System of Foreign Commerce; Brazil Central Bank - Bulletins, vol. 26 - 37. |
| **Observations** | |

| | |
|---|---|
| **121** | **Imports / Foods** |
| **Unit:** | % |
| **Concept** | Values of goods and services exported, evaluated at FOB prices, referent to articles included in the CUCI – Standard Classification for International Commerce – revision 3, regarding:<br>1 – live animals and products related to animal life;<br>2 – fats and vegetable or animal oils, products from its dissociation, produced fat, animal or vegetable wax;<br>3 – food industry products, drinks, alcoholic liquids and vinegar, tobacco and its manufactured derivatives. |
| **Comments** | Os Values that were used as reference were obtained at the Statistic Yearbook of Brazil,<br>Section of Macro-economic Aggregates – Foreign Sector – Merchandise Commerce. |
| **Source** | Ministry of Development, Industry and Commerce, Secretariat of Foreign Commerce. |
| **Observations** | Data subject to rectification 1999 |

| | |
|---|---|
| **122** | **Imports /Fuels** |
| **Unit:** | % |
| **Concept** | Values of goods and services acquired by Brazil from the rest of the world, evaluated at FOB prices, referent to articles included in the CUCI – Standard Classification for International Commerce – revision 3, regarding mineral fuels, mineral oils and related materials, as well as mineral substances, ash and ashes, and also salt, sulfur, earth, stones, plaster, limestone and cement. |
| **Comments** | Values that were used as reference were obtained at the Statistic Yearbook of Brazil,<br>Section of Macro-economic Aggregates – Foreign Sector – Goods Commerce. |
| **Source** | Ministry of Development, Industry and Commerce. |
| **Observations** | |

### B.7.6. - Prices

| | |
|---|---|
| **123** | **Inflation at INPC consumer prices** |
| **Unit:** | % |
| **Concept** | INPC – National Consumer Price Index. Index resulting of the arithmetic mean of consumer price indexes of the metropolitan regions of Belém, Fortaleza, Recife, Salvador, Belo Horizonte, Rio de Janeiro, São Paulo, Curitiba, Porto Alegre, in addition to Brasília and the Municipality of Goiânia. The intervention variable of INPC is the resident urban population obtained by an estimate or based on results from the Demographic Census. INPC collection period extends from day 1 to day 30 of the reference month. |
| **Comments** | Data were obtained from Statistic Yearbook of Brazil, IBGE, Index Section, Prices, Costs and Salaries. |
| **Source** | IBGE – National System of Indexes of Consumer Prices |
| **Observations** | 2001 9.44 |

### B.7.7 –GDP Composition

| | |
|---|---|
| **124** | **Commercial Balance** |
| **Unit:** | Millions US$ |
| **Concept** | Commercial balance:<br>Difference between the FOB value of Exports and the FOB value of Imports |
| **Comments** | Value referent to the years 1975, 1980, and 1985 were obtained from the Statistic Yearbook of Brazil<br>IBGE, Section of Macro-economic Aggregates Foreign Sector, Goods Commerce. |
| **Source** | Brazil Central Bank, Bulletins, vol. 26 - 37. |
| **Observations** | |

| | |
|---|---|
| **125** | **Commerce Chain** |
| **Unit:** | Millions US$ |
| **Concept** | Sum of the Exports FOB value plus the Imports FOB value. |
| **Comments** | Value referent to the years 1975,1980 e 1985 were obtained from the Statistic Yearbook of Brazil<br>IBGE, Section of Macro-economic Aggregates Foreign Sector, Goods Commerce |
| **Source** | Brazil Central Bank, Bulletins vol. 26 - 37. |
| **Observations** | See bulletin of BCB August /2001 vol. nº 08 pg. 154- FOB Commercial Bulletin. |

| | |
|---|---|
| **126** | **Direct Foreign Investment** |
| **Unit:** | Millions US$ |
| **Concept** | Direct investment (net) of the country discriminated in the financial accountability of the balance of payments. |
| **Comments** | International inversion category that reflects the objective, on the part of an entity resident of an economy, of obtaining long-term participation in a resident company of another economy. |
| **Source** | Brazil Central Bank, Bulletin August 2001 |
| **Observations** | |

## B.7.8 –Foreign debt

| | |
|---|---|
| **127** | **Gross Foreign Debt** |
| **Unit:** | Millions US$ |
| **Concept** | Total foreign debt is the sum of both short and long-term debts, whether from the public sector (publicly guaranteed) or private sector (not guaranteed), using IMF credit. |
| **Comments** | IPEA has available on the Internet, the historic series, 1950-2000, of the value of the Brazilian Foreign Debt excluding inter-company loans from March 2001, retroactive to 2000. |
| **Source** | Brazil Central Bank, Bulletins, Balance of Payments Section |
| **Observations** | 2000 – data subject to rectification |

## B.7.9 – Agricultural Productivity / Means of Production

| | |
|---|---|
| **128** | **Total consumption of fertilisers** |
| **Unit:** | t |
| **Concept** | Natural or artificial substance that contains chemical elements or physical properties that promote growth and productivity increase in plants, improving soil natural fertility or returning elements removed from soil through erosion or previous cultures. |
| **Comments** | Information about the quantity of fertilisers sold and delivered to final consumers refers to the sum of its nutrients (N, P2 O5 ,K2O). |
| **Source** | ANDA – National Association for the Dissemination of Fertilisers |
| **Observations** | |

| | |
|---|---|
| **129** | **Total consumption of herbicides** |
| **Unit:** | t |
| **Concept** | Chemical products destined for use in the production, storage and processing sectors of agricultural products, in pastures, in plantations, in native or planted forest protection, and in other ecosystems, as well as in urban, hydro and industrial environments, with the objective of changing the composition of flora or fauna with the objective of protecting them from damaging action from living organisms considered harmful. They also include substances and products employed as deforesting agents, dissecting, stimulants and growth inhibitors. |
| **Comments** | Information about the quality of herbicides sold refer to the sum of its active ingredients |
| **Source** | SINDAG - National Union of the Industry for Agriculture Products |
| **Observations** | |

| | |
|---|---|
| **130** | **Herd / Bovine** |
| **Unit:** | 1 000 Heads |
| **Concept** | Total number of heads of bovine existent in the municipality at the research date of reference, considering common cattle or of special breeds, independently of sex and age. |
| **Comments** | Information about the number of bred species, having as reference date 31/12 of the research year. |
| **Source** | IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970. |
| **Observations** | |

**131** **Herd / Bubalines**
**Unit:** 1000 heads
**Concept** Total number of heads of existing bubalines in the municipality at the research date of reference, independently of race, sex, age or economic aptness.
**Comments** Information about the number of bred species, having as reference date 31/12 of the research year.
**Source** IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970
**Observations**

**132** **Herd / Equine**
**Unit:** 1000 heads
**Concept** Total number of heads of existing equines in the municipality at the research date of reference, independently of race, sex, age or economic aptness.
**Comments** Information about the number of bred species, having as reference date 31/12 of the research year
**Source** IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970.
**Observations**

**133** **Herd / Asinine**
**Unit:** 1000 heads
**Concept** Total number of heads of asinine (donkeys, burros, etc) existent in the municipality at the research date of reference, independently of race, sex, age or economic aptness.
**Comments** Information about the number of bred species, having as reference date 31/12 of the research year
**Source** IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970.
**Observations**

**134** **Cattle / Mules**
**Unit:** 1000 heads
**Concept** Total number of heads of mules (mules and donkeys) existent in the municipality at the research date of reference, independently of race, sex, age or economic aptness.
**Comments**
Information about the number of bred species, having as reference date 31/12 of the research year
**Source** IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970.
**Observations**

**135** **Herd / Swine**
**Unit:** 1000 heads
**Concept** Total number of heads of existing swine in the municipality at the research date of reference, independently of race or sex.
**Comments** Information about the number of bred species, having as reference date 31/12 of the research year.
**Source** IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970.
**Observations**

**136** **Herd / Goats**
**Unit:** 1000 heads
**Concept** Total number of heads of existing Goats in the municipality at the research date of reference, independently of race, sex, age or economic aptness.
**Comments** Information about the number of bred species, having as reference date 31/12 of the research year.
**Source** IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970
**Observations**

**137** **Herd / Sheep**
**Unit:** 1000 heads
**Concept** Total number of heads of existing sheep in the municipality at the research date of reference, independently of race, sex, age or economic aptness.
**Comments** Information about the number of bred species, having as reference date 31/12 of the research year.
**Source** IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970.
**Observations**

**138** **Herd / Rabbit**
**Unit:** 1000 heads
**Concept** Total number of existing heads of rabbits in the municipality at the research date of reference, independently of race, sex, age or economic aptness.
**Comments** Information about the number of bred species, having as reference date 31/12 of the research year.
**Source** IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970.
**Observations**

**139** **Herd / Roosters, Chicken and Young Chicken**
**Unit:** 1000 heads
**Concept** Birds of the same species (except chicken), independently of age, sex, race or economic aptness.
**Comments** Information about the number of bred species, having as reference date 31/12 of the research year.
Information referent to the years 1970, 1975 and 1980 are included in “chicken”.
**Source** IBGE – Municipal Pastoral Research.
**Observations**

**140** **Herd / Chicken**
**Unit:** 1000 heads
**Concept** Adult birds, independently of race or economic aptness, destined for egg production.
**Comments** Information about the number of bred species, having as reference date 31/12 of the research year.
Years 1970, 1975 and 1980 – Includes cocks, chicken and young chicken.
**Source** IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970.
**Observations**

**141** **Herd / Quail**
**Unit:** 1000 heads
**Concept** Birds of the same species, independently on sex, age or race.
**Comments** Information about the number of bred species, having as reference date 31/12 of the research year.
**Source** IBGE – Municipal Pastoral Research; IBGE – Agro-pastoral Census, 1970.
**Observations**

# A. Socioeconomic and cultural factors

## A.1. Land

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A.1.1. | Use | | | | | | | | | | | | | | | | |
| 1 | Land cover / Territorial areas | 1000 ha | | | 851196,5 | | | | | | | | | 854.740,4 | | | |
| 2 | Land destined to Temporary and permanent Cultures | 1000 ha | 33.984 | 42.607 | 57.724 | 62.810 | | | | | | | 50.104 | | | | |
| 3 | Land destined to temporary crops | 1000 ha | 26.000 | 34.222 | 47.252 | 52.907 | | | | | | | 42.563 | | | | |
| 4 | Land destined to temporary crops | 1000 ha | 7.984 | 8.385 | 10.472 | 9.903 | | | | | | | 7.542 | | | | |
| 5 | Land destined to Temporary crops per Inhabitant | ha/100 hab | 27,92 | 31,94 | 39,71 | 39,03 | | | | | | | 27,10 | | | | |
| 6 | Land not destined to Temporary nor permanent Crops | 1000 ha | 820.756 | 812.133 | 797.016 | 791.930 | | | | | | | 804.636 | | | | |
| 7 | Agriculture area | 1000 ha | 223.190 | 241.760 | 262.036 | 272.485 | | | | | | | 249.561 | | | | |
| 8 | Irrigated Land | 1000 ha | 796 | 1.087 | 1.481 | 1.960 | | | | | | | 3.122 | | | | |

Land not destined to temporary nor permanent crops

## A.2. Forests

Variation of Forest Cover - planted forests

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A.2.1. | Land not destined to temporary nor permanent crops | | | | | | | | | | | | | | | | |
| 9 | Variation of Forest Cover - Native Forests - Legal Amazon | 1000ha/ano | | | 2.113 | 2.113 | 1.381 | 1.113 | 1.379 | 1.490 | 1.490 | 2.906 | 1.816 | 1.323 | 1.738 | 1.726 | |
| 10 | Percentage variation of Forest Cover - Native Forests - Legal Amaszon | % ao ano | | | 0,54 | 0,54 | 0,37 | 0,30 | 0,37 | 0,40 | 0,40 | 0,81 | 0,51 | 0,37 | 0,48 | 0,48 | |
| 11 | Variation of Forest Cover - Native Forests/ Atlantic Forest Remnants | 1000 ha/5 anos | | | | | | | | | | 500 | | | | | |
| 12 | Percentage variation of Forest Cover/ Native Forests - Atlantic Forest Remnats | % em 5 anos | | | | | | | | | | 5,76 | | | | | |
| 13 | Forest Cover/ - Native Forest/ Atlantic Forest Remnants | 1000 ha | | | | | 8.682 | | | | | 8.162 | | | | | |
| 14 | Forest Fires and Burning/ Number of Heat Spots | N° | | | | | | | | | | | | | 107.007 | 107.242 | 104.122 |
| 15 | Superfície florestal- Florestas plantadas | 1000 ha | 1.658 | 2.864 | 5.016 | 5.967 | | | | | | 5.396 | | | | | |
| 16 | Forest cover planted forests | 1000 ha/ano | 241 | 430 | 190 | 54 | 54 | 54 | 54 | -54 | -54 | 54 | 54 | | | | |
| 17 | Variation of Forest Cover - planted forests | % ao ano | 14,5 | 15,0 | 3,8 | 0,9 | 0,9 | 0,9 | 0,9 | -0,9 | -0,9 | 0,9 | | | | | |
| A.2.2. | Forest Production | | | | | | | | | | | | | | | | |
| 18 | Wood production in logs | 1000 m³ | | | | | 144.538 | 96.132 | 105.285 | 112.545 | 131.900 | 129.775 | 132.873 | 83.327 | 94.732 | 85.873 | 93.637 |
| 19 | Carbon production | t | | | | | 4.631.371 | 4.578.074 | 4.238.398 | 3.989.892 | 4.269.477 | 4.286.990 | 4.063.903 | 5.432.402 | 4.326.821 | 3.817.972 | 3.814.696 |
| 20 | Wood production | 1000 m³ | | | | | 131.288 | 128.880 | 123.927 | 118.638 | 118.532 | 112.962 | 103.943 | 89.593 | 88.601 | 90.443 | 90.864 |

# A. Socioeconomic and cultural factors

## A.3. Biodiversity

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A.3.1. Protection** | | | | | | | | | | | | | | | | | |
| 21 | Protected Areas / Number | N° | 26 | 31 | 41 | 94 | 155 | 155 | 164 | 165 | 165 | 165 | 167 | 173 | 187 | 195 | 201 |
| 22 | Protected Areas / Total Area | km² | 15.662,58 | 33.353,05 | 103.489,05 | 160.583,14 | 324.099,54 | 324.099,54 | 328.409,69 | 328.556,09 | 328.556,09 | 328.556,09 | 347.619,59 | 375.515,76 | 422.791,56 | 424.415,25 | 429.499,93 |
| 23 | Integral Protected Areas - Number | N° | 14 | 18 | 28 | 59 | 82 | 82 | 83 | 83 | 83 | 83 | 83 | 84 | 89 | 92 | 93 |
| 24 | Integral Protected Areas - Area | km² | 13.085,02 | 24.775,49 | 94.911,49 | 138.067,27 | 160.522,65 | 160.522,65 | 160.695,65 | 160.695,65 | 160.695,65 | 160.695,65 | 160.695,65 | 160.695,65 | 176.679,33 | 172.574,00 | 173.338,81 |
| 25 | Areas for Sustainable Use - Number | N° | 12 | 13 | 13 | 35 | 73 | 73 | 82 | 83 | 83 | 83 | 85 | 90 | 99 | 104 | 109 |
| 26 | Areas for Sustainable Use - Area | km² | 2.577,56 | 8.577,56 | 8.577,56 | 22.515,87 | 163.576,81 | .663.576,89 | 167.806,84 | 167.953,24 | 167.953,24 | 167.953,24 | 187.016,74 | 214.912,91 | 251.205,03 | 251.934,05 | 251.934,05 |
| 27 | Natural Monuments - Number | N° | | | | 1 | | | | | | | | | | 4 | 6 |
| 28 | Natural Monuments - Area | km² | | | | 1.700,86 | | | | | | | | | | 7.502,09 | 32.100,27 |
| **A.3.2. Species** | | | | | | | | | | | | | | | | | |
| 29 | Total number of known species / Mammals | N° | | | | | | | | | | | | | | | 518 |
| 30 | Total number of known species / Birds | N° | | | | | | | | | | | | | | | 1.677 |
| 31 | Total number of known species / Reptiles | N° | | | | | | | | | | | | | | | 468 |
| 32 | Total number of known species / Amphibians | N° | | | | | | | | | | | | | | | 517 |
| 33 | Total number of known species / Fish | N° | | | | | | | | | | | | | | | 300 |
| 34 | Total number of known species / Plants | N° | | | | | | | | | | | | | | | 56000 |
| 35 | Total number of species in danger of extinction / Mammals | N° | | | | 57 | | | 58 | 58 | 58 | 58 | 58 | 58 | 67 | 67 | 67 |
| 36 | Total number of species in danger of extinction / Birds | N° | | | | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 109 | 109 | 109 | 109 |
| 37 | Total number of species in danger of extinction / Reptiles | N° | | | | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| 38 | Total number of species in danger of extinction / Amphibians | N° | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 39 | Total number of species in danger of extinction / Fish of freshwater | N° | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 40 | Total number of species in danger of extinction / Invertebrates | N° | | | | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 |
| 41 | Total number of species in danger of extinction / Plants | N° | | | | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 |
| 42 | Total number of edemic species / Mammals | N° | | | | | | | | | | | | | | | 96 |
| 43 | Total number of edemic species / Birds | N° | | | | | | | | | | | | | | | 191 |
| 44 | Total number of edemic species / Plants | N° | | | | | | | | | | | | | | | 8000 |

# A. Socioeconomic and cultural factors

## A.4. MARINE AND COASTAL AREAS

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A.4.1. Use of the sea | | | | | | | | | | | | | | | | | |
| 45 | Total production of marine fihing | t | | | | | | | | | | | 422.258,4 | 475.894,0 | 447.948,0 | 444.983,5 | |
| 46 | Production of marine fishing / Capture | t | | | | | | | | | | | 422.173,5 | 465.714,0 | 432.599,0 | 418.470,0 | |
| 47 | Production of marine fishing / Aqua - culture | t | | | | | | | | | | | 84,9 | 10.180,0 | 15.349,0 | 26.513,5 | |

## A.5. Fresh Water

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A.5.1. Use | | | | | | | | | | | | | | | | | |
| 48 | Total fishing production in freshwater | t | | | | | | | | | | | 262509,0 | 256.364,5 | 262.755,5 | 299.614,0 | |
| 49 | Total fishing production in freshwater / Capture | t | | | | | | | | | | | 210.277,5 | 178.871,0 | 174.190,0 | 185.471,5 | |
| 50 | Total fishing production in freshwater / Aqua Culture | t | | | | | | | | | | | 52.231,5 | 77.493,5 | 88.565,5 | 114.142,5 | |

## A.6. Atmosphere

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | Emissions of $CO_2$ by fluel burning | 1000 t | | | | | 54.993 | 57.798 | 58.930 | 61.395 | 64.189 | | | | | | |
| 52 | Emissões de $CO_2$ by gas fossil fuels | 1000 t | | | | | 1.889 | 1.835 | 1.992 | 2.192 | 2.266 | | | | | | |
| 53 | Emissões de $CO_2$ by liquid fossil fuels | 1000 t | | | | | 42.872 | 44.147 | 45.412 | 47.274 | 49.639 | | | | | | |
| 54 | Emissões de $CO_2$ by solid fossil fuels | 1000 t | | | | | 10.232 | 11.816 | 11.526 | 11.929 | 12.284 | | | | | | |
| 55 | Emissões de $CO_2$ by cement productions | 1000 t | | | | | | | | | | | 12853 | | | | |
| 56 | Emissions of sulfur dioxide ($SO_2$) | Gg | | | | | 61,65 | 64,80 | 58,22 | 66,69 | 73,49 | 70,40 | 75,47 | | | | |
| 57 | Emissions of nitrogen oxides ($NO_x$) | Gg | | | | | 4,97 | 5,27 | 5,17 | 5,50 | 7,15 | 7,42 | 7,76 | | | | |
| 58 | Emissions of hydrocarbons (HC) | Gg | | | | | 5,02 | 4,99 | 4,98 | 5,22 | 5,63 | 5,59 | 5,49 | | | | |
| 59 | Emissions of carbon monoxide (CO) | Gg | | | | | 11,99 | 11,26 | 11,39 | 12,85 | 12,96 | 13,58 | 12,94 | | | | |

## A. State of the Environment and Trends

### A.7. Sanitation

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A.7.1. Access | | | | | | | | | | | | | | | | | |
| 60 | Percentage of population with access to the general grid of water supply | % | | | | | | | 71,50 | 72,80 | | 74,40 | 76,00 | 76,10 | 77,20 | 78,30 | 75,80 |
| 61 | Percentage of population with access to the general grid of water supply /rural area | % | | | | | | | 12,30 | 14,20 | | 16,70 | 19,40 | 19,60 | 22,30 | 24,90 | 17,80 |
| 62 | Percentage of population with access to the general grid of water supply /urban area | % | | | | | | | 88,30 | 89,00 | | 89,70 | 90,60 | 90,60 | 91,50 | 91,90 | 89,10 |
| 63 | Percentage of population with access to the grid of sewage cellection | % | | | | | | | 36,10 | 36,20 | | 37,00 | 38,00 | 38,60 | 40,10 | 41,20 | 54,50 |
| 64 | Percentage of population with access to the general grid of sewage collection / rural sector | % | | | | | | | 3,00 | 3,00 | | 3,20 | 3,50 | 3,50 | 4,50 | 4,50 | 3,10 |
| 65 | Percentage of population with access to the general grid of sewage collection / urban sector | % | | | | | | | 45,50 | 45,30 | | 45,90 | 46,80 | 47,60 | 49,40 | 50,50 | 53,8 0 |
| 66 | Percentage of population with access to garbage collection | % | | | | | | | 63,60 | 66,80 | | 69,40 | 70,80 | 74,00 | 76,10 | 77,60 | 76,40 |
| 67 | Percentage of population with access to garbage collection / Rural area | | | | | | | | 6,70 | 7,80 | | 9,90 | 11,80 | 14,10 | 16,70 | 18,00 | 12,20 |
| 68 | Percentage of population with access to garbage collection / Urban area | % | | | | | | | 79,70 | 83,10 | | 85,00 | 86,00 | 89,40 | 91,40 | 92,90 | 91,10 |

# B. Socioeconomic and Cultural Factors

## B.1. Population / Employment

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **B.1.1. Demographic** | | | | | | | | | | | | | | | | | |
| 69 | Total population in the middle of the year | 1000 hab | 95.305,0 | 107.145,2 | 118.562,5 | 131.639,3 | 144.090,8 | 146.987,6 | 149.269,2 | 151.546,3 | 153.824,0 | 156.106,4 | 158.400,7 | 160.710,3 | 163.033,8 | 165.371,5 | 166.112,5 |
| 70 | Average annual population growth rate | % | 2,89 | | 2,48 | | | 1,93 | | | | | | | | | 1,64 |
| 71 | Population density | Hab/km² | 11,01 | | 14,07 | | 17,18 | | | | | | 18,38 | | | | 19,87 |
| 72 | Total fertility rate | Nº médio de filhos | | | 4,02 | 3,30 | 2,70 | 2,61 | 2,53 | 2,47 | 2,41 | 2,37 | 2,32 | 2,29 | 2,25 | 2,23 | 2,20 |
| **B.1.2. Employment** | | | | | | | | | | | | | | | | | |
| 73 | Workforce in the middle of the year | 1000 hab | 29.557,2 | | 43.235,7 | 55.098,5 | 64.468,0 | 58.456,1 | 69.968,8 | 70.965,4 | | 74.138,4 | 73.120,1 | 75.213,3 | 76.885,7 | 79.315,3 | |
| 74 | Man-womam workforce index | Homem=100 | 26,4 | | 37,7 | 50,4 | 55,0 | 48,0 | 65,1 | 65,5 | | 67,8 | 66,8 | 67,8 | 68,6 | 70,6 | |
| 75 | Open unemployment rate | % | | | | 4,77 | 425 | 4,35 | 5,74 | 5,05 | 5,05 | 5,19 | 5,23 | 5,63 | 7,65 | 7,40 | 6,70 |

## B.2. URBAN AND INDUSTRIAL AREAS

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **B.2.1. Demographic** | | | | | | | | | | | | | | | | | |
| 76 | Urban population in the middle of the year | 1000 hab | 52.085 | 64.090 | 78.153 | 95.473 | 109.106 | 110.991 | 113.837 | 116.087 | | 120.350 | 122.511 | 124.336 | 125.910 | 127.751 | 137.697 |
| 77 | Urbanization rate | % | 55,92 | | 67,59 | | | 75,59 | | | | | 78,36 | | | | 81,25 |
| 78 | Urban population growth | 1000 | | | 28.351,43 | | | 30.554,43 | | | | | | | | | 26.962,97 |
| 79 | Annual rate of urban population growth | % | | | 4,44 | | | 2,97 | | | | | | | | | 2,47 |
| **B.2.2. Concentration** | | | | | | | | | | | | | | | | | |
| 80 | Number of Municipalities with population over 750.000 inhabitants | Nº | 7 | | 11 | | | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 18 | 18 | 19 |
| 81 | Population in the middle of the year in municipalities with population over 750.000 inhabitants | total absoluto | | | | | | | 33.253 | 33.747 | 34.751 | 35.166 | | 35.683 | 36.841 | 37.253 | 38.423 |
| 82 | Proportion of the population in municipalities with more than de 750.000 inhabitants | % | 16,34 | | 20,78 | | | 22,72 | | | | | 22,42 | | | | 23,33 |

## B.3. Education

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **B.3.1. Literacy** | | | | | | | | | | | | | | | | | |
| 83 | Adult literacy rate, total | % | | | | 79,30 | 81,65 | | 82,77 | 83,55 | | 84,42 | 86,00 | 85,28 | 86,19 | 86,65 | |
| 84 | Adult literacy rate, men (15 years or more) | % | | | | 80,38 | 82,09 | | 83,41 | 83,89 | | 84,53 | 85,49 | 85,36 | 86,19 | 86,64 | |
| 85 | Adult literacy rate, woman (15 years or more) | % | | | | 78,28 | 81,23 | | 82,18 | 83,23 | | 84,31 | 85,17 | 85,20 | 86,20 | 86,65 | |

# B. Socioeconomic and Cultural Factors

## B.4. HEALTH

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B.4.1. State | | | | | | | | | | | | | | | | | |
| 86 | Life expectancy at birth, total | Anos | | | 62,70 | 64,09 | 65,75 | 66,09 | 66,38 | 66,67 | 66,96 | 67,26 | 67,56 | 67,80 | 68,05 | 68,31 | 68,56 |
| 87 | Life expectancy at birth, man | Anos | | | 59,58 | 60,79 | 62,27 | 62,57 | 62,83 | 63,09 | 63,35 | 63,61 | 63,87 | 64,09 | 64,31 | 64,54 | 64,77 |
| 88 | Life expectancy at birth, woman | Anos | | | 65,97 | 67,56 | 69,90 | 69,78 | 70,11 | 70,43 | 70,76 | 71,09 | 71,42 | 71,70 | 71,98 | 72,26 | 72,55 |
| 89 | Gross mortality rate | por 1000 hab | | | 8,64 | 7,87 | 7,20 | 7,11 | 7,02 | 6,95 | 6,89 | 6,82 | 6,77 | 6,74 | 6,72 | 6,70 | 6,69 |
| 90 | Child gross mortality rate | por 1000 nasc | | | 80,1 | 65,4 | 48,2 | 44,8 | 43,3 | 42,0 | 40,7 | 39,3 | 38,0 | 36,9 | 35,9 | 34,8 | 33,8 |
| B.4.2. Resource | | | | | | | | | | | | | | | | | |
| 91 | Doctors | por 1000 hab | | | 1,23 | 1,51 | | | 2,06 | | | | | | | 2,56 | |

## B.5. COMMUNICATION AND TECHNOLOGICAL ACCESS

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B.5.1 - Communication | | | | | | | | | | | | | | | | | |
| 92 | Radio | % | | | | | 83,99 | | 84,89 | 85,87 | | 88,80 | 90,40 | 90,32 | 90,44 | 89,87 | |
| 93 | Television sets | % domiciles with tv | | | | | 73,20 | | 73,91 | 75,72 | | 81,02 | 84,42 | 86,21 | 87,49 | 87,73 | |
| B.5.2 - Telephone | | | | | | | | | | | | | | | | | |
| 94 | Access to Commuted Fixed Telephone | por 1000 hab | | | | | | | | | 86,16 | 93,18 | 104,12 | 117,10 | 135,75 | 167,90 | |
| 95 | Access to Telephone Cellular Mobile Service | por 1000 hab | | | | | | | | | 4,91 | 9,07 | 17,33 | 28,31 | 45,19 | 90,90 | |

## B.6. ENERGY PRODUCTION AND CONSUMPTION

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B.6.1. Energy | | | | | | | | | | | | | | | | | |
| 96 | Total production of primary energy | Tj | 2.203.390,0 | 2.460.285,0 | 2.928.085,0 | 4.710.964,4 | 4.734.009,0 | 4.776.077,2 | 4.764.424,0 | 4.820.145,0 | 5.046.149,1 | 5.065.468,9 | 5.392.479,6 | 5.727.593,2 | 6.075.203,9 | 6.338.138,0 | 6.718.972,5 |
| 97 | Oil Production | Tj | 362.167 | 387309,3 | 410733,3 | 1243233,5 | 1442789,3 | 1425244 | 1440754,4 | 1471956,2 | 1528616,9 | 1578494,5 | 1796138,4 | 1934375,9 | 2241600,6 | 2498495,5 | 2873278,8 |
| 98 | Natural Gas Production | Tj | 55.349,3 | 71.131,1 | 96.499,5 | 239.304,2 | 274.801,9 | 288.774,9 | 305.370,7 | 321.966,4 | 339.511,8 | 348.194,0 | 400.784,9 | 430.087,4 | 472.232,5 | 520.798,7 | 581.438,8 |
| 99 | Mineral Carbon Production | Tj | 49.515,9 | 57.700,7 | 110.155,9 | 156.868,2 | 84.923,2 | 93.334,1 | 83.250,0 | 80.898,6 | 89.761,7 | 90.349,6 | 83.385,7 | 96.273,4 | 92.384,5 | 93.243,6 | 107.668,8 |
| 100 | Hydraulic Energy Production | Tj | 144.161,4 | 261.869,0 | 466.986,9 | 646.188,8 | 748.815,7 | 788.939,1 | 809.075,7 | 851.547,6 | 879.216,7 | 919.789,8 | 962.773,8 | 1.010.604,5 | 1.055.874,5 | 1.060.996,1 | 1.114.360,7 |
| 101 | Nuclear Production | Tj | 0,0 | 0,0 | 0,0 | 44.858,2 | 2.125,3 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1.040,1 | 0,0 | 5.833,4 |
| 102 | Wood Production | Tj | 1.422305,0 | 1.480.458,0 | 1.388.028,0 | 1.470.237,9 | 1.274.299,6 | 1.192.315,7 | 1.120.370,7 | 1.107.573,5 | 1.110.015,3 | 1.038.703,4 | 981.002,7 | 967.346,2 | 949.348,7 | 961.377,2 | 971.416,0 |
| 103 | Production of energy by cane products | Tj | 159.897,9 | 185.628,1 | 410.688,0 | 840.006,7 | 811.111,1 | 882.875,3 | 882.830,1 | 852.804,0 | 964.859,1 | 959.387,5 | 1.030.563,8 | 1.142.302,4 | 1.108.794,4 | 1.083.426,0 | 883.010,9 |
| 104 | Production of energy other primary sources | Tj | 9.993,6 | 16.188,8 | 44.993,9 | 70.724,1 | 95.142,9 | 104.593,9 | 122.772,3 | 133.399,0 | 134.167,7 | 130.550,1 | 137.830,6 | 146.603,2 | 153.928,9 | 169.801,1 | 181.920,1 |

## B.7. PRODUCTION AND CONSUMPTION OF GOODS

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **B.7.1. GDP** | | | | | | | | | | | | | | | | | |
| 105 | Gross Domestic Product at market prices | Milhões R$ | | | | | 12 | 60 | 641 | 14.097 | 349.205 | 646.192 | 778.887 | 870.743 | 914.188 | 963.869 | 1.086.700 |
| 106 | Gross Domestic Product at fixed prices | mil R$ (ano 2000) | 312.788,4 | 505.365,9 | 715.524,3 | 762.252,2 | 836.505,2 | 845.139,5 | 840.541,3 | 881.935,4 | 933.553,9 | 972.985,3 | 998.853,0 | 1.031.529,4 | 1.032.890,1 | 1.041.276,9 | 1.086.699,9 |
| 107 | Gross Domestic Product per inhabitant | R$ (ano 2000) | | | | | 5.667,6 | 5.637,0 | 5.521,6 | 5.707,8 | 5.957,7 | 6.118,8 | 6.194,6 | 6.310,2 | 6.233,9 | 6.201,4 | 6.387,0 |
| 108 | Annual GPD Growth | % | 10,4 | 5,17 | 9,2 | 7,85 | -4,35 | 1,03 | -0,54 | 4,92 | 5,85 | 4,22 | 2,66 | 3,27 | 0,13 | 0,81 | 4,36 |
| **B.7.2. GPD/aggregate value by sector** | | | | | | | | | | | | | | | | | |
| 109 | Average annual growth of industrial aggregate value | % | | | | | | | -4,22 | 7,01 | 6,73 | 1,91 | 3,28 | 4,65 | -1,03 | -2,51 | 4,87 |
| 110 | Agro-pastoral production | % PIB | | | | | 8,10 | 7,79 | 7,72 | 7,56 | 9,85 | 9,01 | 8,32 | 7,96 | 8,23 | 8,19 | 7,69 |
| 111 | Industrial production | % PIB | | | | | 38,69 | 36,16 | 38,70 | 41,61 | 40,00 | 36,67 | 34,70 | 35,21 | 34,62 | 35,60 | 37,52 |
| 112 | Production of industry of transformations | % PIB | | | | | 26,54 | 24,86 | 26,43 | 29,06 | 26,79 | 23,91 | 21,48 | 21,64 | 20,68 | 21,27 | 22,37 |
| 113 | Production of services | % PIB | | | | | 70,34 | 68,93 | 77,50 | 81,82 | 64,26 | 60,72 | 62,31 | 61,92 | 62,27 | 61,00 | 58,88 |
| **B.7.3. Composition of GPD** | | | | | | | | | | | | | | | | | |
| 114 | Final consumption | % PIB | | | | | | 81,7 | 79,1 | 79,3 | 78,9 | 81,2 | 82,6 | 82,5 | 82,5 | 82,4 | 82,2 |
| 115 | Groos formation of fixed capital | % PIB | | | | | | 18,11 | 18,42 | 19,28 | 20,75 | 20,54 | 19,26 | 19,86 | 19,69 | 19,10 | 19,44 |
| **B.7.4. Exports** | | | | | | | | | | | | | | | | | |
| 116 | Total Exports | Milhões US$ | 2.739 | 8.670 | 20.132 | 25.639 | 31.414 | 31.620 | 35.793 | 38.555 | 43.545 | 46.506 | 47.747 | 52.994 | 51.140 | 48.011 | 55.086 |
| 117 | Exports / Manufactures | % | | 28,2 | 39,5 | 45,5 | 54,5 | 57,3 | 59,1 | 60,6 | 57,4 | 57,8 | 56,8 | 56,6 | 57,7 | 57,8 | |
| 118 | Exports / Fuels, minerals and metals | % | | 14,3 | 11,0 | 13,8 | 11,1 | 10,9 | 8,9 | 8,4 | 7,9 | 7,1 | 7,3 | 6,7 | 7,8 | 7,4 | |
| 119 | Exports / Other primary products | % | | 54,6 | 47,1 | 37,3 | 27,9 | 25,2 | 25,9 | 25,8 | 29,4 | 29,1 | 30,4 | 31,1 | 30,0 | 29,2 | |
| **B.7.5. Imports** | | | | | | | | | | | | | | | | | |
| 120 | Total imports | Milhões US$ | | 13.592 | 24.961 | 14.332 | 20.661 | 21.041 | 2.055 | 25.256 | 33.079 | 49.972 | 53.346 | 59.744 | 57.744 | 49.279 | 55.810 |
| 121 | Imports / Food | % | | 1,4 | 1,9 | 1,8 | 5,6 | 5,1 | 3,6 | 3,9 | 5,7 | 6,4 | 5,4 | 4,7 | 4,7 | 3,8 | |
| 122 | Imports / Fuels | % | | 27,5 | 44,5 | 49,4 | 28,4 | 25,3 | 25,6 | 21,3 | 15,7 | 12,4 | 14,0 | 12,4 | 9,7 | 11,8 | |
| **B.7.6. Prices** | | | | | | | | | | | | | | | | | |
| 123 | Inflation of consumer prices INPC | % | | | 99,69 | 239,02 | 1.585,18 | 475,11 | 1.149,05 | 2.489,11 | 929,32 | 21,98 | 9,12 | 4,34 | 2,49 | 8,43 | 5,27 |

# B. Socioeconomic and Cultural Factors

## B.7. PRODUCTION AND CONSUMPTION OF GOODS

| Cod | | Unity | 1970 | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B.7.7. Integration | | | | | | | | | | | | | | | | | |
| 124 | Commercial balance | Milhões US$ | | 4.922 | 4.829 | 11307 | 10.753 | 10.579 | 15.239 | 13.299 | 10.466 | 3.466 | 5.599 | 6.750 | 6.604 | 1.268 | 724 |
| 125 | Commerce chain | Milhões US$ | | 22.262 | 45.093 | 39.971 | 52.075 | 52.661 | 56.347 | 63.811 | 76.624 | 96.478 | 101.093 | 112.738 | 108.884 | 97.290 | 110.896 |
| 126 | Direct foreign investment | Milhões US$ | | | | | | | | | | | | | | | |
| B.7.8. Foreign debt | | | | | | | | | | | | | | | | | |
| 127 | Groos Foreign debt | Milhões US$ | 5.295,2 | 25.115,6 | 64.244,0 | 105.124,9 | 123.438,5 | 123.910,4 | 135.948,8 | 145.725,9 | 148.295,2 | 159.256,2 | 179.935,0 | 199.998,0 | 241.643,8 | 241.467,8 | 236.151,0 |
| B.7.9. Agriculture productivity / production means | | | | | | | | | | | | | | | | | |
| 128 | Total consumption of fertilizers | t | | | | 1.904.873 | 3.148.290 | 3.204.888 | 3.584.367 | 4.150.259 | 4.732.285 | 4.308.799 | 4.846.438 | 5.490.809 | 5.845.250 | 5.438.888 | 6.567.979 |
| 129 | Total consumption of agro-toxics | t | | | | | | | | | | | | 113.933 | 128.712 | 127.585 | 140.423 |
| 130 | Herd / Bovine | 1000 cattle heads | 78.562 | 102.532 | 118.971 | 128.423 | 147.102 | 152.136 | 154.229 | 155.134 | 158.243 | 161.228 | 158.289 | 161.416 | 163.154 | 164.621 | 169.876 |
| 131 | Herb / Bubalinos | 1000 cattle heads | 109 | 267 | 495 | 882 | 1.397 | 1.432 | 1.423 | 1.499 | 1.571 | 1.642 | 1.046 | 978 | 1.017 | 1.068 | 1.103 |
| 132 | Herb / Equine | 1000 cattle heads | 4.859 | 5.507 | 5.055 | 5.550 | 6.122 | 6.237 | 6.329 | 6.314 | 6.356 | 6.394 | 5.705 | 5.832 | 5.867 | 5.831 | 5.832 |
| 133 | Herd / Asinine | 1000 cattle heads | 1.420 | 1.691 | 1.330 | 1.274 | 1.343 | 1.364 | 1.381 | 1.302 | 1.313 | 1.344 | 1.232 | 1.249 | 1.233 | 1.236 | 1.242 |
| 134 | Herd / Mules | 1000 cattle heads | 1.619 | 1.822 | 1.605 | 1.943 | 2.033 | 2.035 | 2.046 | 1.993 | 1.987 | 1.990 | 1.286 | 1.295 | 1.292 | 1.336 | 1.348 |
| 135 | Herd / Swine | 1000 cattle heads | 31.524 | 37.640 | 34.183 | 32.248 | 33.623 | 34.290 | 34.532 | 34.184 | 35.142 | 36.062 | 29.202 | 29.637 | 30.007 | 30.839 | 31.562 |
| 136 | Herd / Caprine | 1000 cattle heads | 5.709 | 7.101 | 8.326 | 10.020 | 11.895 | 12.172 | 12.160 | 10.618 | 10.879 | 11.272 | 7.436 | 7.968 | 8.164 | 8.623 | 9.347 |
| 137 | Herd / Ovine | 1000 cattle heads | 17.643 | 17.828 | 18.381 | 18.659 | 20.015 | 20.128 | 19.956 | 18.008 | 18.436 | 18.336 | 14.726 | 14.534 | 14.268 | 14.400 | 14.785 |
| 138 | Herd / rabbits | 1000 cattle heads | 330 | 581 | 709 | 644 | 697 | 649 | 593 | 565 | 542 | 500 | 319 | 330 | 345 | 377 | 376 |
| 139 | Herd / Chicken, cocks, and young chicken | 1000 cattle heads | | | | 309.587 | 371.727 | 393.848 | 435.465 | 452.382 | 473.549 | 541.164 | 549.559 | 580.993 | 589.370 | 624.381 | 659.246 |
| 140 | Herd / Chicken | 1000 cattle heads | 213.623 | 311.867 | 447.411 | 160.501 | 174.508 | 200.544 | 204.160 | 201.785 | 207.539 | 188.367 | 178.528 | 179.629 | 175.852 | 180.194 | 183.495 |
| 141 | Herd / Tinamous | 1000 cattle heads | 367 | 467 | 831 | 1.394 | 2.464 | 2.542 | 2.488 | 2.418 | 2.424 | 2.939 | 4.220 | 4.303 | 4.707 | 4.838 | 5.775 |

# annex 2 - main economic and environmental links





It is hard to evaluate the environmental connections to the recent macroeconomic context in Brazil, both in value and in magnitude. However, some conclusions may be drawn.

On the positive side of the issue, public deficit control contributed to fiscal inability to maintain fiscal subsidies and sectorial credits. Among these are the ones that affect the environment. A realistic tariff system related to a rise in water, sanitation and energy costs. On the other hand, the need for inflation control may have set up barriers to the internalisation of environmental costs in other economic sectors.

**Chart 2 - Main Environmental Connections in Economic Policies in Brazil**

| Period and economic policy | Positive Concequences | Drawbacks |
|---|---|---|
| **1990 - june 1994** | | |
| Recession (negative or very low growth).<br>High Public Deficit.<br>High and growing inflation rate.<br>Devalued exchange rate.<br>Financial situation abroad = current account surplus + elevated international reserves | Public deficit triggered fiscal inability to keep fiscal subsidies and creditícios setoriais that affect the environment.<br><br>High tax rates that increase the cost of water and energy services. | Recession hinders capital formation and , thus, the possibility of new technology implementation.<br><br>Inefficiency of price system adopted in the country, which does not differ environmental cost from cost in Brazil. |
| **July 1994 - january 1999** | | |
| Policy for the reduction of monetary expansion<br>Credit restriction due to higher interest rates.<br>Consolidation of commercial opening and further privatization process.<br>Very low and declining inflation.<br>Significantly appreciated exchange rate.<br>Elevated public deficit.<br>Financial situation abroad = low export growth rate + high current account deficit. | Commercial opening and privatization may have generated new investments for capital formation, with the implementation of new technologies. | Changes in consumption standards and level might cause a greater environmental pressure.<br><br>Because inflation control is necessary, environmental cost is not internalized<br><br>High interest rates hinder investments in new technologies. |
| **Since january 1999** | | |
| Growth is almost non-existent.<br>Accelerated exchange depreciation.<br><br>Increased wholesale price index.<br><br>Rate of interest kept high.<br><br>Sharp reduction of public deficit.<br><br>Financial situation abroad = commercial deficit + aggressive export policy needed. | The structural adjustment of the production sector now able to bear a cleaner technological model. | Difficulties in internalizing environmental costs caused by the necessity to increase exports in a short term and privatization in the energy sectors. |

High interest rates have always been an obstacle to investment in new technology. Even so, commercial opening and privatisation, and the resulting structural adjustment of the production sector, may have triggered new investments for capital formation, and brought about new technology with cleaner characteristics.

On the negative side, recessive periods may have acted in the opposite direction, reducing the potential of those triggering factors for capital formation. In addition, future privatisation in the energy sectors, intensive in natural resources and in pollution release, impedes the internalisation of environmental costs in order to avoid losses in sale prices. The growing need for foreign financing has been contributing to a misunderstanding about environmental control costs and the systemic cost of the economy.

Therefore, it is necessary to create market mechanisms that may facilitate the internalisation of those environmental costs in a cost-effective manner. This includes economic instruments for environmental taxation. Chart 1 is a summary of these connections for each period previously analysed.

## ENVIRONMENTAL CONSUMPTION STANDARDS, PRODUCTION, ENERGY AND SOIL USE IN BRAZIL

This section concludes the analyses of sustainability indicators of the Brazilian Economy. In this regard, several studies on environmental economy have been considered, mostly from IPEA, that try to analyse the environmental standards of the Brazilian Economy in relation to:

- family consumption,
- industrial production,
- energy consumption and
- the growth of agriculture and cattle raising in forest soils.

The subjects approached and the matters analysed never exhaust the immense challenge of sustainability. The conclusions of these studies show us that there are living tendencies in the compatibility of consumption activities and production for a sustainability trajectory. In cases where this tendency is not guaranteed nor confirmed, political suggestions are welcome.

The text structure follows a sequence of matters previously discussed. The references of summary texts as well as others of relevant interest are mentioned so that the reader interested in more detailed IPEA studies can obtain more information on the following sight www.ipea.gov.br.

## 1. CONSUMPTION STANDARDS AND URBAN DEGRADATION IN BRAZIL

The pollution problems change according to consumption standards that have occurred rapidly as far as Brazil is concerned. This high acceleration is a result of urbanisation and an extremely unequal income distribution. The degradation can be highly concentrated in high-income pattern consumption groups that present high rates of durable goods, energy and water consumption and production of sewage and waste.

However, income restriction, drastically reduces the capability of the poor to generate a defensive demand against the negative effects of deterioration. This includes medical assistance and better housing conditions. In other words, the poor probably are responsible for a bigger part of environmental costs than their number within the population. In other words, they could be consuming the degradation of the rich population.[1]

[1] See Seroa da Motta and Rezende (1999) and Seroa da Motta and Mendes (1996) for estimates on health costs associated to pollution in Brazil.

Seroa da Motta (2002) deals with this matter by making evaluations on pollution and the use of natural resources associated to consumption patterns related to different classes of income groups. To achieve these conclusions, he based his studies on coefficients of industrial pollution intensity (organic material, inorganic, particle and sulfuric related materials), use of fertilisers in agriculture, vehicle gases in urban transport (CO, HC and $NO_2$), domestic use of water and generation of domestic sewage. These coefficients are applied in domestic use, related to the 1995-1996 period, of ten income class groups varying from the lowest one, from 0 to 2 minimum wages, up to the highest one with domestic income over 30 minimum wages. The results achieved permit us to show the conflict between equity and environmental control and suggest relevant political matters.

Table 1 shows that in 1995 the rate of 10% of the highest income group to the 50% poor homes in Brazil was 2:6. This difference provides us with a clear picture of the dimension of income concentration in Brazil where 10% of the richer homes retain almost three times higher than the poorest 50%.

Seroa da Motta (2002), based on pollution estimate of charge as described in the table for each income class group, also determines the same rate of inequality for each type of pollutant. These results, also shown in the table, tell us the following:

**a)** in the case of pollution produced at the same rate as the population, the degradation concentration rate would be 0:2, so the estimated rates indicating figures much above this rate show a certain difference. As far as pollution is concerned, this rate remains between 1:0 and 2:3. However, the rate is found to be much higher in industrial consumption and transportation, where effect-income and effect-technology are higher than in the use of fertilisers;

**b)** in cases of domestic use of untreated water and production of non-collected sewage, the rate between the rich and the poor is only 0:2 and 0:1, respectively. This is justified by fewer sanitation means in the poorest population levels and because water demand is less flexible in relation to income. This means that, when we deal with pollution directly affecting people, the concentration is less unequal. If we consider that the poor have less income power to defend themselves from disease, this difference becomes even more significant;

**c)** although pollution production is quite concentrated, its concentration estimates are always less than income. The rich are able to save part of their income and are than able to consume a smaller part and acquire lesser polluting goods (for example, cars) and live in more adequate sanitation areas; and

**d)** due to this income concentration and the pollution of the rich, an environmental control policy could also concentrate on the same. Even more so pollution charges could be stipulated, according to the pollutant/consumer payment principle. Although this occurs as the loss of efficiency, considerable control levels could be reached and could even exempt the poorest population and concentrate on the richest.

It is quite difficult to make an analysis of well being through a comparison of negative effects of degradation and positive control for each income group. The previously described study only reveals the significance of the equity matter in environmental control policy. The balance between environmental subjects, economic efficiency and equity remain a crucial challenge, for sustainability.

**Table 1 - INCOME CONCENTRATION AND DEGRADATION BETWEEN THE 10% RICHEST AND THE 50% POOREST HOMES IN BRAZIL**

| Income | Industrial Gases | | | | Agricultura 1 Use | City transport | | | Domestic | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Organic material | Inorganic material | Particles | Sulfurous | Fertilisers | CO | HC | No$^2$ | Water use | Sewage |
| 2,6 | 1,3 | 2,3 | 1,8 | 1,4 | 1,0 | 1,2 | 1,6 | 1,2 | 0,3 | 0,3 |

Source: Seroa da Motta (2002)

## 2 INDUSTRIAL PRODUCTION STANDARDS IN BRAZIL

In this section we primarily analyse the intensity of pollution of the Brazilian industrial product in terms of domestic consumption, investments and export. The following presented studies investigated the determining factors of the environmental management of Brazilian industry.

### 2.1 Pollution Intensity of the Brazilian Industrial Product

The pollution intensity of the industrial product determines its environmental and technological standards. Developing countries tend to be more competitive in areas of smaller technological content. At times, these are even more intensive in pollution. This tendency grows if environmental control is less strict.

Young (2001) presents his appraisal of the environmental profile of the Brazilian industrial section using the remaining emission data (posterior to control) in the São Paulo industry of the Cetesb inventory and the source of intra-sectorial guidelines of IBGE for the year 1996. Sectorial emission intensities were calculated, regarding the organic and non-organic materials of liquid effluents and the particle and sulfuric elements of the atmospheric emissions. These were rates between emission data and the sectorial industrial product of the São Paulo industry.[2] The inter-sectorial source indicates the reasons for economic consumption-input, which allow calculations to be made on the way each sector contributes in the production of another sector. In this way, applications of sectorial intensities allow for estimate of the industrial pollution generated in sectorial generation. This takes into consideration the entire production chain.

**Table 2 - Intensity Estimates of Industrial Pullution in Brazil in 1996**

(In kg/US$ $10^6$)

| Pollutant | Domestic consume | Investment | Exports | Total Product |
|---|---|---|---|---|
| Organic material | 903 | 190 | 744 | 744 |
| Non-organic material | 6,6 | 7,2 | 11,5 | 7,4 |
| Particles | 2.388 | 2.794 | 3.667 | 2.634 |
| $SO_2$ | 934 | 1.151 | 939 | 976 |

Source: Young - 2001

The results of this study reveal that the pollutant and its destination differentiate the intensity of the Brazilian industrial product, as observed in Table 1:[3]

**a)** the intensity of organic load is higher in the industrial product portion consumed domestically and quite low in investments;

**b)** as far as inorganic materials and particles are concerned, a higher intensity is found in exportation, followed by investments and domestic consumption; and

**c)** the intensity of sulfurics is higher in investments and quite close to the domestic consumption and exports in magnitude.

In summation, the Brazilian industry maintains a more intense environmental standard on its exportation products when it deals with non-organic pollutants and particles. Organic material is concentrated on domestic consumption and sulfuric material is concentrated in investments. These results confirm previous studies (consult Seroa da Motta (1994)), which indicated that although Brazilian industrial exports are concentrated in high potential pollutant sections (for example: steel metallurgy, cellulose and paper and chemistry), the exporting sections, on the average, adopt much higher control standards.

[2] The same coefficients used in (2002) described in the previous section.
[3] For a more detailed analysis, with historical scenarios, refer to Young (2001).

This is true specially when dealing with the organic and sulfuric loads, which are the main pollutants, controlled by the environmental monitoring agents. In other words, we can not affirm that the Brazilian industrial product demonstrates a specific environmental standard on pollutants.

On the other hand, the observed tendencies in some means should be recognised. This is specially true in a globalise context where environmental demands could turn out to be an obstacle for the competitiveness of the Brazilian industry. In this regard, we will further analyse how the internal market sees this challenge.

## 2.2. Determining Factors of Environmental Management in the Brazilian Industry

Environmental management has gained a place in Brazilian industry over the last decade. A considerable number of companies, today, have environmental units within their organisations. There is also the constant increase of importance they give to certificates like ISO 14000. The results of research performed by CNI (1998) show that approximately 85% of medium and big enterprises adopt some kind of environmental management.

The process of entrepreneurs concerned with the environment is not unique to Brazil. Rather it is a consequence of several modifications and initiatives created to control pollution. While some international markets discriminate against intensive pollution products and reward the so called "green" products, on the other hand a growing globalisation of the Brazilian economy through new investments, fusion and acquisition processes have introduced a modification of entrepreneurs' mentalities. This is specially for those that are financially dependent on countries with a strict environmental policy. Besides this, the population's conscience regarding environment has suffered changes. Community pressures have grown considerably as a result of consciousness raising processes, environmental education and the establishment of new non-governmental organisations dealing with the environment. The official regulation and introduction of informatics in government regulatory agencies has made the pollution control much easier. This was recently complemented by the introduction of new laws, such as the Law on Environmental Crimes.

In spite of all these institutional, social and economic modifications, the investment in environmental protection may still not represent a significant strategy to most entrepreneurs. Although several steps have been taken to improve the regulatory system, there are remote chances of identifying and applying sanctions of environmental violation. This is true specially in cases of small companies. Due to this, there is a debate on the best policies of environmental management and incentives that could be created by the Government.

In this context, informal regulation has achieved importance, promoting the idea that communities need only the information and the right to bargain so they can convince entrepreneurs to control the emission of pollutants. The defended example is that most environmental urban problems could be solved when information on pollutant and emission magnitudes is spread. If this is the truth, part of the funds invested in formal regulation, control, monitoring and charges could be invested in environmental information spreading mechanism or some other action on a social scale. This turns out to be of extreme importance for the implementation of efficient environmental policies in order to investigating if informal regulating pressure really has some influence on entrepreneurs' decisions.

Several formal and informal studies have tested the relation between the emission levels of industrial plants with environmental control indicators. It has been proven that the formal pressure is as important as the characteristics of the company and possible benefits (or costs) of the market where an environmental result may occur. In South Asian economies it has been verified that social pressure has a direct response on environmental decisions in companies.[4] However, as far as Brazil is concerned, the pressure from society may not occur directly, as the previous studies reveal. This is true specially in São Paulo where there is a telephone service for environmental accusations and an environmental regulating agency that is considered the best in the Latin America.

[4] See Cohen (1998) and Hettige, Huq, Pargal and Wheeler (1996) for an essay on these studies.

Ferraz and Seroa da Motta (2002) have developed a model regarding the previous work in order to identify the environmental management determinates in the São Paulo industry, based on environmental investment data of São Paulo economic activity research (Paep) that included more than 8 thousand industries in 1996. For this study, determinants of formal regulation were measured by the number of applied sanctions on environmental problems of companies using a municipal variable of informal pressure. This variable took the form education, income, voting proportions for parties with an environmental platform and the number of environmental NGOs. This result was then used to identify determinants of environmental investment.

The results obtained were in agreement with the literature. They indicated that bigger plants have a higher possibility of investing in the environment. These plants include the older ones, the ones dealing with export and the foreign capital plants. Likewise, the more polluting areas have a higher probability of investing in environmental causes.

In regard to external factors, the number of received environmental sanctions was highly significant in explaining the behaviour of the company. The informal pressure factors, on the other hand, significantly explain the number of sanctions. This suggests, in the São Paulo case, that local organisation and pressure from the society did not occur in a direct form at the company, but occurred indirectly through public demands and the environmental monitoring agency.

This study is quite different from others found in developing countries, specifically in South Asia, where informal regulation seems to be one of the main direct pressuring factors upon companies. However, it is important to mention that in São Paulo the regulatory agency is considered to be sufficient enough to control industrial pollution, incurring notifications and charges to companies that do not uphold the Law. Therefore, it can not be taken into consideration for the rest of the country.

Seroa da Motta (2002) uses a database from CNI (1998) to analyse the adoption practice for environmental control in 325 large and medium industries in Brazil. The achieved results also confirm that the level, foreign origin and potentiality of pollution increase the probability of the company to adapt environmental control practices. Avoiding local environment agency sanctions and motivations for cost reduction, attending to public claims and environmental criteria of government financing also had a positive effect on a higher number of environmental control practices.

In short, monitoring efforts and social pressure have affected the environmental profile of the Brazilian industry. This effect increases when dealing with larger companies, foreign companies, potential polluters and those dealing with foreign markets. However, government financing system can and is collaborating in the sense to provide a more advanced environmental participation of the national industry. In such a way it is possible to say that economic growth in a globalise process, with an effective civil society participation and adequate economic incentives, can offer a sustainable opportunity of industrial development.

## 3 ENERGY SOURCES IN BRAZIL

The world energy consumption is highly based on fossil fuels, which are responsible for the emission of gases of the greenhouse effect (GEE) which affect the planet climate equilibrium. As energy consumption in developing countries is, in historic and up to date terms, highly inferior compared to other more developed countries, the contribution of the first ones to climate problem is also quite small. As far as Brazil is concerned the GEE intensity is much smaller due to, particularly, high participation of renewable energy in the Brazilian energy grid.

Mendonça and Gutierrez (2000) analysed the evolution of the Brazilian energy source. They came to the following conclusion:

- participation of renewable: the rate between the renewable energetic input and total input; and
- thermal efficiency: rate between the production of electrical energy and primary input for energy production.

Table 3 presents these reasons estimated for Brazil based on a database of grid energy from 1970-1995. The rate of renewable participation has remained high at approximately 60%. For comparison only, this same measure in the United States has remained constantly below 8% in the period 1960-1990. Despite this, in the case of energy efficiency a slight fall of this indicator is found, largely due to the period when energy intensity in Brazil, measured by the rate between the energy consumption and GDP, has exceeded the 0.29kgEP/US$ in 1980 for 0.37 kgEP/US$ in 1995.

**Table 3 - Energy Sources in Brazil**

| | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 |
|---|---|---|---|---|---|---|
| Participation of renewables | 0,63 | 0,55 | 0,56 | 0,61 | 0,60 | 0,61 |
| Thermal efficiency | 1,08 | 1,05 | 1,05 | 1,05 | 1,04 | 1,04 |

Source: Mendonça e Gutierrez (2001)

The industrial section is among the main causes of GEE emissions. A way of treating the matter of carbon emission in industry derives from desegregation of intensity variation of $CO_2$ in this section, the intensity being measured by the rate between the $CO_2$ emissions and the production in this section. The variation of intensity aggregated to $CO_2$ may be decomposed in several components in reference to the changes:

- in energy intensity (rate between the energy consumption and energy production);
- in sectorial composition of the product (participation of sections); and
- in use of energy sources (participation of sources).

Mendonça and Gutierrez (2000) estimated this decomposition for the Brazilian industry for the period 1970-1995, as shown in Table 4.

According to estimates in Table 4 we can observe that the variable determinant of the aggregate intensity of $CO_2$ in the Brazilian industry was the energy consumption growth in the same period, which affected energy intensity. The alteration in sectorial composition of the industrial product and the increasing participation of renewable sources in the energy grid resulted in smaller intensities and, contributed to the reduction of aggregate intensity.

Finally, the Brazilian energy source has grown in intensity of the product, the participation of less intensive energy sectors and, specially, in renewable sources in energy generation, which have permitted a more sustainable trajectory from the energetic and climate point of view. Nevertheless, incentive for energy efficiency and conservation should be considered, in a way that this tendency should not be changed.[5]

**Table 4 - Decomposition of Aggregated Intensity of $CO_2$ in the Brazilian Industry**

| Period | Total | Changes in sectorial participation | Changes in energy sources | Changes in energy intensity |
|---|---|---|---|---|
| 1970 - 1995 | 1,03 | 0,96 | 0,71 | 1,46 |

Source: Mendonça e Gutierrez (2001)

[5] The recent energetic crisis may have accidentally contributed for that matter.

## The Amazon Region

The Amazon Region presents a great diversity of The Amazon Region has a great variety of ecosystems, ranging from dense forests to natural fields, including areas of open forest and savannahs, besides agriculture areas – from a wide scale to a small and itinerant form, livestock and extraction. Overall, the Amazon region is the largest biodiversity reserve in the planet and it holds almost 10% of the available fresh water in the world (Rebouças 1999 *in* MMA 2000c), besides storing valuable sources of natural services and genetic stock which may result in new medicine and food.

Although it is the best-conserved biome in the country, deforestation and burning are constant problems in the Amazon Region. The clearance of forests is a consequence of the agricultural border progress, mainly in the States of Tocantins, Mato Grosso, Pará and Rondônia, and of timber company work. The low cut for agricultural purposes in the Amazon Region increased significantly in the 1980's because of wrongheaded public policies, as tax incentives to programs of forest conversion into agricultural projects. As a result, 11-13% of the vegetable covering was lost, during that decade alone (MMA 2000c).

The growth of the soy culture is worrying, since the legal Amazon region already produces more than 1/5 of the soy cultivated in the country, concentrated in the states of Maranhão, Tocantins, Mato Grosso and Rondônia. The cultivation of soybeans has also been growing in the States of Amazonas, Roraima and Pará, moving upon deforested areas of dense forest (MMA 2000c).

In the 1960's and 1970's, the Development Plans for the Amazon region were aimed at favouring the implantation of great occupation projects that relied on subsidies and tax incentives and facilitated access to the land by great private groups. The agrarian concentration and the conflict in the countryside, the accelerated deforestation, the disorganisation of social and cultural space of local communities, the ecological unbalances caused by hydroelectric power stations, pollution caused by mercury, the growing poverty in cities are some of the consequences of those wrongheaded development policies (MMA 2000c). The extensive livestock and wood extraction also came into the process of occupation of the Amazon region, raising countless environmental problems. The wood extracted from the forest represents the third exports product in the line of "paraenses", with an amount of almost 350 million dollars in 1995, more than twice the value registered in 1991. In the Amazon area, 80% of the wooden national production is extracted in logs, which accounts for 40% of the Brazilian wooden exports. In 1996 the Amazon region exported 71,166 cubic meters of sawn wood, generating exchange value of 447 million dollars (MMA 2000a). The wood activity is an important human factor that may affect the species composition and distribution in the Amazon forest. The complete devastation observed in the States of Rondônia and Pará, specially in the south, is a sign of the need to reorganise soil occupation in the area.

The Brazilian government's goal is to restructure and to create national transport and development axes, whose objectives are to spur national production and to integrate Brazil internally and abroad, extending the borders of development and generating production hubs (Brito 2001). Highways, rivers, railroads, transmission lines and gas pipelines will make way to industry, livestock and trade, which will reach distant places. Those axes will form transport and production paths, linking the Brazilian Amazon region to other South American markets and shortening, therefore, the export road to the American and European markets (Brito 2001). The direct and indirect environmental impacts due to current implantation of those projects in the Amazon region are preoccupying. For instance, constructing asphalt highways will reduce the costs of timber transport and will increase the economical reach of timber exploration. Similarly, the incentives to large-scale agriculture, such as soybeans, will bring modifications to the use of the soil's geography. The soybeans can be planted in forest areas or in areas that are current pastures, moving the livestock to other forest areas (*in* Veríssimo *et al.* 2001).

## The Caatinga

The area of the Caatinga covers an area of approximately 735,000 square kilometres, about 11% of the national territory, including part of the States of Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia and Minas Gerais. This biome is dominated by one of the few types of vegetation whose distribution is totally restricted to Brazil (Ferri 1979). This vegetation is mainly constituted by small woody and herbaceous species, many have thorns, being usually the so-called "caducifolias", and for cactaceas and bromeliaceous. The density, frequency and dominance of the species are determined by the topographical variations, type of soil and rains (Drumond *et al.* 2000).

In general, the biota of the savannah has been described as poor and with few endemic species and therefore, of low priority for conservation. Recent studies show that this analysis is far from being true (*in* Drumond *et al.* 2000). The area possesses a considerable number of endemic elements. Out of the 596 arboreal species registered, 180 are endemic (Drumond *et al.* 2000).

Several new species of animals and endemic plants have been described recently, indicating a very precarious zoological and botanical knowledge.

Approximately 50% of the lands in the Caatinga are of sedimentary origin, rich in underground waters. The rivers, in their majority, are intermittent and the water volume, in general, is limited, being insufficient for irrigation.

An estimated population of more than 25 million inhabitants, with large structural problems regarding sustainability of food production systems is settled on this biome. The constant negative effects of the climate, as the periodic droughts, hinder the maintenance and development of those production systems, leading to deterioration of the soil, depletion of the water, decrease in biodiversity and beginning of desertification (Drumond *et al.* 2000).

The demographic density of the municipalities of the Caatinga is, usually, very low. In the states of Maranhão, Minas Gerais and Piauí it is so low that those areas were called "Demographic Emptiness" in the recent past. In Rio Grande do Norte, Paraíba, Pernambuco, Alagoas and Sergipe the density is higher. The Caatinga holds the poorest population in the Northeast and one of the poorest populations in Brazil. In only three municipalities - the capitals Natal, Fortaleza and Teresina - the average per capita income exceeds a minimum wage, being, in its great majority lower than half a minimum wage (Sampaio & Mazza 2000).

The area has been greatly modified by man's presence. The Northeastern soils are undergoing an intense process of desertification due to the substitution of the natural vegetation with culture, mostly by means of burnings (Garda 1996 *in* Casteleti *et al.* 2000). The deforestation and irrigated cultures are to the salinisation of the soils, one of the most serious threats to the Caatinga. In areas such as the "São Francisco Valley", irrigation without appropriate technique, worsened by the characteristics of plain soils and intense evaporation of the water, provoked by the strong heat, has turned the agriculture in these areas impracticable (www.wwf.org.br). Only the presence of the adapted vegetation of the Caatinga region has been preventing the Brazilian Northeast from turning into an immense desert (Garda 1996 *in* Drumond *et al.* 2000).

In spite of the threats to its integrity, less than 1% of the Caatinga is protected by restricted use conservation units (The Nature Conservancy Association - Caatinga). In the last 15 years of the $20^{th}$ century, approximately 40 thousand square kilometres of the Caatinga region became desert due to man's interference on the environment. Steel industries and brickyards have contributed to that process by cutting down native vegetation for firewood production and vegetable coal (www.wwf.org.br).

There is no concrete data for the vegetation loss rate covering the Caatinga. Maps generated by the Radambrasil Project (IGBE 1993) show that the area covered by agricultural activities in the biome was 201,786 square kilometres, which corresponds to 27.5%. A simulation of the effects of the highways as axes of environmental alteration, considering a width of seven kilometres as impact area due to the highway, resulted in a modified area of 131,044 square kilometres. Combining these estimates, the total area modified by man in that region would be 332.830 square kilometres, in other words, 45,3% of the biome. This value places the Caatinga as one of the most modified environments by man in Brazil, being surpassed only by the Atlantic Forest and the Savannah (Casteleti *et al.* 2000).

## The Cerrado

The Cerrado is the second largest biome of Brazil, occupying about two million square kilometres, almost 25% of the Brazilian territory. It includes a mosaic of vegetation types, including the open formations of Central Brazil (clean field, dirty field, closed field and rocky field) and the characteristic forest formations (path, riverbank forest, Cerrado and mesophyte woods). Considered the richest savannah of the world, it is estimated that more than 40% of the species of woody plants and 50% of the species of existent bees in that biome are endemic (Conservation International do Brazil et al. 1999). The diversity of vertebrates is also considerable, existing 161 species of mammals there, of which 12% are endemic; 837 species of birds, 3% endemic; approximately 120 reptiles, 20% endemic; and 150 amphibians, with 30% endemic. That amounts to 1.268 species of vertebrates, of which 117 are endemic.

The role of the Savannah in the climatic balance is also pointed out. According to Assad & Assad (in MMA 2000a), work conducted in the Ecological Reservation of Águas Emendadas in the Federal District showed that the Savannah strict sense, due to the annual balance between breathing and photosynthesis, absorbs more carbon than it emits. The capacity of carbon storage is two times bigger than in the Amazonian forest.

This biome was also target of an intense and uncontrolled occupation. For being considered for many years less important from the biological point of view, big extensions of the Savannah were target of projects that aimed at the expansion of the agricultural border and the production of grains for exportation, without worrying about the consequent environmental impacts. Many of these projects were introduced through governmental incentives. Among those initiatives two programmes stand out: Polocentro and the Prodecer programmes, both developed by the federal government. Their objectives were to incorporate the Savannah area to the country's production of grains and to increase the competitiveness of the agricultural products in the international market (Pires 1996 in MMA 2000c).

The main environmental damages due to the agricultural model in the savannahs may be related to the following factors: erosion of soils, compromising of water resources due to the uncontrolled irrigation and consequent problems of the unmeasured use of chemical fertilisers and pesticides. The growing dependence of chemical input and of irrigation by agricultural activities constitutes a threat not only to the ecosystem as a whole, but to the own continuity of agriculture, which has been draining the natural resources in which they support themselves.

It is unquestionable that the consolidation of conventional agricultural activities and the expansion of the agricultural border in the area generated the country revenue and income, but they also brought alarming implications for the ecosystems integrity and for the non-existence of renewable natural resources.

The irrigation projects to agricultural enterprises, although little studied, have already shown perceptible impacts. In agreement with study from the WWF (1995 in MMA 2000c), it is estimated that ten million cubic meters of water from rain lack feeding the river springs of the Savannah because they flow over cultivated surfaces.

A preliminary analysis on the integrity of the vegetation covering the Savannah demonstrated that only a third part of the biome is not atrophied. While a radical change is observed in the landscape, it is concluded that about 70% of the Savannah area have not been appropriately studied. Besides, very little is known on the effects of the water courses swerving for irrigation projects and for the use as herbicides and pesticides on the fauna and local flora, especially on the small sized organisms (Conservation International of Brazil et al. 1999). Studies have demonstrated that in 25% of the deforested areas in the savannahs have no economical use and that in 80% of the pastures some degradation level is observed (in MMA 2000c).

## The Atlantic Forest

The Atlantic Forest originally covered more than a million square kilometres distributed along the Brazilian coast with some penetrations into the interior. Well diversified in terms of phyto-physiognomic and floristic, the Atlantic forest included the totality of the Dense Tropical Rain Forest from Rio Grande do Sul to Rio Grande do Norte and the Deciduous and Semi-deciduous Seasonal Forests with varying sizes of incursions into the interior, including part of Minas Gerais and Mato Grosso do Sul (Camera 1991).

The great geographic extension and climate diversity, soils and relief provide the existence of an incomparable biological diversity. Data presented by Myers *et al.* (2000) demonstrate the great wealth of the Atlantic forest, where there are 20.000 species of plants (27% of the total of species of the world), being 8.000 of them endemic. This biome is the world record holder of diversity of woody plants, with 458 species found in a single hectare in the south of Bahia. Diversity and endemic number among vertebrates are also impressive: 251 species of mammals with 160 endemic; 620 species of birds with 73 endemic; 200 reptiles with 60 endemic and 280 amphibians, of which 253 are endemic (Mittermeier *et al.* 1999). According to these numbers, 2.1% of the world's total species from those four groups of vertebrates only exist in the Brazilian Atlantic Forest. And two thirds of the world's primate species are endemic from the Atlantic forest.

In the area included by this biome, one may find 70% of the Brazilian population and the largest cities and the most important industrial poles in Brazil. The diversified economy and the concentrated industrial areas surrounding the great cities and development axes, generate pressures on the biodiversity, as they request natural resources and supply energy for their activities. With a population growth rate of 1.26% a year (taking the period from 1991 to 1996) (MMA 2000e), this pressure won't be easily reduced.

Cattle raising development, along with mining and real estate exploration, added to the lack of specific occupation policies and use of the soil, almost resulted in complete destruction of that biome along all its extension. Recent data from "The SOS Atlantic Forest Foundation" (1998) has estimated that only 8% of the original area of the Atlantic Forest still persists in isolated patches. In some areas of the Brazilian Northeast, less than 1% of the original vegetation covering remain.

The devastation level may be noticed through the high rate of endangered species. In the group of birds, 10% of the species found in the biome belong to some endangered category. As for the mammals, the number of threatened species reaches 15% (Conservation International do Brazil *et al.* 2000). It is not a coincidence that all species of the Brazilian fauna considered extinct (two birds, four butterflies, a dragonfly and a type of *Peripatus*) come from the Atlantic Forest (Mittermeier *et al.* 1999).

Although strongly altered, the Atlantic Forest is still one of the richest environments regarding biodiversity in the world. Compared to the other *hotspots*, it occupies the fourth position in the rank of the wealthiest and most threatened areas, according to the endemic degree of plants and vertebrates, and percentage of remaining primary vegetation in relation to the original area (Mittermeier *et al.* 1999). Its importance regarding world biodiversity and the threat that it represents to the remaining vegetation justifies the adoption of urgent measures for its protection.

## The Swampland

The Pantanal is the largest flooded plain in the world, and covers an extension of 365,000 square kilometres including the belt plateau surrounding the plain. Eighty percent of the area is in the Brazilian territory, and the remaining stretches out into Bolivia and Paraguay. The “Pantaneiro” ecosystem can be divided into ten sub-areas with characteristics that result from a unique interaction of the soil, water and bio-geographic factors (Lourival *et al.* 2000).

The fauna and floristic diversity of the Pantanal is very rich, with at least 3,500 species of plants, 264 of fish, 652 of birds, 102 of mammals, 177 of reptiles and 40 of amphibians (Lourival *et al.* 2000). The fauna is largely derived from the Savannah, with Amazonian influences. One of the most interesting aspects is the high density of various species of the great Brazilian vertebrates, which are not found in any other place of the continent.

The great biodiversity of the Pantanal is associated to the floods that maintain great wet areas for periods that vary from six to 12 months. Many vertebrates invade the plain during the drought in order to explore the food abundance deposited and/or created by floods. Migratory animals arrive at the Pantanal during the time of floods searching for reproduction and shelter. The flood cycle determines the availability of dry and flooded areas that, on the other hand, influence the seasonal distribution of several species. With the rise and fall of water level dynamics, generalist species are favoured to the detriment of those very specialised ones. This may explain the low number of endemic groups and indicate the possible existence of a great endemic amount associated to the only stable habitat in the plain: the water (Brown 1984 *in* Lourival *et al.* 2000).

The area takes approximately 1,500 millimetres of rain a year. This provokes the high sedimentation of the Pantanal. The average annual rain in the flood plain is usually between 1.000 to 1.400 millimetres. More than in the plateau, the rain in the plain varies during the year, causing a regular cycle of droughts and floods, which makes the Pantanal a unique ecosystem (Lourival *et al.* 2000).
The annual floods allow some habitats to be mixed regularly, while certain microhabitats remain isolated for as long as 50 or 100 years and they develop distinct characteristics until a great flood links them to the remaining system. In the last decades the deforestation in the headwaters has been causing a significant increase in sedimentation, which resulted in decrease of soil productivity and pasture, and in the increase of the frequency and level of floods (Lourival *et al.* 2000).

Until 1993, only 2% of the State of Mato Grosso do Sul was devoted to agriculture. This production is concentrated in the plateau area, however, some rice (5.841ha) is planted in the Pantanal. The soybean production has been growing at a constant rate (374.164ha), and coffee, hearts of palm and “pequi”, among other products, are also cultivated. By far, the most expressive economic activity in the area is cattle raising, present in this area for centuries. The low part of Mato Grosso do Sul holds approximately 9.8 million head of cattle (1993 data) (Lourival *et al.* 2000).

The fragile balance of “Pantaneiro” ecosystems, defined by periodic flood dynamics, is being threatened by the new economic development tendencies. The traditional models of fishing and livestock are being rapidly replaced by the intensive exploration, accompanied of deforestation and alteration of natural areas (Conservation International do Brazil *et al.* 1999). At the same time, very little is officially protected, mainly along the central humid plains. More recently, the Pantanal has also been facing serious problems, mainly due to great settling projects, such as hydraulic installations, new highways (MMA 2000e), or large-scale projects for soybean production.

ANNEX - Species in Brazil which have Commitees or official Task Forces, Government programs and conservation in situ or inter - institutional management plans and conservations in zoos and nurseries. Isolated non-governamental actions, research projects from scientific institutions, and management projects with commercial purposes are not included (sources: IBAMA, The Brazilian Zoo Society, The World Resource Institute).

| Name | Scientific name | Committee or work group | In situ conservation programme | Ex-situ management programme |
|---|---|---|---|---|
| Reptiles | | | | |
| Broad-Snouted Caiman | Caiman latirostris | | | X |
| Loggerhead Sea Turtle | Caretta caretta | | X | |
| Leatherback Sea Turtle | Dermochelys coriacea | | X | |
| Hawksbill Sea Turtle | Eretmochelys imbricata | | X | |
| South American River Turtle | Podocnemis expansa | | X | X |
| Olive Ridley Sea Turtle | Lepidochelys olivacea | | X | |
| Green Sea Turtle | Chelonia mydas | | X | |
| Tracaja | Podocnemis unifilis | | X | |
| Birds | | | | |
| Hyacinth Macaw | Anadorhyncus hyacinthinus | | | X |
| Lear´s Macaw | Anadorhyncus leari | X | X | X |
| Golden Parakeet | Aratinga guarouba | | | X |
| Spix´s Macaw | Cyanopsitta spixii | X | | X |
| Eared Dove | Zenaida auriculata | X | X | |
| Harpy Eagle | Harpia harpyia | | | X |
| Razor-Belled Curassow | Mitu mitu mitu | | X | X |
| Red Browed Parrot | Amazona rodochoryta | | | X |
| Red-Spectacled Parrot | Amazona pretrei | | X | |
| Red-Tailed Parrot | Amazona brasiliensis | | X | X |
| Blue-Throated Parakeet | Pyrrhura cruentata | | | X |
| Mammals | | | | |
| Giant Otter | Pteronura brasiliensis | X | | X |
| Blue whale | Balaenoptera musculus | X | | |
| Arnnoux's Beaked Whale | Berardius arnuxii | X | | |
| Blainville's Beaked Whale | Mesoplodon densirostris | X | | |
| Cuvier's Beaked Whale | Ziphius cavirostris | X | | |
| Gray's Beaked Whale | Mesoplodon grayi | X | | |
| Hector's Beaked Whale | Mesoplodon hectori | X | | |

| Name | Scientific name | Committee or work group | In situ conservation programme | Ex-situ management programme |
|---|---|---|---|---|
| Finback Whale | Balaenoptera physalus | X | | |
| Right Whale | Eubalaena australis | X | | |
| Humpback Whale | Megaptera novaeangliae | X | X | |
| Minke Whale | Balaenoptera acutorostrata | X | | |
| Short-finned Pilot Whale | Globicephala macrorhyncus | X | | |
| Long-finned Pilot Whale | Globicephala melas | X | | |
| Tucuxi | Sotalia fluviatilis | X | | |
| Pink River dolphin/Boto, South American River Dolphin | Inia geoffrensis | X | | |
| Burmeister's Porpoise | Phocoena spinipinnis | X | | |
| Southern Bottlenose Whale | Hyperoodon planifrons | X | | |
| Sperm Whale | Physeter macrocephalus | X | | |
| Dwarf Sperm Whale | Kogia simus | X | | |
| Pigmy Sperm Whale | Kogia breviceps | X | | |
| Crab-eating fox/common zorro | Cerdocyon thous | X | | X |
| Small-eared Dog | Atelocynus microtis | X | | |
| Bush dog | Speothos venaticus | X | | X |
| Marsh Deer | Blastoceros dichotomus | | | X |
| Southern Elephant Seal | Mirounga leonina | X | | |
| Bryde's Whale | Balaenoptera edeni | X | | |
| Sei Whale | Balaenoptera borealis | X | | |
| False Killer Whale | Pseudorca crassidens | X | | |
| Crabeater Seal | Lobodon carcinophagus | X | | |
| Leopard seal | Hydrurga leptonyx | X | | |
| Brazilian ocelot cat | Leopardus trigrinus | X | | X |
| Geoffroy's cat | Oncifelis geoffroyi | X | | |
| Margay | Leopardus wiedii | X | | |
| Jaguarundi | Herpailurus yaguarondi | X | | |
| Pampas cat | Oncifelis colocolo | X | | |
| Fraser's dolphin | Lagenodelphis hosei | X | | |

| Name | Scientific name | Committee or work group | In situ conservation programme | Ex-situ management programme |
|---|---|---|---|---|
| Melon-headed Whale | Peponocephala electra | X | | |
| Clymene dolphin | Stenella clymene | X | | |
| Common dolphin | Delphinus delphis | X | | |
| Rough-toothed dolphin | Steno bredanensis | X | | |
| Spectacled porpoise | Australophocaena dioptrica | X | | |
| Southern Rightwhale dolphin | Lissodelphis peronii | X | | |
| Risso's dolphin | Grampus griseus | X | | |
| Striped dolphin | Stenella coeruleoalba | X | | |
| Bottlenosed dolphin | Tursiops truncatus | X | | |
| Atlantic spotted dolphin | Stenella frontalis | X | | |
| Pantropical spotted dolphin | Stenella attenuata | X | | |
| Spinner dolphin | Stenella longirostris | X | X | |
| Ocelot | Leopardus pardalis | X | | X |
| Marine Lion | Otaria flacescens | X | X | |
| Maned wolf | Chrysocyon brachyurus | X | | X |
| Antartic Fur Seal | Arctocephalus gazella | X | | |
| Southern Fur Seal | Arctocephalus australis | X | X | |
| Subantartic Fur Seal | Arctocephalus tropicalis | X | X | |
| Neotropical Otter | Lutra longicaudis | X | X | |
| Spider Monkey | Ateles spp. | | | X |
| Buff-headed tufted capuchin | Cebus xanthosternos | X | | X |
| Goeldi's Monkey | Callimico goeldii | | | X |
| Golden-headed Lion Tamarin | Leontopithecus chrysomelas | X | | X |
| Black-headed Lion Tamarin | Leotopithecus caissara | X | X | X |
| Golden Lion Tamarin | Leontopithecus rosalia | X | X | X |
| Black Lion Tamarin | Leotopithecus chrysopygus | X | X | X |
| Puma/Mountain Lion | Puma concolor | | X | X |
| Jaguar | Panthera onca | | X | X |
| Killer Whale | Orcinus orca | X | | |
| Pygmy Killer Whale | Feresa attenuata | X | | |
| Amazonian Manatee | Trichechus inunguis | X | | |

| Name | Scientific name | Committee or work group | In situ conservation programme | Ex-situ management programme |
|---|---|---|---|---|
| Wet Indian Manatee | Trichechus manatus | X | X | |
| Hoary Fox/Small Toothed Dog | Lycalopex vetulus | X | | |
| Geoffroy's Marmoset | Callithrix geoffroyi | | | X |
| Pied Tamarin | Saguinus bicolor | X | | |
| Giant Anteater | Myrmecophaga tridactyla | | | X |
| Collared Anteater/Southern Tamandua | Tamandua tetradactyla | | | X |
| Franciscana/La Plata River dolphin | Pontoporia blainvillei | X | | |
| | TOTAL | 69 | 24 | 30 |

Source: IBAMA / Sociedade Brasileira de Zoológicos / World Resources Institute

| COMPILATION OF BRAZILIAN LEGISLATION ON THEMES DEALT WITH BY GEOBRASIL | | |
|---|---|---|
| Constitution of the Federative Republic of Brazil | 1988 | Title VIII - Of the Social Order — Chapter VI - Of the Environment |
| **1. URBAN AND INDUSTRIAL AREAS** | | |
| LAW 10.257 | 07/10/2001 | Approves the City By Law which has been regulating articles 182 and 183 of the 1988 Federal Constitution |
| LAW 7.797 | 07/10/1989 | Creates the National Environmental Fund |
| COMPLEMENTARY LAW 14 | 06/08/1973 | Establishes the Metropolitan Regions of São Paulo, Belo Horizonte, Porto Alegre, Recife, Salvador, Curitiba, Belém and Fortaleza |
| COMPLEMENTARY LAW 20 | 07/10/1974 | Establishes the Metropolitan Region of Rio de Janeiro |
| **2. ATMOSPHERE** | | |
| LAW 8.723 | 10/29/1993 | Reinforces the legal base of Resolution 18 of CONAMA |
| DECREE 79.134 | 01/17/1977 | Rules over diesel oil engine regulation and provides for further actions |
| DECREE 99.280 | 06/06/1990 | Promulgation of the Vienna Convention for the Protection of the Ozone Layer and of the Montreal Protocol on Substances that Destroy the Ozone Layer |
| DECREE 2.783 | 09/17/1998 | Rules over the prohibition of acquisition of products or equipment which contain or make use of substances that destroy the ozone layer - SDO, by agencies and organisations of the direct Federal Public Administration or by Autarchies and Foundations, and provides for further actions. |
| CQNUMC (RATIFICATION) COMMUNIQUÉE 07 MICT | 02/28/1994 | United Nations Framework Convention on Climate Change. Deals with the negotiation of climatic regime. |
| RESOLUTION 507 CONTRAN | 1976 | Establishes the control of gases and car emissions |
| RESOLUTION 510 CONTRAN | 1977 | Defines parameters for the control of Diesel vehicles smoke emission |
| RESOLUTION 18 | 06/06/1986 | Creates the PROCONVE – Motor Vehicle Emissions Control Programme |
| RESOLUTION 03 CONAMA | 06/15/1989 | Rules over motor vehicles pollutant emission |
| RESOLUTION 04 CONAMA | 06/15/1989 | Rules over motor vehicles pollutant emission |
| RESOLUTION 05 CONAMA | 06/15/1989 | Establishes the National Programme for Air Quality Control |

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| RESOLUTION 08 CONAMA | 12/06/1990 | Establishes maximum emission limits of air pollutants originating from fixed sources |
| RESOLUTION 06 CONAMA | 08/31/1993 | Rules over motor vehicle pollutant emissions |
| RESOLUTION 07 CONAMA | 08/31/1993 | Defines basic guidelines and emission standards for the establishment of Programmes of Inspection and Maintenance for Motor Vehicles in Operation - I/M |
| RESOLUTION 08 CONAMA | 08/31/1993 | To complement CONAMA's Resolution No. 18 of 6 May 1968 establishes maximum pollutant emission limits for engines for the use of national and imported new heavy vehicles |
| RESOLUTION 09 CONAMA | 05/04/1994 | Rules over alcohol motor vehicle pollutant emission |
| RESOLUTION 13 CONAMA | 10/09/1995 | Creates 10 (ten) Permanent Technical Chambers to assist CONAMA's Assembly in matters under their responsibility |
| RESOLUTION 14 CONAMA | 12/13/1995 | Rules over the quality control programme with the aim to guarantee motor vehicle pollutant emission limits |
| RESOLUTION 15 CONAMA | 09/29/1994 | Rules over the development of the Inspection and Maintenance of Operating Motor Vehicles Programme |
| RESOLUTION 15 CONAMA | 12/13/1994 | Establishes particles and evaporating material (new motor vehicles classification method) for the control of vehicle gas emissions with effect from 1st January 1996 |
| RESOLUTION 16 CONAMA | 12/17/1993 | Ratifies emission limits, deadlines and other requirements contained in CONAMA's Resolution no. 18/86, which establishes the Air Pollution by Motor Vehicle Control Programme |
| RESOLUTION 16 CONAMA | 12/13/1995 | Rules over the motor vehicle pollutants emission |
| RESOLUTION 27 CONAMA | 12/07/1994 | Rules over the control of motor vehicle pollutants emission |
| RESOLUTION 226 CONAMA | 08/20/1997 | Rules over the control of motor vehicle pollutants emission |
| RESOLUTION 227 CONAMA | 08/20/1997 | Rules over the control of motor vehicle pollutants emission |
| RESOLUTION 229 CONAMA | 08/20/1997 | Postpones the deadline with effect from which the use of Controlled Substances as solvent is prohibited |
| ESOLUTION 230 CONAMA | 08/22/1997 | Prohibits the use of equipment which reduces the effectiveness of noise and pollutants emission control. |
| RESOLUTION 241 CONAMA | 08/05/1998 | Establishes maximum pollutant emission limits |
| RESOLUTION 242 CONAMA | 08/05/1998 | Establishes maximum pollutant emission limits |
| RESOLUTION 251 CONAMA | 01/07/1999 | Establishes criteria, procedures and maximum limits of capacity from exhaust emission for evaluation of the maintenance condition of Diesel motor vehicles.. |

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| RESOLUTION 252 CONAMA | 01/11/1999 | Establishes exhaustion pipe maximum noise limits for road motor vehicles, national or imported, including modified vehicles or those with increased engine capacity or additional items, intended for mandatory inspection and supervision of vehicles in use. |
| RESOLUTION 256 CONAMA | 07/27/1999 | Establishes rules and mechanisms for vehicles inspection related to pollutant and noise emissions, regulating Article 104 of the National Traffic Code |
| RESOLUTION 267 CONAMA | 09/14/2000 | Prohibition of substances which destroy the ozone layer |
| RESOLUTION 01 CNP | 1989 | |
| RESOLUTION 03 | 1990 | Replaces Act 0231 |
| RESOLUTION 01 CONMETRO | 1987 | |
| RESOLUTION 04 CONMETRO | 1996 | |
| RESOLUTION 510 CONTRAN | | |
| REGULATORY GUIDELINE 01 MINTER SACT/CPAR | 1981 | |
| REGULATORY GUIDELINE 01 IBAMA / DIRCOF | 1997 | |
| MINISTRY OF THE INTERIOR ACT NO. 231. | 04/27/1976 | Maximum allowed concentrations have been established for certain pollutants in order to preserve human heath. |
| ACT 197 ANP | 1999 | |
| ACT 204 ANP | 2000 | |
| ACT 18 DNC | 1995 | |
| ACT 23 DNC | 1991 | |
| ACT 23 DNC | 1992 | |
| ACT 23 DNC | 1994 | |
| ACT 42 DNC | 1994 | |
| ACT 116 IBAMA | 1996 | |
| ACT 167 IBAMA | 12/26/1997 | Rules over motor vehicles production and trade |
| ACT 1937 IBAMA | 1990 | |
| ACT 29 IBAMA | 1995 | |
| ACT 29 IBAMA | 1999 | |
| ACT 85 IBAMA | 1996 | |

| 3. BIODIVERSITY | | |
|---|---|---|
| LAW 5.197 | 01/03/1967 | Hunting Code. No species will be allowed into the country without a favourable technical evaluation and license issued according to the Law. |
| LAW 6.902 | 04/28/1981 | Creation of Ecological Stations, Environmental Protection Areas. Article 1, Article 8, Article 9. |
| LAW 6.938 | 07/18/1989 | Alters Law no. 6.938, of 31st August 1981, which rules over the Environmental National Policy, its formulation and application Mechanisms and purposes, Law no. 7.735, of 22nd February 1989, Law no. 6.803, of 2nd June 1980, and provides further actions. |
| LAW 8.974 | 01/05/1995 | Bio-security Law. Establishes directives for the control of modern Biotechnology originated activities and products and creates the National and Technical Bio-security Commission – CTNBio, with the aim to formulate a bio-security national Policy and establish rules and regulations related to Activities which encompass genetically modified organisms (GMOs) |
| LAW 9.605 | 02/13/1998 | Environmental Crimes Law. Introduced well-defined sanctions And penalties into the Brazilian legal ordinances in a clear and And objective fashion. |
| LAW 9.985 | 07/18/2000 | Establishes the Nature Conservation Units National System. Organises and updates criteria for the creation and Management of Nature Conservation Units by establishing The means and by creating stimulus for an effective Participation by society. |
| DECREE 98.897 | 01/30/1990 | Rules over Extractive Reserves and provides further actions. |
| DECREE 99.274 | 06/06/1990 | Regulates Law no. 6.902, of 27/04/81 and Law no. 6.938, of 31/08/81, respectively dealing wit the creation of Ecological Stations and Environmental Protection Areas and with the Environmental National Policy. Article 1, Heading II, Chapter II - Article 28, Article 29. |
| DECREE 2,519 | 03/16/1998 | Promulgates the Convention on Biological Diversity. The Union commits themselves to avoid the introduction, Control or eradication of exotic species threatening the ecosystems, habitats and/or other species. |
| DECREE 3.179 | 09/21/1999 | Regulates the Environmental Crimes Law – Law 9.605. |
| DECREE | 09/28/2001 | Regulates the provisional measure 2186-16 and regulates Access to the availability of genetic resources for scientific research. However, no regulation covers the commercial access to genetic resources. This is the responsibility of the Genetic Asset Management Council, created by the Government together with the Ministry of the Environment and other government agencies through Act 69, on 21/02/2002. |

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| PROVISIONAL MEASURE 2186 | 08/23/2001 | Blocked the access to any form of genetic resource with origin in the Brazilian fauna or flora. |
| REGULATORY GUIDELINE 38 | 10/14/1999 | Agriculture and Livestock Defence Secretariat. Prepares list of quarantined plagues for Brazil and rules over maximum alert against the high potential risk ones. |
| REGULATORY GUIDELINE IBAMA (01 | 04/15/1999 | Establishes criteria for Environmental Licensing related to Handling activities. It also defines maintenance and breeding of exotic animals as high risk environmental activity. |
| REGULATORY GUIDELINE 02 IBAMA | 03/02/2001 | Determines the individual identification of species of native and exotic wild fauna held in captivity with the aim to control commercialisation, destination and escape. |
| RESOLUTION 11 CONAMA | 12/03/1987 | The following categories of ecological sites of cultural relevance created by an Public Power Act are considered Conservation units: Ecological Stations, Ecological Reservations, Environmental Protection Areas, especially wild life zones and ecological corridors, National, State and Municipal Parks, Biological Reservations, Natural Monuments, Botanical and Zoological Gardens, Forest Gardens. |
| RESOLUTION 10 CONAMA | 12/14/1988 | Environmental Protection Areas (APA): Are conservation units designed to protect and preserve the environmental Quality and the existing natural systems aiming at a better Quality of life for the local population and the protection of Regional ecosystems. The "APAs" always define an Ecological-economic zoning which establishes rules of usage according to biotic, geological, urban, pasture-agricultural, Extraction and cultivation conditions among others. |
| RESOLUTION 237 CONAMA | 12/19/1997 | Regulates the environmental licensing and defines co-related activities |
| ACT 324 PIBAMA | 07/22/1987 | Prohibits the introduction of swamp-alligators breeding in areas outside the Paraguai River Basin which is a natural Habitat for the species. |
| ACT 93 IBAMA | 07/07/1998 | Regulates the import and commercialisation of wild fauna and their by- products. |
| ACT 102 N IBAMA | 07/15/1998 | Rules over wild exotic fauna cultivators. |

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| **4. ENVIRONMENTAL DISASTERS** | | |
| DECREE 895 | 08/16/1993 | Rules over the organisation of the National Civil Defence System - SINDEC, and provides for further actions. |
| RESOLUTION 02 CONDEC | 1994 | |
| RESOLUTION 03 CONDEC | 1999 | |
| **5. FOREST** | | |
| LAW 4.771 | 09/15/1965 | Establishes a Forest Code. In case of reforestation, priority should be given to projects using native species . |
| DECREE 84.017 | 09/21/1979 | Approves the National Parks regulation. Determines removal of exotic species living in National parks. |
| | | |
| DECREE 3.420 | 04/20/2000 | Creates the Forests National Program. Its mission is to promote the sustainable forest development thus conciliating exploration and ecosystems protection. It also makes the policy compatible with the remaining government public policies. |
| PROVISIONAL MEASURE | 07/1996 | Alters and adds articles to Law 4.771 with the aim to increase the protection of forests located in rural properties in the Legal Amazon. |
| **5. HUNTING** | | |
| LAW DECREE 221 | 02/28/1967 | Hunting Code. Prohibits the import or export of any aquatic species at any evolution stage, as well as the introduction of native or exotic species in the interior waters without the authorisation by the competent authority. |
| DECREE 2.869 | 12/09/1998 | Regulates granting of public waters for aquaculture exploration. In fresh water aquaculture exploitation, permission will only be Granted to the use of local native species from the basin where the enterprise is located. The use of exotic species already established in the aquatic environment will also be permitted. |
| ACT 142 IBANA | 12/22/1994 | Prohibits the commercialisation of living forms, the introduction and breeding of the African-catfish, the canal catfish or catfish located in the Amazon and Paraguai River basins. |
| ACT 145 IBAMA purposes. | 10/29/1998 | Rules applied to the introduction, re-introduction and transfer of fish, crustaceans, molluscs and aquatic macrophytos for aqua culture |

| 6. WATER RESOURCES | | |
|---|---|---|
| LAW 7.661 | 05/18/1988 | Establishes the National Coastal Management Plan, Art. 3, Art 9. |
| LAW 9.427 | 12/26/1996 | Creates the National Hydroelectric Power Agency – ANEEL (*Agência Nacional de Energia Elétrica*).. |
| LAW 9.433 | 01/08/1997 | Establishes the Water Resources National Policy and creates the National Water Resources Management System. |
| LAW 9.649 | 05/27/1998 | Rules over the organisation of the Presidency of the Republic and the Ministries, and provides for further actions. |
| LAW 9.966 | 04/28/2000 | Rules over the prevention, control and supervision of pollution caused by oil spilling and other hazardous or dangerous substances in waters under national jurisdiction. Article 1, Article 3, Article 4. |
| LAW 9.984 | 07/17/2000 | Creates the Waters National Agency ANA(Agência Nacional de Águas). |
| BILL 4.417 | 2001 | Establishes national directives for basic sanitation and provides for further actions |
| DECREE 24.643 | 07/10/1934 | Waters Code. Tackles "water" subjects under the most diversified aspects: a permanent reference source. |
| DECREE 24.643 | 06/29/1961 | Rules over the toxic and oil residues spilling on inland waters or shore waters in the country. Art. 1, Art, 2, Art, 4. |
| DECREE 99.556 | 10/01/1990 | Establishes the National Program for Natural Underground Cavities Protection |
| DECREE 2.612 | 06/03/1998 | Regulates the Waters Resource National Council – (CNRH – (*Conselho Nacional de Recursos Hídricos*) |
| RESOLUTION 20 CONAMA | 06/18/1986 | Classifies fresh, briny and salty waters in nine classes according to their prevalent use and fixes limits and/or further conditions as to their quality level. |
| RESOLUTION 05 CONAMA | 12/03/1997 | Inter-ministerial Commission for Sea Resources. Approves the National Plan for Coastal Management II (II PNGC). |
| RESOLUTION 03 CNRH | 06/10/1999 | Creates the Work Group for elaboration of proposals for the Creation of Provisional and Permanent Technical Chambers. |

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| RESOLUTION 04 CNRH | 06/10/1999 | Creates the Water Resources National Plan Technical Chambers and the Legal and Institutional Matters Technical Chamber. |
| RESOLUTION 05 CNRH | 04/10/2000 | Rules over the criteria for the creation, organisation and operation of Hydrographic Basins Committees. |
| RESOLUTION 07 CNRH | 06/21/2000 | Establishes the Procedures Integration for Permanent Technical Chamber, Granting and Regulatory Actions |
| RESOLUTION 08 CNRH | 06/21/2000 | Establishes the Analysis and Projects for Permanent Technical Chamber |
| RESOLUTION 09 CNRH | 06/21/2000 | Establishes the Underground Waters Permanent Technical Chamber |
| RESOLUTION 10 CNRH | 06/21/2000 | Creates the Border Crossing Water Resources Management Permanent Technical Chamber |
| RESOLUTION 11 CNRH | 06/21/2000 | Establishes the Science and Technology Permanent Technical Chamber |
| RESOLUTION 12 CNRH | 07/19/2000 | Rules over the fitting of water bodies into classes according to their prevalent use |
| RESOLUTION 13 CNRH | 09/25/2000 | Establishes directives for the implementation of the Water Resources National Information System |
| RESOLUTION 14 CNRH | 10/20/2000 | Establishes directives for the process of nomination of representatives to the Water Resources State, Users and Civil Organisation Councils |
| RESOLUTION 15 CNRH | 01/11/2001 | Establishes directives for the Integrated Management of Underground Waters discipline |
| RESOLUTION 16 CNRH | 05/08/2001 | Establishes the concept for granting right of use of Water Resources. It also establishes the general directives and procedures to be followed when requests for the use of Water Resources or granting analysis occur |
| RESOLUTION 17 CNRH | 05/29/2001 | Establishes complementary directives for the elaboration of the Hydrographic Basins Water Resources Plans |
| RESOLUTION 18 CNRH | 12/20/2001 | Establishes the possibility of extension of ruling authority of the Hydrographic Basins Committees Provisional Directorate |
| RESOLUTION 19 CNRH | 03/14/2002 | Approves the cost value related to the use of the Paraíba do Sul Hydrographic Basin water resources |
| RESOLUTION 20 CNRH | 03/14/2002 | Establishes the composition of the Permanent Technical Chambers whose ruling authority shall expire on July 2002 |
| RESOLUTION 21 CNRH | 03/14/2002 | Establishes the Permanent Bill Technical Commission for the use of Water Resources |
| RESOLUTION 213 ANVISA / RDC | 11/13/2001 | Technical Regulation of Sanitary Inspection of Ports and Ships |
| ACT 407 MMA | 11/23/1999 | Approves the National Water Resources Council Internal Regime |
| ACT 307 | 12/13/2000 | Nominates the permanent and deputy members of the National Water Resources Council. |

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| **7. HEALTH AND ENVIRONMENT** | | |
| REGULATORY ACT 113 IBAMA | 09/25/1997 | Requires the registration of individuals or companies involved in activities related to aquaculture, animal trading, breeders of native and exotic wild animal species, import and export of wild, zoological or circus animals among others |
| ACT 922 | 06/21/2001 | Approves the Ministry of Health technical group which forms the "Project Group for Health and Environment International Matters" |
| ACT 2.253 GM | 12/11/2001 | Establishes the Ministry of Health Permanent Environmental Health Commission |
| PUBLIC CONSULTATION 48 | 07/04/2000 | Promoted by ANVISA – National Agency for Sanitary Surveillance – with the aim to establish technical regulation over general directives for procedures related to handling residues produced by health services. |
| **8. SOIL** | | |
| LAW 7.802 | 07/11/1989 | Rules over research, experimentation, production, packing and Labelling, transport, stocking, commercialisation, commercial advertising, utilisation, import, export, final destination of residues and packing, registration, classification, control, inspection and supervision of toxic materials and their components and by-products, and provides for further action. |
| LAW 7.805 | 07/18/1989 | Abolishes the Mineral Extraction Registration regime and establishes the legal figure of the Mining Grant. |
| LAW 7.876 | 11/13/1989 | Establishes the "Soil Conservation National Day" |
| LAW 8.717 | 01/17/1991 | Rules over the Agricultural Policy |
| LAW 10.228 | 05/29/2001 | Adds disposition referring to desertification processes to the Law of Agricultural Policy |
| LAW 10.267 | 08/28/2001 | Establishes the exchange of information between INCRA and the services responsible for property registration and creates the Rural Information National Record – CNIR (*Cadastro Nacional* de Informações Rurais). |
| DECREE 98.812 | 01/09/1990 | Regulates Law 7.805, of 1989 |
| DECREE 4.074 | 01/08/2002 | Regulates Law 7.802, of 11/07/1989 and deals with the "life cycle" of toxic materials. |
| PROVISIONAL MEASURE 1956 | 12/14/2000 | Alters articles 1, 4, 14, 16, and 44, and adds provisions to Law 4.771, of 15th September 1965, which establishes the Forest Code. It also alters article 10 of Law 9.393, of 19th December 1996, which rules over taxation on rural territorial property – ITR, and provides for further actions. |
| PROVISIONAL | 08/24/2001 | Alters articles 1, 4, 14, 16, and 44, and adds provisions to Law 4.771, of 15th September 1965, which creates the Forest Code. It also alters Art. 10 of Law 9.393, of 19 December 1996, which rules over taxation over rural territorial property – ITR, and provides for further actions. |

| 9. UNDERGROUND | | |
|---|---|---|
| LAW 7.347 | 07/24/1985 | Disciplines the Public Civil Action of Responsibility for damages caused to the environment, to the consumer, to goods and artistic, aesthetic, historic, tourist and scenic (vetoed) value rights, and provides further actions. |
| LAW 7.809 | 07/20/1989 | Rules over the revision of basic remuneration of members of the Union's Public Ministry (Civil Servants) and provides further actions. |
| LAW 9.314 | 11/14/1996 | Alters provisions to LAW DECREE 227, of 28th February 1967, and provides further actions. |
| LAW 9.795 | 04/27/1999 | Rules over the environmental education, establishes the National Environmental Education Policy and dictates further actions. |
| LAW 9.827 | 08/27/1999 | Adds a single paragraph to Article 2 of LAW DECREE 227, of 28th February 1967, using the exact words contained in LAW 9.314, of 14th November 1996. |
| LAW 11.520 | 2000 | |
| LAW DECREE 4.146 | 03/04/1942 | Rules over the protection of fossilised material deposits |
| LAW DECREE 227 | 02/28/1967 | Provides new wording to LAW DECREE 1.985 (Mining Code), of January 29, 1940. |
| DECREE LAW 72.312 | 05/31/1973 | Promulgates the convention on measures to be adopted in order to prohibit and stop import, export and transfer of illegal cultural properties. |
| DECREE 97.632 | 04/10/1989 | Rules over the regulation of Article 2, Incised VIII, of LAW 6.938, of 31st August 1981, and dictates further actions. |
| DECREE 3.179 | 09/21/1999 | Rules over the specification of sanctions applicable to behaviour and activities damaging to the environment, and dictates further actions. |
| RESOLUTION 265 CONAMA | 01/27/2000 | Oil spilling on the Guanabara Bay and Petrol Industry |
| RESOLUTION 273 CONAMA | 11/29/2000 | Rules over the prevention and pollution control in gas and service stations |
| RESOLUTION 01 CONAMA | 01/23/1986 | Establishes the necessity to study the environmental impact and respective environmental impact report – EIA/RIMA |

**COMPILATION OF STATE LEGISLATION ON WATER RESOURCES**

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| **1. ALAGOAS** | | |
| LAW 5.965 | 11/10/1997 | Establishes the Water Resources State Policy and the Water Resources Integrated Management State System |
| LAW 6.126 | 12/16/1999 | Establishes the Water Resources State Secretariat |
| LAW 6.145 | 01/13/2000 | Reforms and re-organises the State of Alagoas Executive Power |
| DECREE 37.784 | 10/22/1998 | Regulates the Water Resources State Council |
| DECREE 006 | 01/23/2001 | Grants water resources right of use |
| **2. BAHIA** | | |
| LAW 6.812 | 01/18/1995 | Establishes the Superintendence of Water Resources, an autarchy attached to the Water Resources, Sanitation and Habitation Secretariat |
| LAW 6.855 | 05/12/1995 | Establishes the Water Resources Policy, Management and State Plan |
| LAW 7.354 | 09/14/1998 | Regulates the Water Resources State Council |
| DECREE 4.082 | 03/271995 | Approves the Water Resources Secretariat internal regime |
| DECREE 6.295 | 03/21/1997 | Regulates the Planning, Co-ordination System |
| DECREE 6.296 | 03/21/1997 | Deliberates over the Water Resources Law |
| **3. CEARÁ** | | |
| LAW 11.996 | 07/24/1992 | Establishes the Water Resources State Policy / Water Resources Integrated Management System – SIGERH |
| DECREE 14.535 | 07/02/1981 | Regulates the Preservation of Water Resources |
| DECREE 22.485 | 04/20/1993 | Approves the Water Resources Secretariat's Regulation |
| DECREE 23.039 | 02/01/1994 | Regulates the Water Resources State Council |
| DECREE 23.047 | 02/03/1994 | Regulates the Water Resources State Fund – FUNORH |
| DECREE 23.067 | 02/11/1994 | Regulates the Deliberation System on the Use of Water |
| DECREE 23.068 | 02/19/1994 | Regulates the technical control of water offer works |
| DECREE 24.264 | 11/12/1996 | Regulates the billing over water resources |
| DECREE 25.931 | 03/01/1999 | Regulates Basin Committees |
| DECREE 25.443 | 04/28/1999 | Deliberates on Water Resources Law |
| **4. DISTRITO FEDERAL** | | |
| LAW 55 | 11/24/1989 | Rules over the use of underground waters in the Federal District |
| LAW 512 | 07/28/1993 | |
| LAW 2.725 | 06/13/2001 | Establishes the Federal District Water Resources Policy and the Federal District Water Resources Management System. Revokes Law no. 512, of 28th July 1993 |
| DECREE 20.882 | 12/14/1999 | Regulates the Water Resources Council |
| DECREE 20.883 | 12/14/1999 | Regulates the Federal District Water Resources Information System ( (Regulation of Law 041/89) |
| DECREE 20.884 | 12/14/1999 | Regulates Article 21, Incised III of Law no. 512 of 28 July 1993 |
| DECREE 21.007 | 09/18/2000 | Deliberates on the Water Resources Law |
| ACT No. 01 | 03/20/2000 | Regulates the Federal District Water Resources Information System |

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| **5. ESPÍRITO SANTO** | | |
| LAW 5.818 | 12/30/1998 | Rules over the Water Resources State Policy and the Water Resources Management and Monitoring Integrated System – SIGERH/ES |
| DECREE 4.338-N | 09/24/1998 | Regulates the Construction and Regularisation of Dams and Reservoirs |
| **6. GOIÁS** | | |
| LAW 12.603 | 04/07/1995 | Establishes the Water Resources and Environment Secretariat, SEMARH |
| LAW 13.025 | 01/13/1997 | Regulates Fishing, aquaculture and protection of aquatic fauna |
| LAW 13.040 | 03/20/1997 | Establishes the Water and Mineral Resources 1995/1998 State Plan |
| LAW 13.061 | 05/09/1997 | Alters the Water and Mineral Resources 1995/1998 State Plan |
| LAW 13.123 | 07/16/1997 | Rules over the Water Resources State Policy |
| LAW 13.456 | 04/16/1999 | Establishes the Environment, Water Resources and Habitation Secretariat |
| LAW 13.583 | 01/11/2000 | Rules over the conservation and environmental protection of underground water deposits |
| ACT No. 130 | 04/22/1999 | Granting Instrument |
| **7. MARANHÃO** | | |
| LAW 7.052 | 12/22/1997 | Rules over the Water Resources State Policy and the Water Resources Integrated Management System |
| DECREE 16.679 | 01/04/1999 | Establishes the Quality of Life Management Organisation |
| **8. MATO GROSSO** | | |
| LAW 6.945 | 11/05/1997 | Rules over the Water Resources State Policy / Water Resources State System |
| LAW 7.083 | 12/23/1998 | |
| LAW 7.153 | 07/21/1999 | |
| LAW 7.663 | 12/30/1991 | Rules over the Water Resources State Fund - COFEHIDRO |
| DECREE 37.300 | 08/25/1993 | Regulates the Water Resources State Fund - COFEHIDRO |
| DECREE 2.545 | 09/14/1998 | Regulates the Water Resources State Council |
| DECREE 1.291 | 04/14/2000 | Rules over the Incised VI of Article 2 of Law no. 7.153 of 21.07.99, which alters paragraph 4 of article 1 of Law no. 7.083 if 23.12.98 / licensing of tubular wells |
| DECREE 2.548 | 05/10/2001 | Modifies Decree 2.545 of 14 September 1998 |
| **9. MINAS GERAIS** | | |
| LAW 11.516 | 12/30/1997 | |
| LAW 12.584 | 07/17/1997 | Alters the DRH denomination to read IGAM |
| LAW 13.194 | 01/29/1999 | Creates the Recovery, Protection and Sustainable Development of the Minas Gerais State Water Basins Fund – FHIDRO. |
| LAW 13.199 | 01/29/1999 | Rules over the Water Resources State Policy |
| LAW 13.771 | 12/11/2000 | Rules over the administration, protection and conservation of State-owned underground waters. |
| DECREE 40.055 | 11/16/1998 | Contains regulation related to the “Mineiro” Institute of Water Management – IGAM |
| DECREE Gerais 40.057 | 11/16/1998 | Regulates the inspection and control of water resources for Minas Institute of Water Management |
| ACT No. 01 IGAM | 04/04/2000 | |
| ACT No. 06 IGAM | 05/25/2000 | Deliberates on the right of use State-owned waters |
| **10. PARÁ** | | |
| LAW 5.457 | 05/11/1988 | Creates the Science, Technology and Environment State Secretariat – SECTAM |
| LAW 5.752 | 07/26/1993 | Rules over the re-organisation of SECTAM |
| LAW 5.793 | 01/04/1994 | Rules over the Mining and Water State Policy |

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| LAW 6.105 | 01/14/1998 | Rules over the conservation and protection of underground waters Deposits |
| DECREE 3.060 | 08/26/1998 | Reinforces Law no. 6.105, of 14 January 1998 |
| **11. PARAÍBA** | | |
| LAW 6.308 | 07/02/1996 | Rules over the Water Resources State Policy |
| LAW 6.544 | 10/20/1997 | Creates the Extraordinary Secretariat for the Environment, Water and Mineral Resources / new wording and revokes Provisions of Law no. 6.308, of 2nd July 1996 |
| DECREE 18.824 | 04/02/1997 | Reinforces the Water Resources State Council – CERH |
| DECREE 19.256 | 10/31/1997 | Regulates the Water Resources State Fund |
| DECREE 19.257 | 10/31/1997 | Regulates the Water Resources State Council – CERH |
| DECREE 19.259 | 10/31/1997 | Regulates the basic structure of the Extraordinary Secretariat for the Environment, Water and Mineral Resources |
| DECREE 19.260 | 10/31/1997 | Deliberates |
| **12. PARANÁ** | | |
| LAW 11.352 | 1966 | Establishes the Superintendence of Development, Water Resources and Environmental Sanitation (SUDERHSA) |
| LAW 12.726 | 11/26/1999 | |
| DECREE 2.314 | 07/18/2000 | Regulates the Water Resources State Council |
| DECREE 2.315 | 07/18/2000 | Regulates Basin Committees |
| DECREE 2.316 | 07/18/2000 | Regulates the participation of civil organisations of water resources next to the Water Resources Management State System |
| DECREE 2.317 | 07/18/2000 | Delegates SEMA's competence to SUDERHSA |
| ACT No. 5 SUDERHSA | 1966 | Rules over the control of deep underground waters for human use and consumption |
| ACT No. 6 SUDERHSA | 1966 | Deliberates |
| ACT No. 20 SUDERHSA | 1966 | Regulates the use and waters derivation owned by Paraná State |
| **13. PERNAMBUCO** | | |
| LAW 11.426 | 01/17/1997 | Rules over the Water Resources State Policy and the Water Resources State Plan / Water Resources Management Integrated System |
| LAW 11.427 | 01/17/1997 | Rules over the conservation and protection of underground waters |
| DECREE 20.269 | 12/24/1997 | Regulates the Water Resources State Policy / The Water Resources State Plan and the Water Resources Management Integrated System |
| DECREE 20.423 | 03/26/1998 | Reinforces Law no. 11.427 |
| DECREE 21.281 | 02/04/1999 | Establishes the basic structure for the Water Resources Secretariat |
| **14. PIAUÍ** | | |
| LAW 5.165 | 08/17/2000 | Rules over the Water Resources State Policy / Water Resources Management State System |
| **15. RIO DE JANEIRO** | | |
| LAW 3.239 | 08/02/1999 | Rules over the Water Resources State Policy / Water Resources Management State Policy |
| **16. RIO GRANDE DO NORTE** | | |
| LAW 6.908 | 07/01/1996 | Rules over the Water Resources State Policy / Water Resources Management Integrated System - SIGERH |
| DECREE 113.283 | 03/22/1997 | Regulates Incised III of Art. 4 of Law no. 6.908 |

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| DECREE 13.284 | 03/22/1997 | Regulates the Water Resources Management Integrated System |
| DECREE 13.285 | 03/22/1997 | Approves the Regulation of the Rio Grande do Norte State Water Resources Secretariat |
| DECREE 13.836 | 03/11/1998 | Regulates the Water Resources State Fund – FUNERH |
| **17. RIO GRANDE DO SUL** | | |
| LAW 10.350 | 12/30/1994 | Rules over the Water Resources State System / Art. 171 of the State Constitution |
| DECREE 36.055 | 07/04/1995 | Regulates Art. 7 of Law no. 10.350 |
| DECREE 37.033 | 11/21/1996 | Deliberates |
| DECREE 37.034 | 11/21/1996 | Regulates Art. 18 of Law no. 10.350 |
| RESOLUTION No. 1 CERH | 1997 | Waving of deliberation |
| **18. SANTA CATARINA** | | |
| LAW 6.739 | 12/16/1985 | Regulates the Water Resources State Council |
| LAW 9.022 | 05/06/1993 | Rules over the Water Resources Management State System |
| LAW 9.748 | 11/30/1994 | Rules over the Water Resources State Policy |
| LAW 10.644 | 01/07/1998 | Provides new wording to Article 2 of Law no. 6.739 |
| **19. SÃO PAULO** | | |
| LAW 6.134 | 06/02/1988 | Rules over the preservation of underground waters natural deposits |
| LAW 7.663 | 12/30/1991 | Rules over the Water Resources State Policy / the Water Resources Management Integrated System / Water Resources State Fund |
| LAW 9.034 | 12/27/1994 | Rules over the Water Resources 1994/1995 State Plan |
| LAW 9.866 | 11/28/1997 | Rules over the protection and recovery of sources |
| LAW 10.020 | 07/03/1998 | Authorises the Executive Power to participate in the formation of Basins Agencies |
| DECREE 27.576 | 11/11/1987 | Regulates the Water Resources State Council |
| DECREE 32.955 | 02/07/1991 | Reinforces Law no. 6.134/88 |
| DECREE 37.300 | 08/25/1993 | Regulates the Water Resources State Fund – FEHUDRO |
| DECREE 41.258 | 10/31/1996 | Deliberates on the Uses of Water Resources |
| DECREE 43.022 | 04/07/1998 | Reinforces Law no. 9.866/97 |
| ACT No. 717 DAEE | 12/12/1996 | Approves the rules and the annexes which discipline the use of water resources |
| **20. SERGIPE** | | |
| LAW 3.870 | 09/25/1997 | Rules over the Water Resources State Policy / the Water Resources Management Integrated System |
| DECREE 18.099 | 03/26/1998 | Regulates the Water Resources State Council – CONERH/SE |
| DECREE 18.456 | 12/03/1999 | Deliberates |
| DECREE 19.079 | 01/05/2000 | Regulates the Water Resources State Fund – FUNERH |
| **21. TOCANTINS** | | |
| DECREE 647 | 07/22/1998 | Regulates the Water Resources State Council |
| ACT 006 | 07/30/2001 | Deliberates on the right to use water resources |

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# glossary of the acronyms



**ABEMA** - Associação Brasileira de Entidades do Meio Ambiente

**ABINAM -** Associação Brasileira da Indústria de Águas Minerais

**ABNT** - Associação Brasileira de Normas Técnicas

**ABRASE** - Associação Brasileira de Criadores e Comerciantes de Animais Silvestres

**AC** - Acre

**ACAS** - Água Central do Atlântico Sul

Agência GTZ, do governo alemão,

**AGESPISA/PI -** Cia de Água e Esgoto do Piauí

**AL** – Alagoas

**ALL** - Companhia América Latina Logística

**AM** - Amazonas

**ANA** - Agência Nacional de Águas

**ANEEL** - Agência Nacional de Energia Elétrica

**ANFAVEA** - Associação Nacional dos Fabricantes de Veículos

**ANP –** Agência Nacional de Petróleo

**ANVISA** - Agência Nacional de Vigilância Sanitária

**AP** – Amapá

**APAs** - Áreas de Proteção Ambiental

**APPs** - Áreas de Preservação Permanente

**ATSDR** - Agency for Toxic Substances and Disease Registry

**AVADAN- BA –** Avaliação de Danos –BAHIA

**BA** - Bahia

**BDT** - Base de Dados Tropical

**BID -** Banco Interamericano de Desenvolvimento

**BIRD** - International Bank for Reconstruction and Development

**CAEMA/MA -** Companhia de Águas e Esgoto do Maranhão

**CAER/RR -** Companhia de Águas e Esgotos de Roraima

**CAER/RR** - Companhia de Águas e

Esgotos de Roraima

**CAERD/RO** - Companhia de Águas e Esgotos de Rondônia.

**CAERN/RN** - Companhia de Águas e Esgotos do Rio Grande do Norte

**CAESA/AP** – Companhia de Água e Esgoto do Amapá

**CAESB/DF** – Companhia de Água e Saneamento do Distrito Federal

**CAGECE/CE** - Companhia de Águas e Esgoto do Ceará

**CAGEPA/PB** - Companhia de Água e Esgoto da Paraíba

**CASAL/AL** - Companhia de Abastecimento D'Água e

**CASAN/SC** - Companhia Catarinense de Águas e Saneamento

**CCD –** Convenção das Nações Unidas para o Combate à Desertificação

**CDB** - Convenção sobre a Diversidade Biológica

**CDC –** Center for Disease Control

**CDM** - Clean Development Mechanism ou Mecanismo de Desenvolvimento Limpo

**CE** - Ceará

**CECAV -** Centro de Estudos de Cavernas

**CEDAE/RJ -** Companhia Estadual de Águas e Esgotos do Rio de Janeiro

**CEDEC/AC** - Coordenadoria Estadual de Defesa Civil do Acre

**CEDEC/AI** - Coordenadoria Estadual de Defesa Civil de Alagoas

**CEDEC/AM** - Coordenadoria Estadual de Defesa Civil do Amazonas

**CEDEC/AM** - Coordenadoria Estadual de Defesa Civil do Paraná

**CEDEC/AP** - Coordenadoria Estadual de Defesa Civil do Amapá

**CEDEC/BA -** Coordenadoria Estadual de Defesa Civil da Bahia

**CEDEC/CE** - Coordenadoria Estadual de Defesa Civil do Ceará

**CEDEC/ES** - Coordenadoria Estadual de Defesa Civil do Espírito Santo

**CEDEC/GO** - Coordenadoria Estadual de Defesa Civil de Goiás

**CEDEC/MA** - Coordenadoria Estadual de Defesa Civil do Maranhão

**CEDEC/MG** - Coordenadoria Estadual de Defesa Civil de Minas Gerais

**CEDEC/MS** - Coordenadoria Estadual de Defesa Civil do Mato Grosso do Sul

**CEDEC/MT** - Coordenadoria Estadual de Defesa Civil do Mato Grosso

**CEDEC/PA** - Coordenadoria Estadual de Defesa Civil do Pará

**CEDEC/PB** - Coordenadoria Estadual de Defesa Civil do Paraíba

**CEDEC/PE** - Coordenadoria Estadual de Defesa Civil do Pernambuco

**CEDEC/PI -** Coordenadoria Estadual de Defesa Civil de Piauí

**CEDEC/RN** - Coordenadoria Estadual de Defesa Civil do Rio Grande do Norte

**CEDEC/RO** - Coordenadoria Estadual de Defesa Civil de Rondônia

**CEDEC/RR** - Coordenadoria Estadual de Defesa Civil do Roraima

**CEDEC/RS** - Coordenadoria Estadual de Defesa Civil do Rio Grande do Sul

**CEDEC/SE** - Coordenadoria Estadual de Defesa Civil de Sergipe

**CEDEC/SP** - Coordenadoria Estadual de Defesa Civil de São Paulo

**CEDEC/TO** - Coordenadoria Estadual de Defesa Civil de Tocantins

**CEF** – Caixa Econômica Federal

**CEMAVE** - Centro de Pesquisa para a Conservação de Aves Silvestres

**CENAP** - Centro Nacional de Pesquisa para a Conservação dos Predadores Naturais

**CEPERG** – Centro de Pesquisa e Extensão pesqueira do Rio Grande

**CEPF** - Fundo de Parcerias para Ecossistemas Críticos Cerrados

**CESAN/ES** - Cia Espírito Santense de Saneamento

**CESP** - Companhia Energética de São Paulo

**CESTEH** – Centro de Estudos da Saúde do Trabalhador e Ecologia Humana

**CETEA** – Comitê De Ética Em Experimentação Animal

**CETEC-MG** - Centro Tecnológico de Minas Gerais

**CETEM –** Centro de Tecnologia Mineral

**CETESB** Companhia de Tecnologia de Saneamento Ambiental

**CGVAM**

**CIRM** - Comissão Interministerial para os Recursos do Mar

**CMMA** - Conselhos Municipais

de Meio Ambiente

**CNI** – Confederação Nacional da Indústria

**CNIR** – Cadastro Nacional de Informações Rurais

**CNUDM** - Convenção das Nações Unidas sobre o Direito do Mar

**CNUMAD** - Conferência das Nações Unidas sobre o Meio Ambiente e Desenvolvimento

**CODAR** - Codificação de Desastres, Ameaças e Riscos

**COMPESA/PE** - Compahia Pernambucana de Saneamento

**CONAMA** – Conselho Nacional do Meio Ambiente

**CONDEC** - Conselho Nacional de Defesa Civil

**CONIMA** – Conselho Nacional das Instituições de Mediação e Arbitragem

**CONTRAN** - Conselho Nacional de Trânsito

**COP** - Conferência das Partes - Órgão supremo da Convenção do Clima

**COPASA/MG** - Companhia de Saneamento de Minas Gerais

**COPPE** – Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa em Engenharia

**CORDEC/NE** - Coordenadoria Regional de Defesa Civil do Nordeste

**CORSAN/RS** - Companhia Riograndense de Saneamento

**COSAMA/AM** - Cia de Saneamento do Amazonas

**COSAN/PA** – Cia de Saneamento do Pará

**COSAVE** – Comitê de Sanidade Vegetal do Conesul

CPRM **– Companhia de Pesquisa de Recursos Minerais**

**CPT** – Comissão Pastoral da Terra

**CQNUMC** - Convenção Quadro das Nações Unidas sobre Mudança do Clima

**CSN** - Companhia Siderúrgica Nacional

**CTNBio** - Comissão Técnica Nacional Biossegurança

**DATASUS** - Banco de dados do Sistema Único de Saúde

**DEAS/AC –** Departamento Estadual de Água e Saneamento - Acre

**DESO/SE** - Cia de Saneamento de SERGIPE

**DF** - Distrito Federal

**DIDEC/SC** - Diretoria Estadual de Defesa Civil de Santa Catarina

**DNAEE –** Departamento Nacional de Energia Elétrica

**DNAPL's** – Dense Non Aqueous Phase Liquids

**DNPM -** Departamento Nacional de Produção Mineral

dos Cerrados

**DPC** - Diretoria de Portos e Costas da Marinha do Brasil

**DTCS** - Ductos e Terminais do Centro Sul

**EIA –** Estudo de Impacto Ambiental

**ELETROBRÁS** – Centrais Elétricas Brasileiras S.A.

**EMATER –** Empresa de Assistência Técnica e Extensão Rural

**EMBASA/BA –** Empresa Baiana de Águas e Saneamento

**Embraco** – Empresa Brasilera De Compressores

**EMBRAPA –** Empresa Brasileira de Pesquisa Agropecuária

**EMBRATUR** - Empresa Brasileira de Turismo

**ENSP** -Escola Nacional de Saúde Pública

**EPA** –Environmental Protection Agency

**ES** - Espírito Santo

**ESTATPESCA** - Programa de Estatística Pesqueira do IBAMA

**EUA** – Estados Unidos da América

**FAO** - Food and Agriculture Organization

**FEEMA** - Fundação Estadual de Engenharia do Meio Ambiente

**FIOCRUZ** - Fundação Oswaldo Cruz

**FMPM** – Fundo Multilateral para a Implementação do Protocolo de Montreal

**FNMA -** Fundo Nacional do Meio Ambiente

**FUNAI** – Fundação Nacional do Índio

**FUNASA** – Fundação Nacional de Saúde

**FUNDESPA** - Fundação de Estudos e Pesquisas Aquáticas

**GAU** - Gestão Ambiental Urbana (Projeto de cooperação técnica Brasil – Alemanha)

**GEACAP -** Grupo de Apoio às Calamidades Públicas

**GEF** - Fundo Mundial para o Meio Ambiente

**GERCO -** Gerenciamento Costeiro/ MMA

**GESAMP** – Group of Experts on Scientific Aspects of Marine Environmental Protection

**GO** - Goiás

**GTZ** - Deutsche Gesellschaft für Technische Zusammenarbeit / Agência Alemã de Cooperação Técnica

**GWP** - Global Warmimg Potential ou Potencial de Aquecimento Global

**IBAM** – Instituto Brasileiro de Administração Municipal

**IBAMA** - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis

**IBDF** - Instituto Brasileiro de Desenvolvimento Florestal

**IBGE** - Instituto Brasileiro de Geografia e Estatística

**IBRAM –** Instituto Brasileiro de Mineiração

**ICCAT** – International Commission for the Conservation of Atlantic Tunas

**IDH** - Índice de Desenvolvimento Humano

**INCQS** - Instituto Nacional de Controle de Qualidade em Saúde

**INCRA** - Instituto Nacional de Colonização e Reforma Agrária

**INMET** - Instituto Nacional de Meteorologia

**INPE** - Instituto Nacional de Pesquisas Espaciais

**IPCC** - Intergovermental Panel on Climate Change/ Painel Intergovernamental sobre Mudança Climática

**IPEA -** Instituto de Pesquisa e Economia Aplicada

**IPPUR** – Instituto de Pesquisa em Planejamento Urbano e Regional

**IPT –** Instituto de Pesquisas Tecnológicas

**ISER** - Instituto de Estudos da Religião

**ITR** - Imposto Territorial Rural

**IUCN** - União Internacional de Conservação da Natureza

**JICA –** Japan International Cooperation Agency . Agência de Cooperação Internacional do Japão

**LACESM** - Laboratório de Ciências Espaciais da Universidade Federal de Santa Maria

**LNAPL's** - Light Non Aqueous Phase Liquids

**MA** - Maranhão

**MA** - Ministério da Agricultura e do Abastecimento

**MCT** - Ministério de Ciência e Tecnologia

**MDF** –Medium Density Fiberboard

**MG** - Minas Gerais

**MI** - Ministério do Integração

**MMA** - Ministério do Meio Ambiente

**MME –** MINISTÉRIO DE MINAS E ENERGIA

**MMSD –** Mining, Minerals And Sustainable Developement Project/ Projeto Mineraçào Minerais e Desenvolvimento Sustentável

**MS** - Mato Grosso do Sul

**MS** - Ministério da Saúde

**MT** - Mato Grosso

**NBR** – Norma Brasileira

**NOPRED** - Notificação Preliminar de Desastres

**NUDEC** - Núcleo Comunitário de Defesa Civil

**OIMT** - Organização Internacional de Madeiras Tropicais

**OIMT** - Organização Internacional de Madeiras Tropicais

**OMM** - Organização Meteorológica Mundial

**OMS** - Organização Mundial de Saúde

**ONGs** - Organizações Não-Governamentais

**ONU** - Organização das Nações Unidas

**ONUDI** – Organização das Nações

**OPS** - Organização Panamericana da Saúde

**PA** - Pará

**PASS** - Programa de Ação Social em Saneamento

**PB** - Paraíba

**PBCO** - Programa Brasileiro de Eliminação da Produção e Consumo das substâncias que Destroem a Camada de Ozônio

**PBCO –** Programa Brasileiro de Eliminação e do Consumo de Substâncias que Destroem a Camada de Ozônio

**PCA –** Plano de Controle Ambiental

**PCD"s –** Plataformas de Coleta de Dados

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**PCS** - Programa Comunidade Solidária

**PD-A** - Projetos Demonstrativos

**PD-I** - Projetos Demonstrativos em Terras Indígenas

**PDM –** Planos Diretores de Mineraçào

**PE** - Pernambuco

**PEA** - População Economicamente Ativa

**PETROBRAS** – Petróleo Brasileiro S.A.

**PI** - Piauí

**PIB** - Produto Interno Bruto

**PLANASA –** Plano Nacional de Saneamento

**PLIRHNE** – Plano Integrado de Recursos Hídricos do Nordeste

**PMSS** - Programa de Modernização do Setor Saneamento

**PNAD** - Pesquisa Nacional por Amostra de Domicílios

**PNB** - Produto Nacional Bruto per capita

**PNCD** – Política Nacional de Combate à Desrtificação

**PNF** - Programa Nacional de Florestas

**PNMA –** Programa Nacional do Meio Ambiente

**PNMT** - Programa Nacional de Municipalização do Turismo

**PNSB** - Pesquisa Nacional de Saneamento Básico

**PNUD** – Programa das Nações Unidas para o Desenvolvimento

**PNUMA -** Programa das Nações Unidas para o Meio Ambiente

**POLOCENTRO** – Programa de Desenvolvimento dos

**PPA** - Programação Orçamentária Plurianual

**PP-G7** - Programa Piloto de Proteção às Florestas Tropicais

**PPTAL** - Projetos de Proteção e Demarcação de Terras Indígenas

**PQA** – Projeto Qualidade das Águas e Controle da Poluição Hídrica

**PR** - Paraná

**PRISMA** - Programa de Reestruturação Institucional do Setor Mineral

**PRMI** - Redução da Mortalidade na Infância

**PROALCOOL** - Programa do Álcool

**PROBIO** – Programa de Conservação e Utilização Sustentável da Diversidade Biológica Brasileira

**PROCEL** – Programa Nacional de Conservação de Energia Elétrica

**PROCONVE** - Programa de Controle das Emissões de Veículos Automotores

**PRODECER** – Programa de Cooperação Nipo-Brasileira para o Desenvolvimento

**PRODES** - Projeto de Desflorestamento

Programa de Atenção à Saúde da Família

**PRO-INFRA** - Programa de Infra-estrutura urbana

**PRONAF** – Programa de Fortalecimento Da Agricultura Familiar

**PRONAR** - Programa Nacional de Controle da Qualidade do Ar

**PRONEA –** Programa Nacional de Educação Ambiental

**PROZON** - Comitê Executivo Interministerial

**PROZONESP** - Programa Estadual de Prevenção à Destruição da Camada de Ozônio em São Paulo

**PSRM** - Plano Setorial para os Recursos do Mar

**RAN** - Centro de Conservação e Manejo de Répteis e Anfíbios

**RECA** – Projeto de Reflorestamento Consorciado e Adensado

**REDEH** - Rede de Desenvolvimento Humano

**REDESERT** – Rede de Informação e Documentação Sobre Desrtificação

**REMAN** - Refinaria de Manaus no Estado do Amazonas

**REPAR** - Refinaria Presidente Getúlio Vargas

**REVIZEE** - Programa de Avaliação do Potencial Sustentável de Recursos Vivos na Zona Econômica Exclusiva

**RGR** - Reserva Global de Reversão

**RIMA** – Relatório de Impacto Ambiental

**RIPSA -** Rede Interagencial de Informações para a Saúde

**RJ** - Rio de Janeiro

**RMSP** - Região Metropolitana de São Paulo

**RN** - Rio Grande do Norte

**RO** - Rondônia

**RPPN** - Reservas Particulares do Patrimônio Natural

**RR** - Roraima

**RS** - Rio Grande do Sul

**SABESP** - Companhia de Saneamento Básico do Estado de São Paulo

**SANEAGO/GO** - Companhia de Saneamento de Goiás

Saneamento do Estado de Alagoas

**SANEATINS/TO** – Companhia de Saneamento de Tocantins

**SANEMA/MT** – Companhia de Saneamento do Estado do Mato Grosso

**SANEPAR/PR** – Companhia de Saneamento do Paraná

**SANESUL/MS** - Empresa de Saneamento do Mato Grosso do Sul

**SC** - Santa Catarina

**SCDI –** Satélite de Coleta de Dados Brasileiros

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**SDOs** - Substâncias Controladas ou Substâncias que Destroem a Camada de Ozônio

**SE** - Sergipe

**SEDEC** - Secretaria de Estado de Defesa Civil do Rio de Janeiro

**SEDU/PR** - Secretaria Especial de Desenvolvimento Urbano da Presidência da República

**SESIDEC /DF** - Secretaria Executiva de Defesa Civil do Distrito Federal

**SINDEC** - Sistema Nacional de Defesa Civil

**SINDESB** - Sistema de Informações sobre Desastres no Brasil

**SINITOX** - Sistema Nacional de Informação Tóxico-Farmacológica

**SISNAMA –** Sistema Nacional de Meio Ambiente

**Sivam** - Sistema de Vigilância da Amazônia

**SMA** - Secretaria do Meio Ambiente

**SMM –** Secretaria de Minas e Metalurgia

**SNIS –** Sistema Nacional de Informações Sobre Saneamento

**SNUC** – Sistema Nacional de Unidades de Conservação

**SP** - São Paulo

**SPIR** – Metodologia adotada pelos documentos da série GEO (estado, pressões, impactos e respostas)

**SPU** – Secretaria De Patrimônio Da União

**SQA** – Secretaria de Qualidade Ambiental nos Assentamentos Humanos

**SRES** - Special Report on Emission Scenarios ou Relatório Especial sobre Cenários de Emissões

**SRF** – Secretaria da Receita Federal

**SRH** - Secretaria Nacional de Recursos Hídricos

**STD** - Sólidos Totais Dissolvidos

**SUDENE** - Superintendência do Desenvolvimento do Nordeste

**SUDEPE** - Superintendência do Desenvolvimento da Pesca

**TAMAR** - Centro Nacional de Conservação e Manejo das Tartarugas Marinhas

**TCA** - Tratado de Cooperação Amazônica

**TCU** - Tribunal de Contas da União

**TEBAR** – Terminal Marítimo Almirante Barroso

**TI** - Terras Indígenas

**TO** - Tocantins

**Ucs** – Unidades de Conservação Ambiental

**UFPA** - Universidade Federal do Pará

**UFRJ** – Universidade Federal do Rio de Janeiro

**UFSC** - Universidade Federal de Santa Catarina

**UGRHI** – Unidade de Gerenciamento dos Recursos Hídricos Integrado

**UNCCD –** CONVENÇÃO DAS NAÇÕES UNIDAS DE COMBATE À DESERTIFICAÇÃO

**UNCED** - United Nations Conference on Environment and Development

**UNCSD** - United Nations Common Supply Database

**UNESCO** – United Nations Educational, Scientific and Cultural Organization

**UNFCCC** - United Nations Framework Conference on Climate Change

**UNICAMP** - Universidade de Campinas

**UNICEF** – United Nations Children's Fund

Unidas para o Desenvolvimento Industrial

**USP** - Universidade São Paulo

**WBCSD –** Conselho Empresarial Mundial para o Desenvolvimento Sustentável

**WGI** - Working Group I – Grupo de trabalho de cientistas que estuda os aspectos científicos do sistema climático e da mudança climática

**WGII** - Working Group II – Grupo de trabalho de cientistas que avalia a vulnerabilidade da humanidade e dos sistemas naturais às mudanças climáticas

**WGIII** - Working Group III – Grupo de trabalho de cientistas que analisa as possibilidades de limitação de emissão de GEE e de mitigação da mudança climática e as conseqüências destas medidas do ponto de vista sócio-econômico.

**WWF** – World Wild Foudation  Fundo Mundial para Natureza

**ZEE** – Zoneamento Ecológico-Econômico